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FINAL

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
IROQUOIS GAS/WESTWOOD PHARMACEUTICALS SITE #915141

FEASIBILITY STUDY

VOLUME II

February 1994

Prepared by:
GeoTrans, Inc.
Sterling, Virginia

915141

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Iroquois Gas/Westwood Squibb
Feasibility Study
Volume II

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Abbreviations

ACLs	Alternative Cleanup Levels
ARARs	Applicable Relevant and Appropriate
BAT	Best Available Technology
BCT	Best Conventional Technology
BPJ	Best Professional Judgement
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CAA	Clean Air Act
CPAHs	Carcinogenic Polycyclic Aromatic Hydrocarbons
CERCLA	Comprehensive
CFR	Code of Federal Register
CWA	Clean Water Act
DOT	Department of Transportation
EPA	Environmental Protection Agency
FS	Feasibility Study
IG/WS	Iroquois Gas/Westwood Squibb
MCLs	Maximum Contaminant Levels
MCLGs	Maximum Contaminant Level Goals
NCP	National Contingency Plan
NPDES	National Pollution Discharge Elimination System
NYSDEC	New York State Department of Environmental Conservation
PAHs	Polycyclic Aromatic Hydrocarbons
POTW	Publicly owned treatment works
RAOs	Remedial Action Objectives
ROD	Record of Decision
SCGs	Standards, Criteria, and Guidelines
SDWA	Safe Drinking Water Act
SPDES	State Pollution Discharge Elimination System
SWDA	Solid Waste Disposal Act
TAGM	Technical and Administrative Guidance Memorandum
TBCs	To be considered
UIC	Underground Injection Control

8 IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

8.1 INTRODUCTION

Section 121(d)(1) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) as enacted in the Superfund Amendment and Reauthorization Act (SARA) in 1986, states that remedial actions at contaminated sites must reach a degree of cleanup that assures protection of human health and the environment. In addition, after a CERCLA remedial action is completed, the levels of any hazardous substances, pollutants, or contaminants that are left on site must meet or exceed the standards, requirements, limitations, or criteria that are "applicable or relevant and appropriate" (ARAR) under the circumstances of the release or threatened release. These ARARs may be waived only for those instances outlined in Section 121(d)(4) of CERCLA.

Both state and federal laws can be considered ARARs. As outlined in Section 121(d)(2), the federal ARARs for a site may include such environmental laws as the Clean Air Act, the Clean Water Act, the Solid Waste Disposal Act, and the Safe Drinking Water Act. State ARARs might include any requirements under a state's environmental laws that are more stringent than federal requirements and which have been formally promulgated as laws or regulations.

The requirements of federal and state laws are generally identified and applied to remedial actions at hazardous waste sites as outlined in the CERCLA Compliance with Other Laws Manual Part 1, Draft (OSWER Directive 9234.1-01) and Part 2, Interim Final (EPA/540/G-89/009). ARARs are identified by first determining if a requirement is applicable, and then, if it is applicable, determining if it is both relevant and appropriate. The following definitions of ARAR requirements are presented in the guidance documents:

- Applicable requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant or contaminant, remedial action, location, or other circumstances at a CERCLA site.

- Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. For example, requirements may be relevant and appropriate if they would be "applicable" but for jurisdictional restrictions associated with the requirements.

The relevance and appropriateness of a requirement can be judged on the basis of the type of remedial action, the hazardous substances in question, and the physical situation of the site. Only some portions of a requirement may be relevant and appropriate for a given remedial action. However, any requirement or portion of a requirement that is determined to be relevant and appropriate may be treated as if it were applicable.

The three types of ARARs are chemical-specific ARARs, location-specific ARARs, and action-specific ARARs. Chemical-specific ARARs limit concentrations of specific contaminants in the environment. For example, Maximum Concentration Limits (MCLs) are a federal ARAR for any water which might be used for drinking purposes. Location-specific ARARs set restrictions on certain site activities based on the physiographic characteristics of the site. These include restrictions on activities within wetlands, floodplains, and historic sites. Action-specific ARARs are limits based on the remedial technologies which are under consideration. Examples include Resource Conservation and Recovery Act (RCRA) regulations for waste treatment, storage, and disposal.

Distinguished from the three types of ARARs are federal and state government advisories or guidance that are not legally binding and are not potential ARARs. However, these TBCs (guidelines which are to be considered), may be evaluated along with ARARs in assessing the necessary level of site cleanup. The following sections discuss the potential ARARs and TBCs identified for the Iroquois Gas/Westwood Squibb (IG/WS) site.

8.2 CHEMICAL-SPECIFIC ARARs AND TBCs

Chemical-specific ARARs for chemicals of concern in the designated media set levels that are considered protective of human health and the environment. These ARARs may also indicate acceptable discharge levels for remedial actions, if discharge occurs as part of a remedial activity. If a chemical is covered by more than one ARAR, normally the most stringent requirement must be met. Most criteria are not applicable if background concentrations exceed them. The conditions for applying this exclusion vary somewhat from standard to standard.

The media of potential concern at the IG/WS site are groundwater, surface soil, and subsurface soil. Federal regulations and standards that are potential ARARs include the Safe Drinking Water Act (SDWA), Clean Water Act (CWA), the Solid Waste Disposal Act (SWDA) and the Clean Air Act (CAA). New York State pollution control regulations that supersede or supplement federal standards are also potential ARARs. (State ARARs must meet or exceed federal standards.)

The contaminants which were detected in groundwater are presented in Table 8-1, which includes contaminant levels and their corresponding potential chemical-specific ARARs. The contaminants which were detected in surface soil are presented in Table 8-2, and those which were detected in subsurface soil are presented in Table 8-3. Tables 8-2 and 8-3 also include contaminant levels and their corresponding potential chemical-specific ARARs. Table 8-4 presents the potential chemical-specific ARARs and an evaluation of their applicability or relevance and appropriateness to the site.

The chemical-specific ARARs for each proposed remedial alternative will depend on the remedial technology employed. Specific ARARs for each alternative are discussed in Chapter 10 as part of the detailed evaluation of each alternative. Several chemical-specific ARARs that generally apply to remedial alternatives are discussed below.

Table 8-1. Chemicals of potential concern detected in groundwater (μg/l).

Compound	Minimum	Geometric	Maximum	NYS Water	MCLs	MCLGs	HAL[1]
ORGANICS:							
Benzene	14.0	27.0	310.0	0.7	5	zero	
Di-n-butylphthalate	1.0		2.0	50.0			
Dibenzofuran	5.0	7.4	53.0				
2,4-Dimethylphenol	3.0	5.8	20.0	5.0[2]			
Ethyl benzene	46.0	30.0	710.0	5.0[2]	700	700	700
Benzo(a)anthracene	3.0	11.0	410.0		0.1	zero	
Benzo(a)pyrene	2.0	9.6	310.0	ND	0.2	zero	
Benzo(b)fluoranthene	2.0	8.1	160.0		0.2	zero	
Benzo(k)fluoranthene	11.0	9.5	200.0		0.2	zero	
Chrysene	2.0	10.0	380.0		0.2	zero	
Dibenz(a,h)anthracene	38.0	6.7	38.0		0.3	zero	
Indeno(1,2,3-c,d)pyrene	5.0	7.2	67.0		0.4	zero	
Acenaphthylene	9.0	14.0	81.0				
Acenaphthene	1.0	34.0	830.0	20.0			
Anthracene	9.0	17.0	580.0				
Benzo(g,h,i)perylene	7.0	7.8	79.0				

Table 8-1. Chemicals of potential concern detected in groundwater ($\mu g/l$) (continued).

Compound	Minimum	Geometric	Maximum	NYS Water	MCLs	MCLGs	HAL[1]
Fluoranthene	1.0	9.3	640.0				
Fluorene	3.5	27.0	560.0				
2-Methylnaphthalene	2.0	41.0	580.0	5.0[2]			
Naphthalene	18.0	83.0	2,900.0	10.0[3]			
Phenanthrene	4.0	36.0	1,500.0				
Pyrene	3.0	15.0	1,000.0				
Phenol	18.0	6.2	18.0				4,000
Toluene	20.0	10.0	170.0	5.0[2]	1,000	1,000	1,000
o-Xylene	15.0	26.0	260.0	5.0[2]	10,000	10,000	10,000
(m+p)Xylene	7.0	30.0	400.0	5.0[2]	10,000	10,000	10,000
INORGANICS:							
Antimony	44.8	29.0	44.8		6	6	3
Barium	74.8	36.0	551.5	1,000.0	2,000	2,000	2,000
Calcium	77,800.0	180,000.0	415,000.0				
Chromium[4]	2.6	2.3	22.6	50.0[3]	100	100	100
Cyanide	28.1	74.0	433.0	100.0	200	200	200

Table 8-1. Chemicals of potential concern detected in groundwater (µg/l) (continued).

Compound	Minimum	Geometric	Maximum	NYS Water	MCLs	MCLGs	HAL[1]
Iron	95.8	660.0	12,950.0	300.0			
Magnesium	24,900.0	81,000.0	574,000.0				
Manganese	70.2	380.0	848.0	300.0		200	
Potassium	7,020.0	3,300.0	8,210.0			50	
Selenium	1.5	0.9	1.5	10.0	50		100
Silver	3.6	6.0	23.0	50.0			
Sodium	13,700.0	38,000.0	166,000.0				
Zinc	3.8	3.1	9.5	300.0			2,000

Notes:
[1] EPA Health Advisory Limits for lifetime ingestion for a 70kg adult
[2] Principle Organic Contaminant, as defined in 6NYCRR Section 700.1
[3] Surface Water Standard
[4] Hexavalent chromium
MCLs, MCLGs, and HALs are taken from drinking water regulations and health advisories, USEPA Office of Water, May 1993.

Table 8-2. Chemicals of potential concern detected in surface soil ($\mu g/kg$).

Compound	Minimum Detected	Geometric Mean	Maximum Detected	NYS Soil[1] Guidelines
ORGANICS:				
Benzyl alcohol	130.0		130.0	
4-Chloroaniline	110.0		110.0	220 or MDL
Chloroform	1.0	2.1	3.0	300
Di-n-butylphthalate	97.0	110.0	130.0	8,100
Dibenzofuran	83.0	340.0	770.0	6,200
cis-1,2-Dichloroethene	2.5	2.9	4.0	
bis(2-Ethylhexyl)phthalate	820.0	230.0	820.0	50,000
Methylene Chloride	2.0	3.3	16.0	100
Benzo(a)anthracene	80.0	1,500.0	14,400.0	220 or MDL
Benzo(a)pyrene	460.0	1,800.0	18,650.0	610 or MDL
Benzo(b)fluoranthene	270.0	1,700.0	22,800.0	1,100
Benzo(k)fluoranthene	360.0	1,500.0	37,000.0	1,100
Chrysene	130.0	1,800.0	18,800.0	400
Dibenz(a,h)anthracene	92.0	460.0	2,500.0	14 or MDL
Indeno(1,2,3-c,d)pyrene	205.0	1,200.0	17,600.0	3,200
Acenaphylene	110.0	620.0	7,900.0	41,000

Table 8-2. Chemicals of potential concern detected in surface soil (μg/kg) (continued).

Compound	Minimum Detected	Geometric Mean	Maximum Detected	NYS Soil[1] Guidelines
Acenaphthene	250.0	430.0	1,100.0	50,000
Anthracene	92.0	660.0	8,400.0	50,000
Benzo(g,h,i)perylene	880.0	1,400.0	25,500.0	50,000
Fluoranthene	170.0	1,600.0	9,000.0	50,000
Fluorene	370.0	430.0	1,100.0	50,000
2-Methylnaphthalene	120.0	360.0	960.0	36.4
Naphthalene	260.0	470.0	1,100	50,000
Phenanthrene	98.0	1,000.0	6,000.0	50,000
Pyrene	150.0	2,500.0	20,000.0	50,000
Phenol	370.0	360.0	370.0	30 or MDL
Tetrachloroethene	4.0	3.0	4.0	1,500
Toluene	1.0		1.0	800
Trichloroethene	1.0	2.9	6.0	700
(m+p)Xylene	3.0	2.7	3.0	1,200
INORGANICS:				
Aluminum	2,180.0	8,400.0	21,100.0	30,000 or SB

Table 8-2. Chemicals of potential concern detected in surface soil (μg/kg) (continued).

Compound	Minimum Detected	Geometric Mean	Maximum Detected	NYS Soil[1] Guidelines
Antimony	3.6	3.8	4.8	30,000 or SB
Arsenic	1.8	2.1	14.7	7,500 or SB
Barium	14.0	78.0	159.0	300,000 or SB
Beryllium	0.6	1.0	3.2	140
Cadmium	0.5	0.6	1.0	1,000 or SB
Calcium	53,800.0	87,000.0	206,000.0	SB
Chromium	4.2	15.0	45.2	10,000 or SB
Cobalt	6.5	6.2	11.8	30,000 or SB
Copper	9.3	20.0	57.2	25,000 or SB
Cyanide	9.3	20.0	57.2	N/A
Iron	638.0	10,000.0	57,000.0	2,000,000 or SB
Lead	9.9	79.0	352.0	30,000 or SB
Magnesium	10,100.0	28,000.0	102,000.0	SB
Manganese	338.0	590.0	2,290.0	SB
Mercury	0.2	0.1	43.9	100
Nickel	4.9	15.0	28.6	13,000 or SB
Potassium	1,100.0	1,900.0	4,090.0	4,000,000 or SB

Table 8-2. Chemicals of potential concern detected in surface soil (µg/kg) (continued).

Compound	Minimum Detected	Geometric Mean	Maximum Detected	NYS Soil[1] Guidelines
Selenium	0.4	1.3	6.0	2,000 or SB
Thallium	0.1	0.1	0.1	20,000 or SB
Vanadium	14.2	12.0	43.8	150,000 or SB
Zinc	35.1	76.0	361.0	20,000 or SB

Notes:
[1] As presented in NY State Dept. of Environmental Conservation Technical and Administrative Guidance Memorandum dated November 16, 1992.
[2] MDL is minimum detection limit
[3] SB is site background

Table 8-3. Chemicals of potential concern detected in subsurface soils (μg/kg).

Compound	Minimum Detected	Geometric Mean	Maximum Detected	NYS Soil[1] Guidelines
ORGANICS:				
Acetone	4.0	38.0	1,400.0	200
Benzene	1.0	55.0	90,000.0	60
Benzoic Acid	110.0	160.0	290.0	2,700
2-Butanone	1,100.0	49.0	57,000.0	300
Butylbenzylphthalate	50.0		50.0	50,000
Carbon Disulfide	15.0	3.5	15.0	2,700
4-Chloroaniline	110.0		110.0	220 or MDL
Chlorobenzene	180.0	4.5	180.0	1,700
Chloroform	1.0	1.8	3.0	300
Di-n-butylphthalate	110.0		110.0	8,100
Dibenzofuran	88.0	1,100.0	250,000.0	6,200
1,2-Dichlorobenzene	120.0		120.0	8,500
1,2-Dichloroethane	330.0	4.6	330.0	100
cis-1,2-Dichloroethane	2.0	3.1	4.0	
2,4-Dinitrotoluene	120.0	620.0	18,000.0	200 or MDL
bis(2-ethylhexyl)phthalate	130.0	100.0	400.0	50,000

Table 8-3. Chemicals of potential concern detected in subsurface soils (μg/kg) (continued).

Compound	Minimum Detected	Geometric Mean	Maximum Detected	NYS Soil[1] Guidelines
Methylene Chloride	2.0	32.0	29,000.0	100
4-Nitrophenol	130,000.0	3,000.0	130,000.0	100 or MDL
Ethylbenzene	2.0	76.0	480,000.0	5,500
Benzo(a)anthracene	97.0	2,600.0	780,000.0	220 or MDL
Benzo(a)pyrene	120.0	2,700.0	580,000.0	61 or MDL
Benzo(b)fluoranthene	85.0	2,000.0	390,000.0	1,100
Benzo(k)fluoranthene	130.0	2,200.0	390,000.0	1,100
Chrysene	100.0	2,800.0	730,000.0	400
Dibenz(a,h)anthracene	140.0	780.0	21,000.0	14 or MDL
Indeno(1,2,3-c,d)pyrene	190.0	1,800.0	190,000.0	3,200
Acenaphthylene	150.0	1,800.0	710,000.0	41,000
Acenaphthene	120.0	2,400.0	2,300,000.0	50,000
Anthracene	76.0	2,400.0	1,500,000.0	50,000
Benzo(g,h,i)perylene	99.0	1,800.0	260,000.0	50,000
Fluoranthene	91.0	3,500.0	1,400,000.0	50,000
Fluorene	110.0	2,400.0	1,400,000.0	50,000
2-Methylnaphthalene	130.0	3,000.0	4,900,000.0	36,400

Table 8-3. Chemicals of potential concern detected in subsurface soils (μg/kg) (continued).

Compound	Minimum Detected	Geometric Mean	Maximum Detected	NYS Soil[1] Guidelines
Naphthalene	93.0	4,000.0	5,800,000.0	50,000
Phenanthrene	92.0	4,100.0	3,100,000.0	50,000
Pyrene	140.0	5,000.0	2,000,000.0	50,000
Styrene	350.0	11.0	1,200.0	1,400
Tetrachloroethene	2.5	3.2	4.0	1,500
Toluene	5.0	44.0	150,000.0	800
1,1,1-Trichloroethane	2.0	24.0	11,000.0	800
Trichloroethene	2.0	3.2	9.0	700
o-Xylene	3.5	56.0	170,000.0	1,200
(m+p)Xylene	4.0	65.0	210,000.0	1,200
INORGANICS:				
Aluminum	2,520.0	16,000.0	53,200.0	30,000 or SB
Antimony	3.6	2.5	3.6	30,000 or SB
Arsenic	0.6	6.1	22.6	7,500
Barium	16.8	130.0	2,070.0	300,000 or SB
Beryllium	0.4	1.0	2.0	140

Table 8-3. Chemicals of potential concern detected in subsurface soils (μg/kg) (continued).

Compound	Minimum Detected	Geometric Mean	Maximum Detected	NYS Soil[1] Guidelines
Cadmium	0.5	0.7	32.8	1,000 or SB
Calcium	2,550.0	31,000.0	95,500.0	SB
Chromium	11.0	22.0	57.2	10,000 or SB
Cobalt	5.8	12.0	25.6	30,000 or SB
Copper	9.1	30.0	234.0	25,000 or SB
Cyanide	1.4	1.0	270.0	N/A
Iron	1,560.0	23,000.0	54,700.0	2,000,000 or SB
Lead	8.7	40.0	865.0	30,000 or SB
Magnesium	735.0	11,000.0	36,000.0	SB
Manganese	45.1	430.0	975.0	SB
Mercury	0.1	0.1	97.9	100
Nickel	9.5	25.0	56.5	13,000 or SB
Potassium	207.0	2,900.0	8,140.0	4,000,000 or SB
Selenium	0.4	0.8	49.8	2,000 or SB
Silver	13.8	0.2	13.8	200,000
Sodium	164.0	230.0	839.0	3,000,000 or SB
Thallium	0.2	0.1	1.6	20,000 or SB

Table 8-3. Chemicals of potential concern detected in subsurface soils (μg/kg) (continued).

Compound	Minimum Detected	Geometric Mean	Maximum Detected	NYS Soil[1] Guidelines
Vanadium	7.8	28.0	66.2	150,000 or SB
Zinc	45.5	110.0	5,630.0	20,000 or SB

Notes:
[1] As presented in NY State Department of Environmental Conservation Technical and Administrative Guidance Memorandum, dated November 16, 1992
[2] MDL is minimum detection limit
[3] SB is site background

Table 8-4. Chemical-Specific ARARs.

Standard Requirement, Criterion, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Federal Contaminant-Specific ARARs				
Safe Drinking Water Act (SDWA)	40 USC Sect. 300			
National Primary Drinking Water Standards (MCLs)	40 CFR Part 141	Establishes health-based standards for public water systems (maximum contaminant levels).	No/Yes	The MCLs for organic and inorganic contaminants may be relevant and appropriate for the remediation of groundwater contamination.
Maximum Contaminant Level Goals (MCLGs)	40 CFR 141.50 141.51	Establishes drinking water quality goals set at levels of no known or anticipated adverse health effects, with an adequate margin of safety.	No/No	MCLGs should be treated as "to be considered (TBC)"
Clean Water Act (CWA)	33 USC Sect. 1251-1376			
Toxic Pollutant Effluent Standards	40 CFR Part 129	Establishes effluent standards or prohibitions for certain toxic pollutants: aldrin/dieldrin, DDT, endrin, toxaphene, benzidine, PCBs.	No/No	These pollutants are not present on the site at levels above CLP detection limits.
Ambient Water Quality Criteria Guidelines (AWQCG)	40 CFR Part 131 Quality Criteria for Water, 1976, 1980, 1986.	Sets criteria for water quality based on toxicity to aquatic organisms and human health.	No/No	AWQCGs should be treated as TBCs.
Solid Waste Disposal Act (SWDA)	40 USC Sect. 6901-6987			

Table 8-4. Chemical-Specific ARARs (continued).

Standard Requirement, Criterion, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Identification and Listing of Hazardous Waste	40 CFR Part 261	Defines those solid wastes which are subject to regulations as hazardous wastes under 40 CFR Parts 262-265 and Parts 124, 270, and 271.	Yes/-	Some materials at the IG/WS MGP site are considered RCRA wastes.
Land Disposal	40 CFR Part 268	Establishes a timetable for restriction of burial of hazardous wastes and other hazardous materials.	Yes/-	Some materials at the IG/WS MGP site are considered RCRA wastes.
Clean Air Act	42 USC Sect. 7401-7642			
National Primary and Secondary Ambient Air Quality Standards (NAAQS)	40 CFR Part 50	Establishes standards for ambient air quality to protect public health and welfare.	Yes/Yes	No air emissions are anticipated during remedial actions.
State Contaminant-Specific ARARs				
New York State Water Quality Regulations	6NYCRR Part 703	Establishes standards for groundwater quality.	Yes/-	These regulations are applicable to any groundwater contaminated above New York State Action levels.
New York State Recommended Soil Cleanup Objectives	Technical and Administrative Guidance Memorandum (November 16, 1992)	Establishes goals for cleanup of contaminated soils.	No/No	Should be treated as TBCs.

8.2.1 Federal Safe Drinking Water Act Maximum Contaminant Levels

MCLs are Federal standards for public drinking water supplies. USEPA has stated that MCLs are applicable or relevant and appropriate to groundwater which is or may be used as a drinking water source. As discussed in Chapter 6, the groundwater present in the fill aquifer at the site is not, and most probably will not, be used as a drinking water source because: 1) all residences in the area are connected to the municipal water supply, and 2) the low yield of the unconfined system makes it unlikely that a drinking water well would be installed in the future for domestic use. However, MCLs will be evaluated as part of this ARARs analysis. The MCLs which have been established or proposed for the contaminants which have been detected at the site are included in Table 8-1.

8.2.2 Maximum Contaminant Level Goals

MCLGs are non-enforceable health goals for public drinking water (40 CFR 141.50-141.51) and thus are TBCs. MCLGs have been calculated to determine contaminant levels that would result in no known or anticipated adverse health effects. These levels are then corrected using uncertainty factors to set levels that provide a reasonable margin of safety for the entire population. MCLGs for probable human carcinogens are set at zero, while MCLGs for other contaminants are based on chronic toxicity or other data.

Table 8-1 includes MCLGs which have been established, proposed, or drafted for contaminants detected at the site.

8.2.3 New York State Rules for Determining Cleanup Actions

8.2.3.1 Soil

Soil cleanup objectives are outlined in a New York State Department of Environmental Conservation (NYSDEC) Technical and Administrative Guidance Memorandum (TAGM) dated November 16, 1992. The TAGM, an internal guidance document that has not been officially promulgated, outlines recommended soil cleanup levels based on human health (direct contact with soil) and concentrations which are protective of water quality. Soil cleanup levels are included in Tables 8-2 and 8-3. These soil cleanup levels are considered as TBCs.

8.2.3.2 Groundwater

The NYSDEC Water Quality Regulations for Surface Waters and Groundwaters (6NYCRR Parts 700-705) promulgate contaminant limits for surface water and groundwater. For the purpose of this analysis, the water in the fill aquifer beneath the site is considered to be Class GA, fresh groundwater (i.e., a source of potable water, 6NYCRR Section 701.15). Surface water and groundwater quality standards are defined in 6NYCRR Part 703. Limits for contaminants detected at the site are included in Table 8-1.

8.3 LOCATION-SPECIFIC ARARs AND TBCs

Location-specific ARARs are protective of sensitive locations such as wetlands, historical sites, floodplains, and sensitive habitats. These ARARs may restrict the concentration of a contaminant in the sensitive location. These ARARs may also restrict or regulate the types of remedial activities that can be performed in the sensitive location.

Table 8-5 presents the potential location-specific ARARs. None were identified for the site, because it is not located in any of the critical areas regulated by the location-specific ARARs.

8.4 ACTION-SPECIFIC ARARs AND TBCs

Action-specific requirements are established for remedial actions, rather than specific contaminants. They may determine performance levels, remedial actions, or technologies. They may also specify discharge limits or post-closure residual contaminant limits.

Table 8-6 lists the potential action-specific ARARs for the site. The action-specific ARARs for each alternative will depend upon the remedial action employed at the site. Some action-specific ARARs that normally apply to remedial alternatives are discussed below. The specific ARARs for each alternative will be determined in Chapter 10, during the detailed evaluation of each alternative.

Table 8-5. Location-Specific ARARs.

Location	Citation	Requirement	Applicable/Relevant and Appropriate	Comment
Federal				
Flood Plain	Executive Order No. 11988, Protection of Floodplain 16 USC 661 et seq. 40 CFR Part 6, Appendix A and 40 CFR 6:302	Actions that will occur in a flood plain and relatively flat areas adjoining inland and coastal waters and other flood plain areas must avoid adverse effects.	No/No	The site is not located within a flood plain area.
100-Year Flood Plain	40 CFR 264.18(b); 40 CFR 761.75	RCRA treatment, storage, or disposal facility must be designed, constructed, operated, and maintained to avoid washout within 100-year flood plain.	No/No	No part of the site is located within a 100-year flood plain.
Wetlands	Executive Order No. 11990, Section 7; 40 CFR Part 6, Appendix A	Action involving construction of facilities or management of property in wetlands is to avoid adverse effects, minimize potential harm, and preserve and enhance wetlands, to the extent possible.	No/No	No wetlands are located at or near the project site.
	CWA Section 404; 40 CFR Part 230 33 CFR Part 320-330	Prohibits discharge of dredged or fill material into wetlands (as defined in U.S. Army COE regulations) without permit.	No/No	No dredged or fill material will be discharged into a wetland.

Table 8-5. Location-Specific ARARs (continued).

Location	Citation	Requirement	Applicable/Relevant and Appropriate	Comment
Wilderness Area	Wilderness Act 16 USC 1311 et seq. 50 CFR 35.1 et seq.	Federally owned areas designated as wilderness areas must be administered in such a manner that will preserve their wilderness status.	No/No	No federally owned wilderness area is located on site or in the vicinity of the site.
Wildlife Refuge	16 USC 668dd (c) et seq. 50 CFR Part 27	Only actions allowed under the provisions of 16 USC 668dd(c) may be undertaken in areas designated as part of National Refuge System.	No/No	Site and immediate area do not contain areas designated as part of National Wildlife Refuge System.
Near Holocene Fault	40 CFR 264.18(a)	New RCRA treatment, storage or disposal of hazardous waste prohibited within 61 meters of a fault displaced in Holocene time.	No/No	The site is not located in a county which is considered seismically active, listed in 40 CFR 264 Appendix VI.
Salt Dome, Mine, Cave	40 CFR 264.18(c)	Placement of non-containerize or bulk liquid RCRA hazardous waste is prohibited within salt dome formation, underground mine, or cave.	No/No	None of the formations is identified on the site.
Rivers and Harbors Act of 1899	33 USC Sect. 403			
Navigable Waters	Section 10 Permit 33 CFR Parts 320-330	Requires permit for structure or work in or affecting navigable water.	No/No	No structure or work will affect navigable rivers.

Table 8-5. Location-Specific ARARs (continued).

Location	Citation	Requirement	Applicable/Relevant and Appropriate	Comment
Critical Habitat Area	Endangered Species Act 16 USC 15321 et seq.	Action to conserve endangered species within critical habitats upon which endangered species depend, including consultation with the Department of Interior.	No/No	There are no critical identified habitats of endangered species in the immediate vicinity of the IG/WS MGP site.
Area Affecting a Stream or River	Fish and Wildlife Coordination Act 16 USC 661 et seq. 33 CFR Parts 320-330 40 CFR 6:302	Action to protect fish or wildlife from diversion, channeling, or other activity that modifies a stream or river and affects fish or wildlife.	No/No	None of the alternatives developed will modify a stream or water body in a manner regulated by this act.
Coastal Zone	Coastal Zone Management Act 16 USC Section 1451 et seq.	Conduct activities affecting the coastal zone, including lands therein and thereunder and adjacent shorelands in manner consistent with approved state management programs.	No/No	The site is not located within a coastal zone.
	Coastal Barrier Resources Act 16 USC 3502 et seq.	Prohibits any new federal expenditure within the coastal barrier resource system.	No/No	Actions at the site will not affect the coastal barrier resource system.
Area Affecting National Wild, Scenic, or Recreational River	Wild and Scenic Rivers Act 16 USC 1271 et seq; Section 7(a) 40 CFR 6:302(e)	Avoid taking or assisting an action that will have direct adverse effect on scenic river specified in 16 USC 1276(a).	No/No	Actions at the site will not affect a scenic river.

Table 8-5. Location-Specific ARARs (continued).

Location	Citation	Requirement	Applicable/Relevant and Appropriate	Comment
Historic Area	National Historical Preservation Act Section 106 (16 USC 470 et seq.); 36 CFR Part 800	Requires Federal agencies to take into account the effect of any Federally assisted undertaking or licensing on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places.	No/No	The remedies will not affect any current district site, building, structure, or object listed on or eligible for the National Register.
Historic or Archaeological Site	Archaeological and Historical Preservation Act 16 USC 469. 36 CR Part 65	Action is required to recover and preserve artifacts that are threatened by alteration of terrain that contains significant scientific, prehistorical, historical, and archaeological data.	No/No	The remedies will not affect any current natural landmark. No archaeological or historical landmark has been identified within the area potentially impacted by the remedial action alternatives.
Historic Site	Historic Sites, Buildings, and Antiaquifer Act 16 USC Section 461-467 40 CFR Section 6:30(a)	Requires Federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts on such landmarks.	No/No	The site is not included in the National Registry of Historic Places. The remedies will not affect any current natural landmark.

Table 8-6. Action-Specific ARARs.

Standard Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate	Comment
Federal Action-Specific ARARs	42 USC Sect. 6901-6987			
Criteria for Classification of Solid Waste Disposal Facilities and Practices	40 CFR Part 257	Defines "Solid Waste." Establishes criteria for use in determining which solid wastes disposal facilities and practices pose a reasonable probability of adverse effects on health and thereby constitute prohibited open dumps.	Yes/-	Wastes at the IG/WS MGP site are solid wastes. This part would be applicable to remedial alternatives that involve the disposal of solid wastes as defined in Subtitle D.
Hazardous Waste Management Systems General	40 CFR Part 260	Establishes procedure and criteria for modification or revocation of any provision in 40 CFR Part 260-265.	No/No	Creates no substantive cleanup requirements.
Identification and Listing of Hazardous Wastes	40 CFR Part 261	Defines those solid wastes which are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and Parts 124, 270, and 271.	Yes/-	Material at the IG/WS MGP site is considered a RCRA hazardous waste and thus these regulations are applicable.
Standards Applicable to Generators of Hazardous Waste	40 CFR Part 262	Establishes standards for generators of hazardous waste.	Yes/-	Material at the IG/WS MGP site is considered a RCRA hazardous waste and thus these regulations are applicable.

Table 8-6. Action-Specific ARARs (continued).

Standard Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate	Comment
Standards Applicable to Transporters of Hazardous Waste	40 CFR Part 263	Establishes standards which apply to persons transporting hazardous waste within the U.S. if the transportation requires a manifest under 40 CFR Part 262.	Yes/-	Some materials at the IG/WS MGP site are considered RCRA hazardous waste and thus these regulations are applicable.
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.	40 CFR Part 264	Establishes minimum national standards which define the acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste.	Yes/-	Some materials at the IG/WS MGP site are considered RCRA hazardous waste and thus these regulations are applicable.
	40 CFR Part 264 3Subpart B	General Facilities Standards 40 CFR 264.14 Security	No/Yes	General facility standards for security are relevant and appropriate to on-site remedial actions.
	Subpart C	Preparedness and Prevention	No/No	OSHA workplace regulations for these activities are at least as stringent and are applicable.
	Subpart D	Contingency Plan and Emergency Procedures	No/No	OSHA workplace regulations for these activities are at least as stringent and are applicable.

Table 8-6. Action-Specific ARARs (continued).

Standard Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate	Comment
	Subpart E	Manifest System, Record-keeping, and Reporting	No/Yes	Regulations requiring recordkeeping and reporting are relevant and appropriate to facilities receiving waste from the site because the waste is a to RCRA waste.
	Subpart F	Releases from Solid Waste Management Units	No/No	Only 40 CFR 264.101, Corrective Action for Solid Waste Management Units, is relevant and appropriate.
	Subpart G	Closure and Post-Closure	No/Yes	Substantive portions of this subpart establishing closure and post-closure requirements to prevent threats to human health and the environment are relevant and appropriate for on-site remedial actions.

Table 8-6. Action-Specific ARARs (continued).

Standard Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate	Comment
	Subpart H	Financial Requirements	Yes/-	Some materials at the IG/WS MGP site are considered RCRA hazardous waste and thus these regulations are relevant and may be appropriate depending on the actions selected.
	Subpart I	Use and Management of Containers	Yes/-	Some materials at the IG/WS MGP site are considered RCRA hazardous waste and thus these regulations might be applicable depending on the action taken.
	Subpart J	Tanks	Yes/-	Some materials at the IG/WS MGP site are considered RCRA hazardous waste and thus these regulations are applicable.
	Subpart K	Surface Impoundments	No/No	There are no surface impoundments at the site and none are included in the proposed remedial alternatives.

Table 8-6. Action-Specific ARARs (continued).

Standard Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate	Comment
	Subpart L	Waste Piles	Yes/-	Some materials at the IG/WS MGP site are considered RCRA hazardous waste and thus these regulations might become applicable depending on the action taken.
	Subpart M	Land Treatment	Yes/-	The landfarming alternative would involve land treatment.
	Subpart N	Landfills	No/No	No alternative developed would involve disposal of material in an on-site landfill but could be relevant for capping considerations.
	Subpart O	Incinerators	Yes/-	Some materials at the IG/WS MGP site are considered RCRA hazardous waste and thus these regulations might be applicable depending on the action taken.

Table 8-6. Action-Specific ARARs (continued).

Standard Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate	Comment
Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities	40 CFR Part 266	Establishes requirements which apply to recyclable materials that are reclaimed to recover economically significant amounts of precious metals, including gold and silver.	No/No	The requirements in this part are not applicable or relevant and appropriate to the wastes at the site.
Interim Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilities	40 CFR Part 267	Establishes minimum national standards that define acceptable management of hazardous waste for new land disposal facilities.	No/No	These regulations are not applicable or relevant and appropriate because no proposed remedy would construct a new land disposal facility.
Land Disposal	40 CFR Part 268	Established a timetable for prohibiting the land disposal of hazardous wastes.	Yes/-	Some materials at the IG/WS MGP site are considered RCRA hazardous waste and thus these regulations might be applicable.
Hazardous Waste Permit	40 CFR Part 270	Establishes provisions covering basic EPA permitting requirements.	No/No	According to DEC Guidance, a permit is not required for on-site CERCLA response actions.
Underground Storage Tanks	40 CFR Part 280	Establishes regulations related to underground storage tanks.	No/No	No alternative developed would involve use of underground storage tanks.

Table 8-6. Action-Specific ARARs (continued).

Standard Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate	Comment
Occupational Safety and Health Act	29 USC Sect. 651-678	Regulates worker health and safety.	Yes/-	Under 40 CFR Sect. 300.38, requirements of the Act apply to all response activities under the NCP.
Hazardous Waste Operations and Emergency Response, Final Rule	29 CFR 1910.120	Establish training, medical monitoring and workplace regulations and standards for all work done at hazardous waste sites.	Yes/-	These regulations are applicable to all remedial activities conducted at the IG/WS MGP site.
Safe Drinking Water Act	42 USC Sect. 300(f)			
Standards for Owners and Operators of Public Water Supply System	40 CFR Part 141	Provides treatment (water quality) requirements for public water supply systems.	No/No	No alternative considered involves a public water supply system.
Underground Injection Control Regulations	40 CFR Parts 144-147	Provides for protection of underground sources of drinking water.	No/No	No alternative considered involves the use of injection wells.
Clean Water Act	33 USC Sect. 1251-1376			
Ambient Water Quality Criteria Guidelines (AWQCG)	40 CFR Part 131 Quality Criteria for water, 1976, 1980, 1986	Sets criteria for water quality based on toxicity to aquatic organisms and human health.	No/Yes	AWQCGs for PAHs and aromatics are relevant and appropriate to all remedies which discharge groundwater to a POTW or surface water.

Table 8-6. Action-Specific ARARs (continued).

Standard Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate	Comment
National Pretreatment Standards	40 CFR Part 403	Sets standards to control pollutants which pass through or interfere with treatment processes in publicly owned treatment works (POTW) or which may contaminate sewage sludge.	Yes/-	These standards are applicable to all alternatives that involve discharge to a POTW.
Toxic Pollutant Effluent Standards	40 CFR Part 129	Establishes effluent standards or prohibitions for certain toxic pollutants: aldrin/dieldrin, DDT, endrin, toxaphene, benzidine, PCBs.	No/No	These contaminants were not found at the IG/WS MGP site.
Maine Protection, Research, and Sanctuaries Act	13 USC Sect. 1401-1445	Regulates ocean dumping.	No/No	No ocean dumping will occur.
Toxic Substances Control Act PCB Requirements	13 USC Sect. 2601-2629 40 CFR	Establishes storage and disposal requirements for PCBs.	No/No	PCBs were not found at the IG/WS MGP site.
Clean Air Act	42 USC Sect. 7401-7642			
National Ambient Air Quality Standards/ NESHAPSINSPS/BACT/PSD/LAER	40 CFR 60.1-17 .50-.54, .150-.154 .480-.489 40 CFR 53.1-.33 40 CFR 61.01-.18 .50-.112,.240-.247	Sets treatment technology standards for emissions to air from: • Incinerators • Fugitive Emissions	Yes/-	These requirements are applicable to any alternatives that involve emissions regulated by these standards.

Table 8-6. Action-Specific ARARs (continued).

Standard Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate	Comment
Hazardous Materials Transportation Act	49 USC Sect. 1801-1813			
Hazardous Materials Transportation Regulations	49 CFR Parts 107, 171-177	Regulates transportation of hazardous materials.	Yes/-	These requirements are applicable to all alternatives that involve transport of contaminated materials from the site.
State Action-Specific ARARs				
Air Emissions Regulations	6 NYCRR Parts 200-202	Establishes limits for air emissions.	Yes/Yes	No air emissions anticipated for any site remedial activities.
Incinerator Regulations	6 NYCRR Part 219	Establishes limits for incinerator emissions.	Yes/Yes	No onsite incineration is anticipated.
Industrial Hazardous Waste Management	Environmental Conservation Law, Article 27, Title 9	Establishes guidelines for management of industrial waste.	Yes/-	Some materials at the IG/WS site are considered RCRA hazardous waste and thus these regulations might be applicable depending on the action taken.
Inactive Hazardous Waste Disposal Sites	Environmental Conservation Law, Article 27, Title 13 and Title 6, Chapter 4, Subchapter B, Part 375	Provides for actions concerning inactive hazardous waste disposal sites.	Yes/-	This site is listed as an inactive hazardous waste disposal facility.

Table 8-6. Action-Specific ARARs (continued).

Standard Requirement, Criterion, or Limitation	Citation	Description	Applicable/Relevant and Appropriate	Comment
Land Application Facilities	6 NYCRR Chapter 4 Sub-chapter B, Subpart 360-4	Establishes regulations for land treatment facilities.	Yes/-	May apply to landfarming remedial action.
Treatment, Storage, and Disposal Facility Permitting	6 NYCRR Chapter 373-1	Establishes permitting of hazardous waste treatment, storage, and disposal facilities.	Yes/-	May apply to any remedial action at the site.
Land Treatment	6 NYCRR Section 373-2.13, 373-3.13	Regulates land treatment of hazardous wastes.	Yes/-	May apply to landfarming remedial action.
Discharge to Surface Waters (SPDES)	6 NYCRR Part 750 et. seq.	Establishes state limits for discharge to surface waters.	Yes/-	May apply to any remedial action which proposes to discharge treated water.

8.4.1 Solid Waste Disposal Act

The Solid Waste Disposal Act (SWDA) was amended by RCRA and the Hazardous and Solid Waste Amendments of 1984. These three acts and the regulations which enforce them established a program to control the generation, transport, and disposal of solid and hazardous waste. This is the RCRA program. Because RCRA regulates solid and hazardous waste activities and is normally the most stringent federal regulation, its provisions may be ARARs.

RCRA is applicable if the wastes at a site are determined to be "solid" wastes (which are regulated by Subtitle D of the SWDA). All RCRA hazardous wastes are also "solid" wastes (40 CFR 257 defines the types of wastes that are "solid" wastes). The wastes at the site meet this definition and, thus, are "solid" wastes.

RCRA "hazardous" wastes are defined in 40 CFR 261. There are some classes of RCRA listed hazardous wastes, F,K,P and U code wastes. The F codes are hazardous wastes from non-specific sources. The coal tar wastes present at the site are not considered F code wastes. The K code wastes are wastes from specific manufacturing or chemical processes. The manufactured gas process used at the site is not listed, and therefore, the wastes are not K code wastes. The P and U code wastes are defined as discarded commercial chemical products, off-specification commercial chemical products, or manufacturing chemical intermediates. The wastes at the site do not fit any of these definitions because the materials were wastes, not products or chemical intermediates and, therefore, are not P or U code wastes. The D code wastes are the "characteristic" hazardous wastes, and are considered hazardous because they have one or more hazardous characteristics. The four characteristics used to determine if a waste is a D code waste are ignitability, corrosivity, reactivity and TCLP. Soil samples from the site fail TCLP for benzene, and thus can be considered a RCRA hazardous waste. Groundwater at the site passes the TCLP test and thus is not considered a RCRA waste.

Since the soil at the IG/WS MGP site can be considered a RCRA hazardous waste, a number of the provisions of RCRA could be potential ARARs. They are as follows:

(1) 40 CFR 261, identification and listing of hazardous waste,

(2) 40 CFR 262, standards applicable to generators of hazardous waste,
(3) 40 CFR 263, standards applicable to transporters of hazardous waste,
(4) 40 CFR 264, standards for owners and operators of hazardous waste treatment, storage, and disposal facilities,
(5) 40 CFR 264, Subpart H, financial requirements,
(6) 40 CFR 264, Subpart I, use and management of containers,
(7) 40 CFR 264, Subpart J, tanks,
(8) 40 CFR 264, Subpart L, waste piles,
(9) 40 CFR 264, Subpart M, land treatment,
(10) 40 CFR 264, Subpart O, incinerators, and
(11) 40 CFR 268, land disposal.

In addition, 40 CFR 264.14, site security, and 40 CFR 264 Subpart G, regulations for closure and post-closure might also apply.

8.4.2 Occupational Safety and Health Act

The requirements of OSHA are applicable to all response and remedial activities taken under the National Contingency Plan (NCP). Because the applicable consent decree requires that the FS comply with the NCP, these requirements are applicable to all activities taken at the site.

8.4.3 Safe Drinking Water Act

As part of the SDWA, the Underground Injection Control (UIC) Program was established. Remedial alternatives which include injection wells are applicable to UIC regulations. Reinjected water which is not a RCRA waste must comply with Class V regulations under this program.

8.4.4 Clean Water Act

CERCLA 121(d) requires that storm water discharges and remedial-activity discharges during remediation meet the pollutant limitation and performance standards of the CWA. The CWA has two programs which regulate discharges. The NPDES regulates discharges to surface waters and the National Pretreatment Standards regulates discharges to POTW. The wastewater treatment technology proposed in CERCLA response alternatives is required to meet the equivalent of best conventional pollutant control technology (BCT) and best available technology (BAT) economically achievable. EPA has established technology-based effluent limitation guidelines for specific categories of industries with on-going operations. These effluent guidelines do not typically apply specifically to CERCLA sites; thus technology-based treatment requirements equivalent to BCT/BAT are determined on a case-by-case basis using best professional judgment (BPJ) in accordance with CWA 402(a)(1) and 40 CFR 125.3(c)(2) and reviewed by USEPA and the state.

Determination will need to be made if the site does or does not include the creek. If the creek is part of the site, a permit waiver applies. If the creek is not part of the site, surface water discharged onsite would only need to meet the substantive portions of the NPDES standards, and any discharges to offsite surface waters must take place via a NPDES permit and meet all NPDES administrative requirements. Discharges to a POTW must comply with both the substantive and the administrative portions of the National Pretreatment Standards, and a POTW discharge agreement must be obtained.

8.4.5 Clean Air Act

The Clean Air Act was promulgated "to protect and enhance the quality of the nation's air resources so as to promote the public health and welfare and the production capacity of its population." Sections of the Clean Air Act establish Standards of Performance for Incinerators (40 CFR 60.50-54). The National Emission Standards for Hazardous Air Pollution (40 CFR 61) set emission standards for incineration and the handling of volatile organic compounds (fugitive emissions). These laws could be considered applicable to some of the alternatives developed in this FS.

8.4.6 Hazardous Materials Transportation Act

These regulations determine how hazardous materials must be transported. Since the wastes at the site are considered to be Department of Transportation (DOT) hazardous substances, these regulations are applicable to any alternatives that involve transportation offsite.

9 IDENTIFICATION AND SCREENING OF REMEDIAL ACTION AND TECHNOLOGIES

The objective of this chapter of the Feasibility Study (FS) is to select, from available technologies, remedial technologies consistent with CERCLA, SARA, and the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) to develop remedial alternatives encompassing all site media. The technology screening includes the following steps and will be addressed in the subsequent two sections:

1. Development of remedial action objectives (RAOs) specifying the media of interest, exposure pathways, and remediation goals for the contaminants of concern.

2. Identification of areas and volumes of contaminated media.

3. Development of general response actions that address the remedial action objectives.

4. Identification of potential remedial technologies and the initial screening of these technologies based primarily on their ability to be technically implemented.

5. Final screening of remaining technologies on the basis of effectiveness, implementability, and relative cost during which representative process options and technologies are selected for the development and evaluation of remedial alternatives.

9.1 REMEDIAL ACTION OBJECTIVES

The primary goals of the Remedial Action Objectives (RAOs) for the Iroquois Gas/Westwood Squibb (IG/WS) site are to protect human health and the environment from potential contaminants and to remediate the contaminated media as required by ARARs. Tables presented in Chapter 8 indicate cleanup standards for groundwater and soil. In developing the RAOs for the site, the following conclusions were made regarding the cleanup guidelines, based on information gathered during the remedial investigation (RI) and ARAR evaluation in Chapter 8:

- The depth to the water table ranges from nine to 18 feet, and is less than 15 feet over much of the site. Based on this information, the average depth for potential excavation activities is approximately 12 feet.

- Buildings cover approximately two-thirds of the site and most of the contaminant source areas. The buildings are active facilities, and demolition is not expected in the near future. The buildings act as an effective cap on the contaminants, preventing exposure and infiltration. Based on the risk associated with this site, no remedial technology or alternative will consider demolition of the buildings.

- The target chemicals of concern identified in the risk assessment are PAHs, benzene, toluene, ethylbenzene, and xylenes (BTEX). BTEX and PAHs also are the target chemicals of concern in groundwater. In developing RAOs for the groundwater, benzene has been selected as the indicator chemical for evaluating the extent of contaminated groundwater at the site due to its relative mobility and toxicity.

- The hydrogeologic and contaminant characteristics of the shallow groundwater system render groundwater restoration infeasible within any reasonable timeframe. The important limiting characteristics include fill heterogeneity and the presence of a viscous DNAPL.

- Federal and state regulations for BTEX and PAHs for groundwater and soils are presented in Tables 8.1 - 8-3. The New York State cleanup standards will be considered RAOs.

- In cases of significant risk, the goal of groundwater cleanup is to use the best available technology and best management practices as long as it is reasonable and practical to prevent migration and remove contaminants until water contamination remains below the action level of any contaminant. An ACL may be established where site conditions and available technology are such that attainment of the New York State cleanup standards goals would be impractical; it may be the case at this site due to the presence of DNAPL.

The specific goals and objectives of the remedial actions at the IG/WS site in accordance with the CERCLA/SARA requirements and the preceding assumptions are as follows:

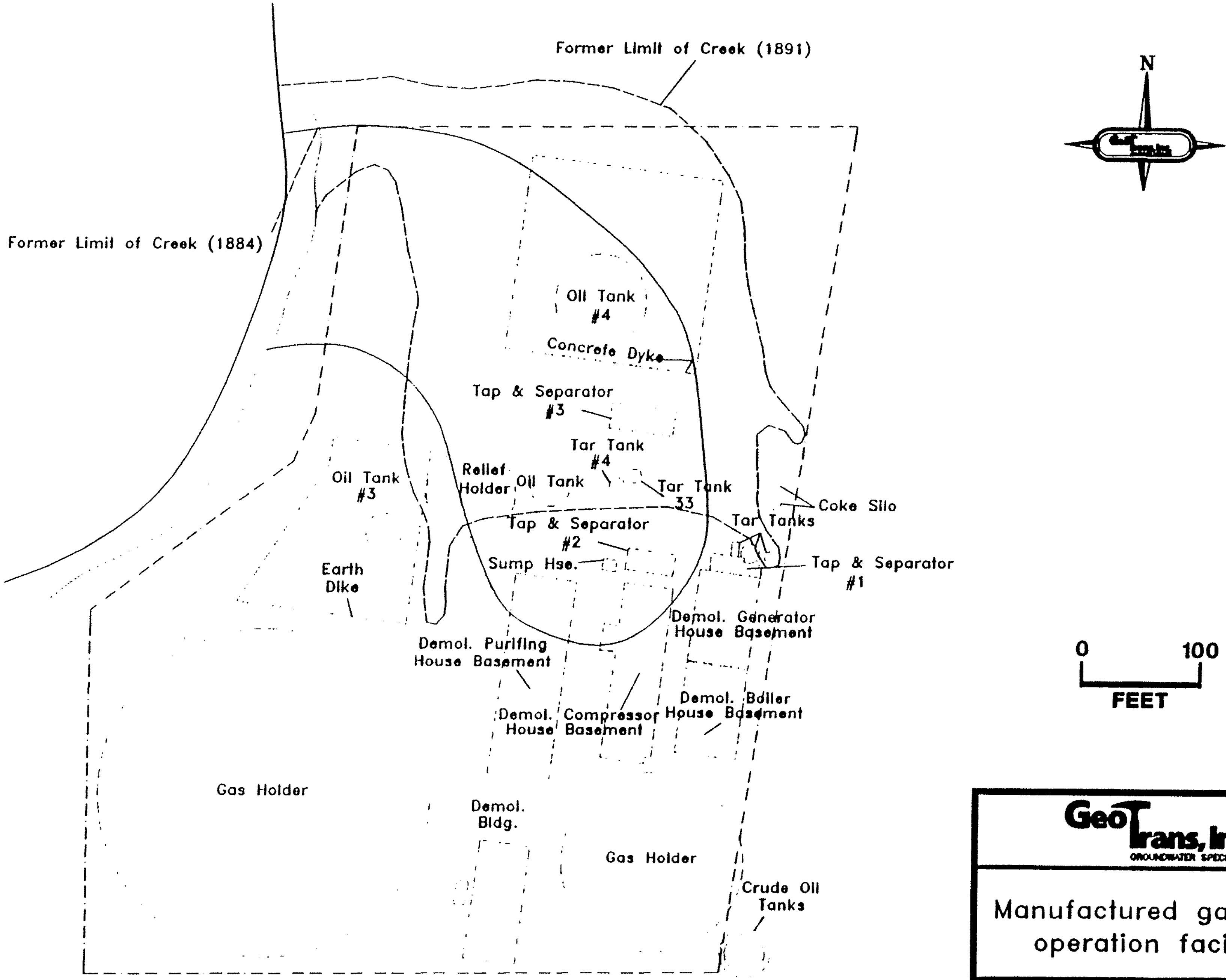
1. Remove or contain contaminated source area materials in order to a) minimize the potential for ingestion, dermal contact, and inhalation of materials containing concentrations of BTEX and PAHs in excess of RAOs, and b) reduce the potential for further migration of contaminants from these units.

2. Prevent or minimize the potential for future inhalation, ingestion, or dermal contact with contaminants in groundwater in excess of New York State quality standards or ACLs.

9.2 AREAS AND VOLUMES OF CONTAMINATED MEDIA

The media sampled during the RI were soil, groundwater, surface water, creek sediment, and DNAPL. Sampling each of these media indicated the presence of contaminants. The types and volumes of contaminants identified are consistent with the use of the site as a MGP facility.

Historical standard operational practice of the former MGP owners/operators included disposing of waste products in pits, ponds, and landfills (GRI, 1987). Surface soil contamination likely occurred from accidental spills and leaks in and around plant operation areas. Purifier boxes, used to filter impurities out of manufactured gas during the production process, are believed to be the source of a layer of wood chips observed in several borings during drilling. The wood chips found at the site are similar in nature to purifier-box filter material waste from MGP operations (GRI, 1987). Former creek beds beneath portions of the IG/WS site and surrounding areas were filled with construction debris and waste products generated during MGP operations. Figure 9-1 is a map showing areas of former MGP operations at the site and the former creek bed locations.



Source: Modified Termini, 1987

GeoTrans, Inc.
GROUNDWATER SPECIALISTS

Manufactured gas plant operation facilities

FIGURE 9-1

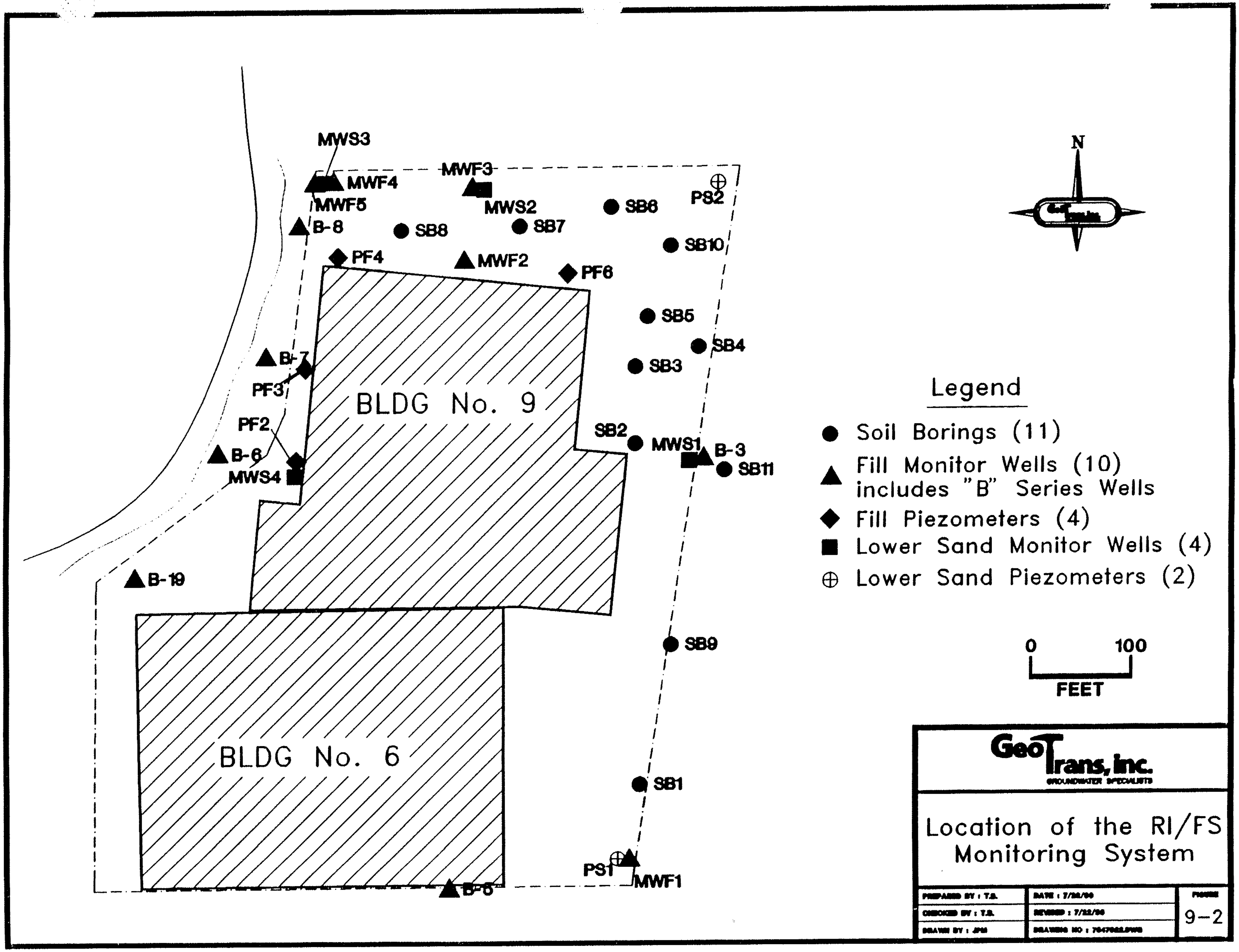
9.2.1 Source Areas/Soils

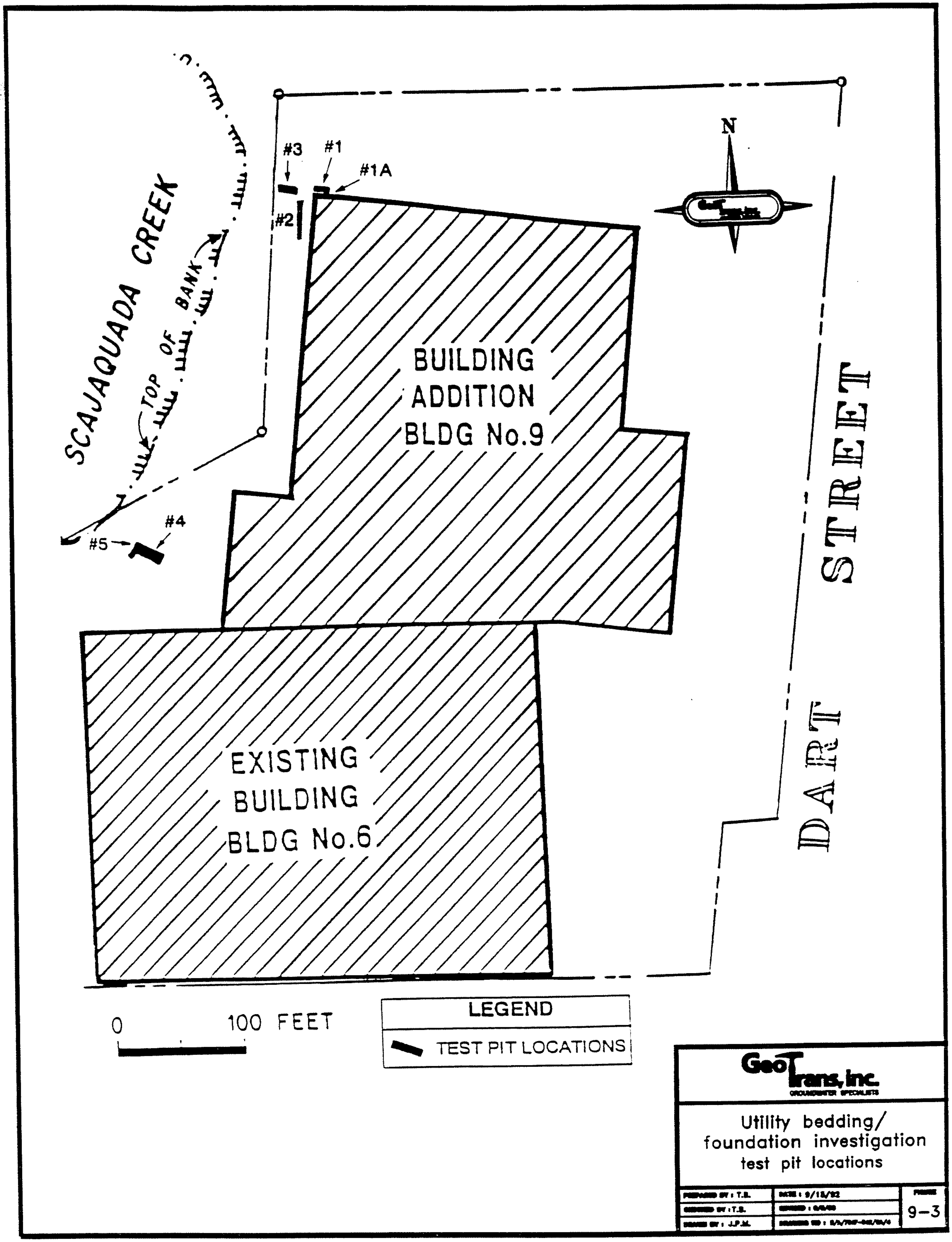
Source areas of contamination for soils, groundwater and DNAPL are based on the results of samples collected during the RI, the probable plant operational history, and the known locations of the 1884 and 1891 creek beds. The contaminant source areas are believed to be the subsurface soils beneath the northern and eastern portions of the site and in some of the surface soil of the former MGP operation area. Figures 9-2 and 9-3 show the sampling locations of soil borings and test pit excavations at the IG/WS site. Five soil samples were collected from test pit excavations and 43 from drilling operations for a total of 48 samples. All samples were collected to the east, north and west of the current building locations. Soils were sampled for PAHs, BTEX compounds, metals and cyanide. Figures 9-4 and 9-5 present the contaminant distribution for the highest concentration of total PAHs and BTEX at each sampling location in soil. Elevated levels of these contaminants are primarily located in the fill material in the northern and eastern portions of the site. Elevated levels of metal contamination were indicated in similar distribution patterns as presented for PAHs and BTEX.

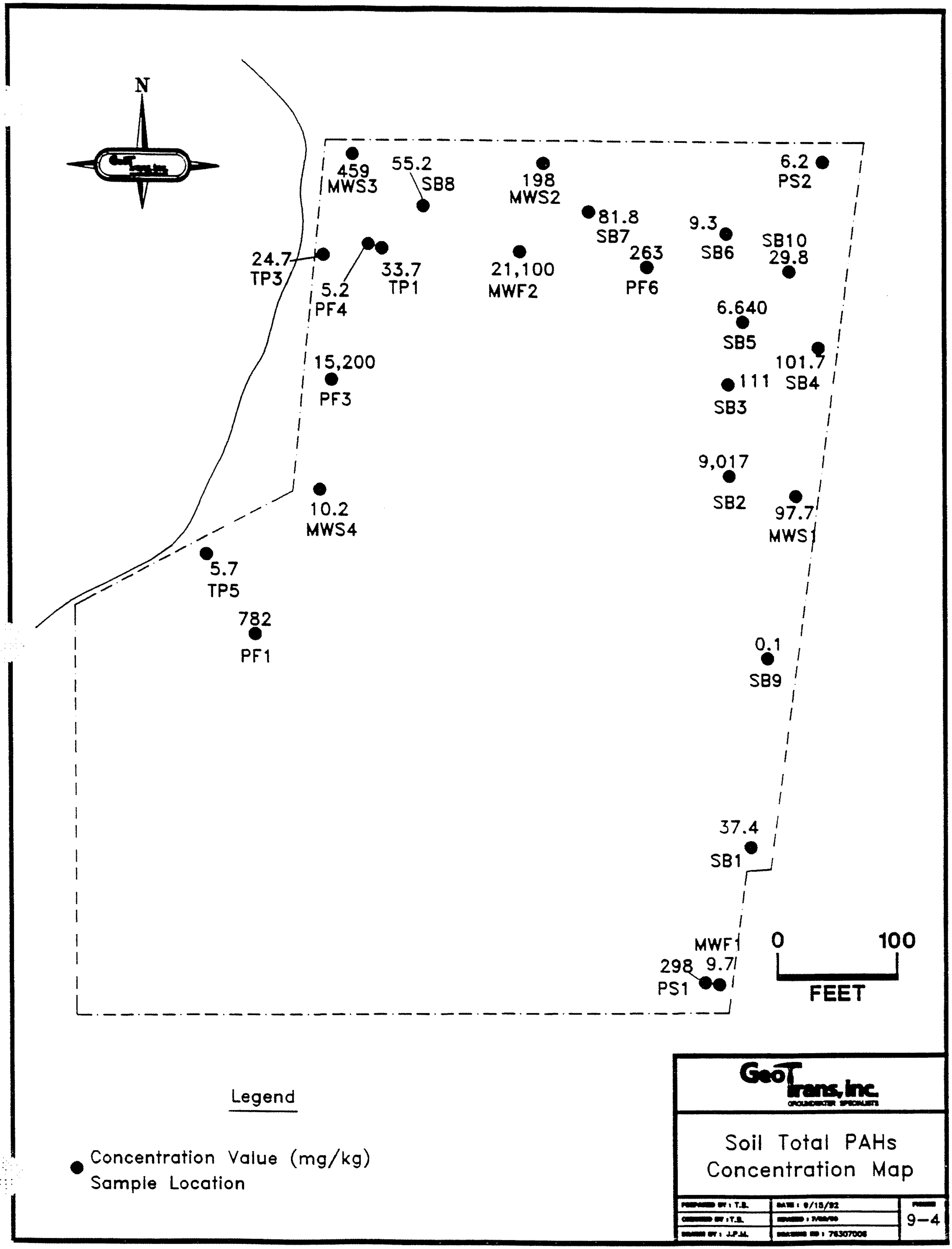
The estimated volume of contaminated soil is 156,000 cubic yards. This estimate is based on the surface area of the site and the depth to the fill material west, north, and east of Building No. 9 and east of Building No. 6. The estimated volume of contaminated soil not beneath existing building structures is 86,000 cubic yards.

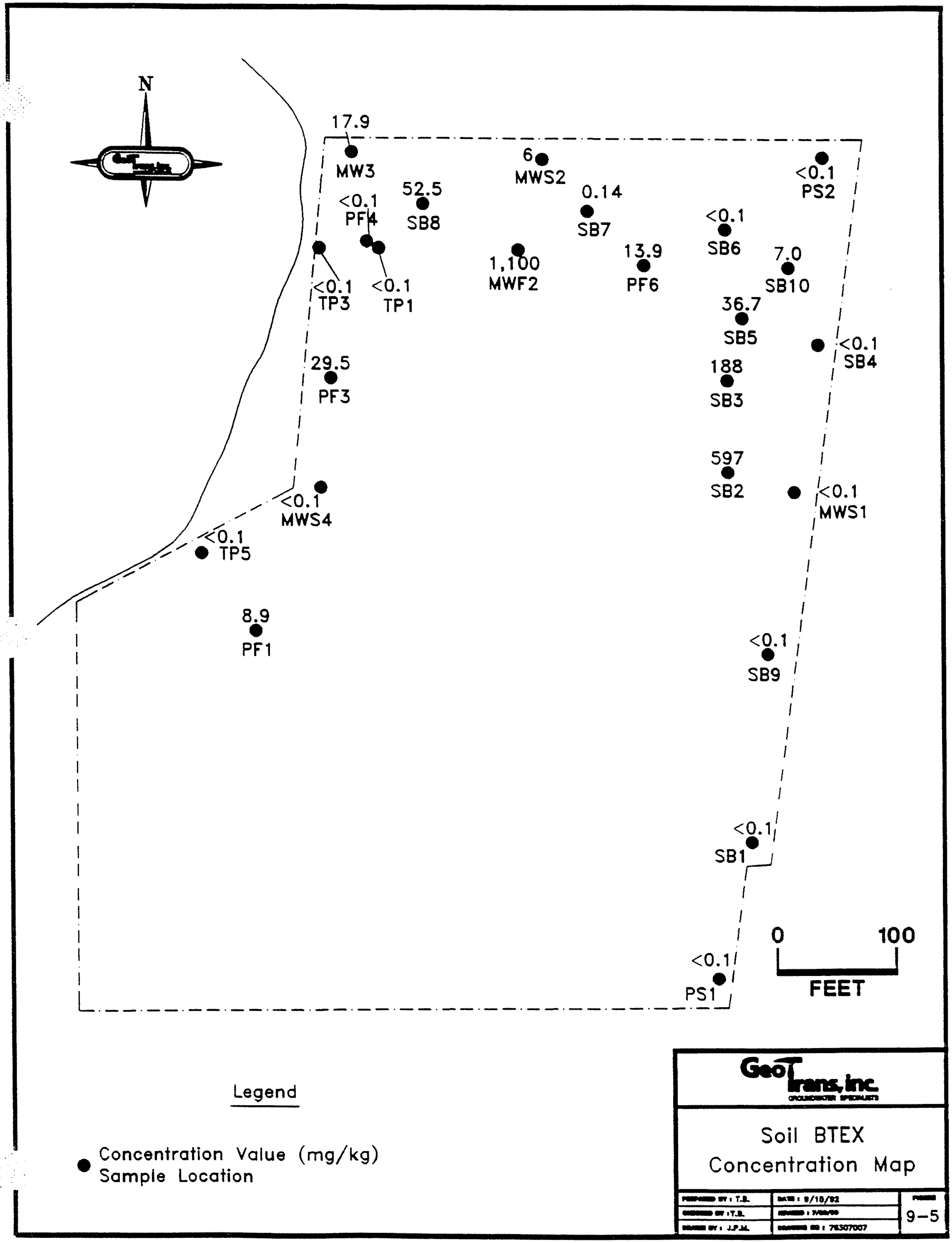
9.2.2 Contaminated Groundwater Plume/DNAPL

Based on the RI results, the target contaminants for groundwater are PAHs and BTEX. Figures 9-6 and 9-7 present isoconcentration contours for total PAHs and BTEX in groundwater. Elevated total cyanide levels (dissolved analysis was not accomplished) were limited to three wells; due to few observances and the relative immobility and insolubility of cyanide, its potential as a groundwater contaminant is limited. DNAPL was consistently detected in wells B8 and MWF2.


N
MWS3
MWF4
MWF5
B-8
MWF3
MWS2
SB6
PS2
SB8
SB7
SB10
PF4
MWF2
PF6
SB5
SB4
SB3
B-7
PF3
BLDG No. 9
PF2
B-6
MWS4
SB2
MWS1
B-3
SB11
B-19
SB9
BLDG No. 6
SB1
PS1
MWF1
B-5
Legend
Soil Borings (11)
Fill Monitor Wells (10) includes "B" Series Wells
Fill Piezometers (4)
Lower Sand Monitor Wells (4)
Lower Sand Piezometers (2)
0
100
FEET
GeoTrans, inc.
Location of the RI/FS Monitoring System
9-2


SCAJAQUADA CREEK
TOP OF BANK
#3
#1
#1A
#2
#4
#5
N
BUILDING
ADDITION
BLDG No.9
EXISTING
BUILDING
BLDG No.6
DART STREET
0
100 FEET
LEGEND
TEST PIT LOCATIONS
GeoTrans, inc.
GROUNDWATER SPECIALISTS
Utility bedding/
foundation investigation
test pit locations
9-3


N
459
MWS3
55.2
SB8
198
MWS2
6.2
PS2
81.8
SB7
9.3
SB6
SB10
29.8
24.7
TP3
5.2
PF4
33.7
TP1
21,100
MWF2
263
PF6
6.640
SB5
15,200
PF3
101.7
SB4
111
SB3
9,017
SB2
10.2
MWS4
97.7
MWS1
5.7
TP5
782
PF1
0.1
SB9
37.4
SB1
MWF1
9.7
298
PS1
0
100
FEET
Legend
Concentration Value (mg/kg)
Sample Location
GeoTrans, Inc.
Soil Total PAHs
Concentration Map
9–4


N
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MW3
6
MWS2
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PS2
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SB8
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PF4
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SB7
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SB6
1,100
MWF2
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PF6
7.0
SB10
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TP3
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TP1
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SB5
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SB4
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PF3
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SB3
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SB2
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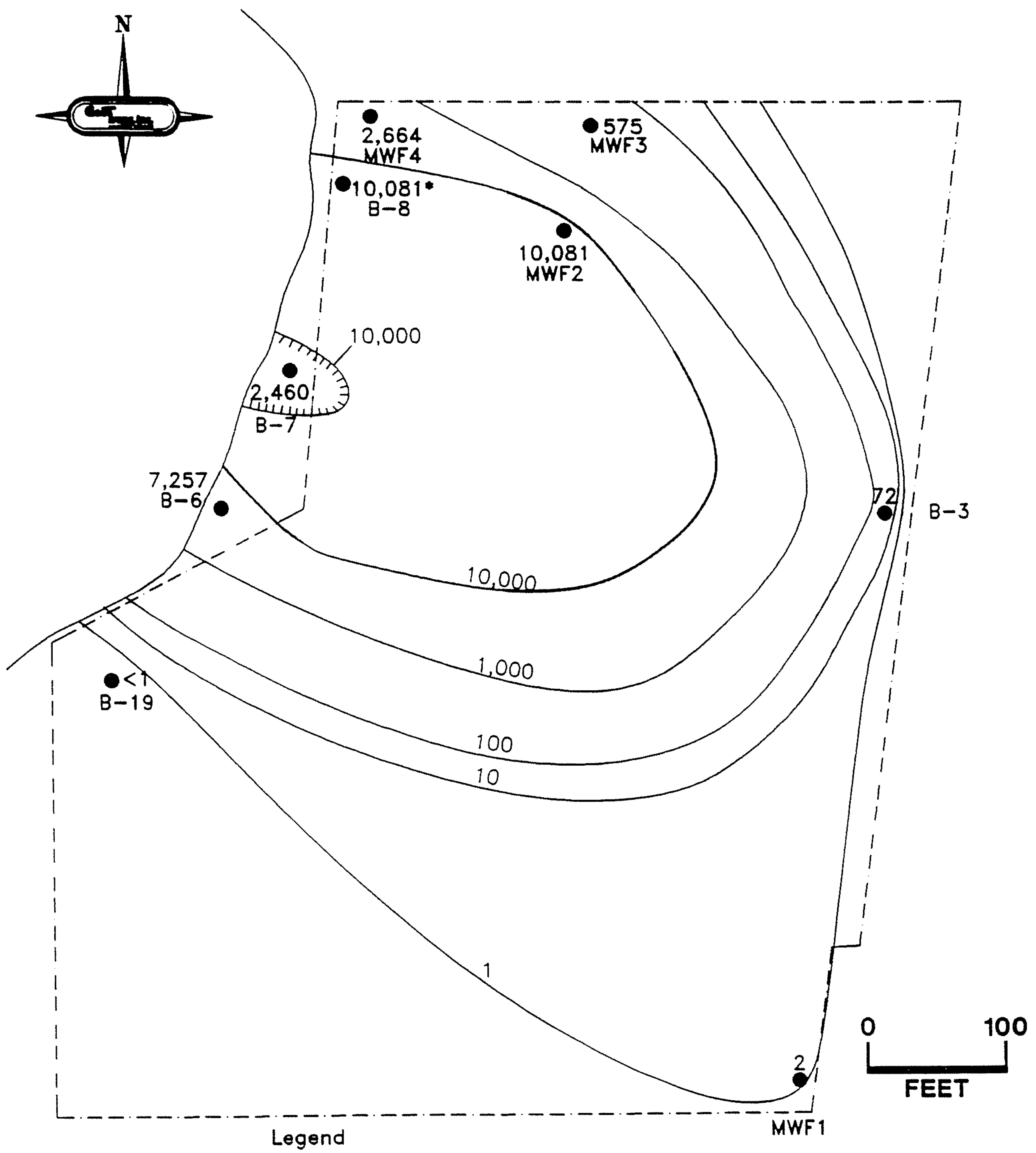
MWS1
<0.1
TP5
8.9
PF1
<0.1
SB9
<0.1
SB1
0 100
FEET
<0.1
PS1
Legend
Concentration Value (mg/kg)
Sample Location
GeoTrans, inc.
Soil BTEX
Concentration Map
9-5



Legend

● TPAH concentration (ug/ℓ)
Well Identification

Note:

1) Concentrations May 1992 except sample from well B-6 which was collected in August, 1992.

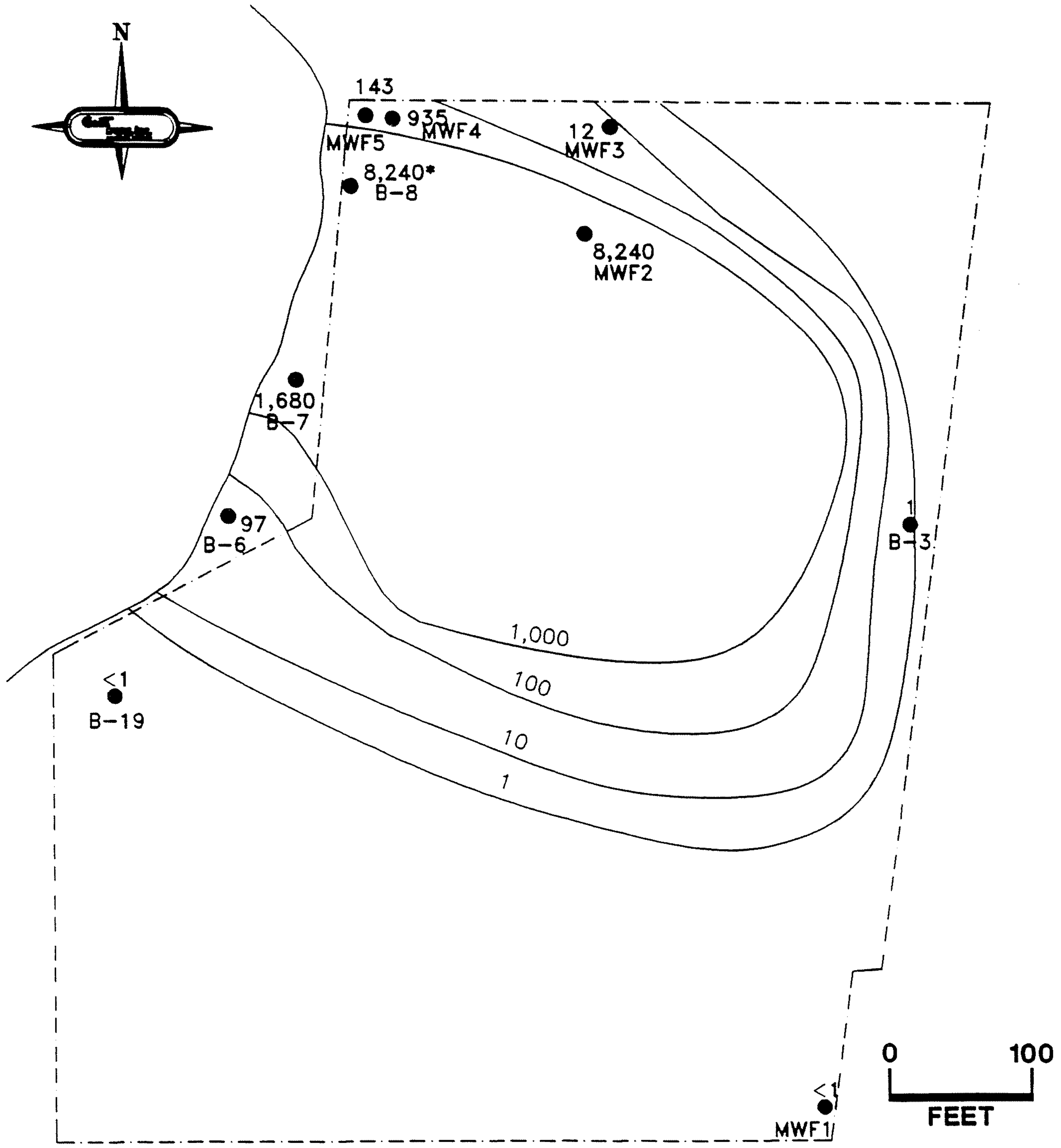
2) * No groundwater sample collected. Assumed concentration was similar to MWF2.

Note: Isoconcentration contour lines are interpolated between data points.

GeoTrans, Inc.

Groundwater Total PAHs Isoconcentration Map

9-6



Legend

● BTEX concentration (ug/ℓ)
Well Identification

Note:

1) Concentrations May 1992 except sample from well B-6 which was collected in August, 1992.

2) * No groundwater sample collected. Assumed concentration was similar to MWF2.

Note: Isoconcentration contour lines are interpolated between data points.

Groundwater BTEX Isoconcentration Map

9-7

Likely pathways for offsite contaminant migration would be in the groundwater and as DNAPL. The discharge point for groundwater and DNAPL from the site is Scajaquada Creek. Final discharge options for any collected groundwater include reinjection, discharge to a POTW, or discharge under a state pollution discharge elimination system (SPDES) permit. Contaminated groundwater is present in the near surface fill aquifer at the site. The saturated maximum thickness of the fill aquifer is less than 15 feet. The fill aquifer is underlain by a low permeability silty-clay aquitard.

9.2.3 Future Remedial Action

This FS will be used to select final retained process options for soils, groundwater, and DNAPL remediation. Scajaquada Creek sediments will be addressed if required in future FS work.

9.3 GENERAL RESPONSE ACTIONS

General response actions are defined as remedies that meet the remedial action objectives. Identification of general response actions is necessary prior to development of a list of potential technologies and process options applicable to remediation of the source areas, groundwater and DNAPL at the IG/WS site. The following is a list of the general response actions that have been identified for the site:

- No action: The site is left in its existing state and no funds are expended for monitoring, control, or cleanup of the contamination.
- Institutional control: Restrictions are established and implemented to control public and environmental contact with the contaminants (i.e., site access and use restrictions and periodic groundwater monitoring).
- Containment: Direct physical or chemical isolation of the contaminants.
- Removal: Excavation or extraction of the contaminated media and removal from the immediate area.

- Onsite treatment: Application of biological, chemical, physical or thermal processes to reduce the toxicity, mobility, or volume of the contaminated material.

- Offsite treatment: Similar to onsite treatment, except the contaminated media are transported to an offsite facility for treatment.

- In-situ treatment: In-place treatment to render the contaminated material less harmful.

- Offsite disposal/discharge: Transport of the contaminated material to an offsite disposal facility.

Table 9-1 describes the general response actions and their associated potential remedial action technologies applicable to the remediation of source area soil and material. Table 9-2 lists response actions for groundwater and DNAPL.

9.4 INITIAL TECHNOLOGY SCREENING

The screening of technologies follows the conceptual development of potential applicable processes and precedes the final screening and detailed analysis of alternatives. Following screening, technologies are identified and combined into alternatives, although specific details of the alternatives may not be defined. The initial set of alternatives developed shall include appropriate remedial technologies that are representative of the general response actions. During the screening, the extent of remedial action (e.g., quantities of media to be affected), the sizes and capacities of treatment units, and other details of each alternative should be further defined, as necessary, so that screening evaluations can be conducted.

The objective of initial remedial technology screening is to narrow the list of potential technologies that will be evaluated in detail. In some situations, the number of viable alternatives to address site

Table 9-1. General response actions and associated potential remedial action technologies for source area material and soils.

General Response Action	Potential Remedial Action Technology
No Action	No Action
Institutional Control	Site Access and Use Restrictions Environment Monitoring
Containment	Capping Horizontal Barriers
Removal	Removal
Onsite Treatment	Biological Chemical Thermal Physical/Chemical Physical
Offsite Treatment	Thermal Biological
In-Situ Treatment	Biological Chemical Physical/Chemical Thermal
Onsite Disposal	Disposal
Offsite Disposal	Disposal

Table 9-2. General response actions and associated potential remedial action technologies for groundwater/DNAPL.

General Response Action	Potential Remedial Action Technology
No Action	No Action
Institutional Control	Groundwater Use Restrictions Groundwater Monitoring
Containment	Capping Vertical Barriers Horizontal Barriers Gradient Control Subsurface Drains
Removal	Extraction
Onsite Treatment	Biological Physical Chemical Thermal
Offsite Treatment	Thermal Biological/Physical/Chemical
In-Situ Treatment	Biological Physical/Chemical
Onsite Discharge	Reinjection, Discharge
Offsite Discharge	Discharge

problems may be limited so that screening may be unnecessary or minimized. At this time, cost will not be used to guide the initial development and screening of remedial technologies or alternatives. Because the purpose of the screening evaluation is to reduce the number of technologies that will undergo a more thorough and extensive analysis, technologies should be evaluated more generally in this phase than during the detailed analysis.

A key aspect of the initial technology screening evaluation is determination of the technical implementability of each technology in protecting human health and the environment. This screening is accomplished by use of information from the RI on contaminant types, concentrations, and site characteristics. The following is a list of reasons why screening technologies and process options may be rejected:

- Technology/process option would not be a practical method for the volume or area of contaminated media that is to be remediated.
- Technology/process options would not be an effective method for the remediation of all of the contaminants due to the characteristics or concentrations of contaminants present at the site.
- Technology/process options would not be feasible and/or effective due to site conditions. These include site location and size, surrounding land use, site weather, geology and soils, hydrogeology, and characteristics of the contaminated media.
- Technology/process option could not be effectively administered.
- Technology/process option could result in the creation of a new contaminated site at a different location with the associated risks and liabilities.
- Technology has not been proven on site contaminants or media.
- Extremely high costs relative to other equally effective technologies.

Tables 9-3 and 9-4 present the initial screening of remedial technologies for the source areas/soils and groundwater/DNAPL.

Table 9-3. Initial screening of remedial technologies for the source areas and soils.

Technology	Process Option	Process Description	Comments
No action	None	Site is left in its existing state.	RETAINED. Required by the National Oil and Hazardous Substances Pollution Contingency Plan as a baseline alternative.
Site access and use restrictions	Land use restrictions	Land use restrictions would be recorded in the property deeds to prohibit activities that might disturb contaminated subsurface materials.	RETAINED. Limited application. Difficult to implement beyond existing site property boundaries. Would not reduce or control contaminant migration. Would be used with other technologies such as capping.
	Fencing	Site would be fenced and warning signs posted. Long-term maintenance and security would be required.	RETAINED. Limited application. Not practical for an active site. Would not reduce or control contaminant migration. Would be used with other technologies, such as capping.
Environmental Monitoring	Monitoring	Groundwater and/or surface water monitoring.	RETAINED. Would be used in conjunction with other technologies.
Capping	Native soil	Placement and compaction of uncontaminated native soil over the contaminated area.	REJECTED. Ineffective due to lack of erosion and moisture control. Subject to cracking due to freeze-thaw and drying action.
	Clay	Placement and compaction of clay over the contaminated area.	REJECTED. Ineffective due to lack of erosion and moisture control. Subject to cracking due to freeze-thaw and drying action.
	Asphalt	Placement of a layer of asphalt over the contaminated area.	RETAINED. High maintenance due to poor weathering characteristics, such as photosensitivity, susceptibility to cracking, and brittleness from aging.
	Concrete	Installation of concrete slabs over the contaminated area.	RETAINED. Potential for cracking from settling and freeze-thaw action. Maintenance required.
	Gravel- or Soil-Clay	Placement of compacted clay followed by gravel or soil over the contaminated area.	RETAINED. More self-healing than single layer caps. Gravel has a cost advantage over loam or other soil cover. Maintenance required.
	Soil-Synthetic Membrane	Placement of low permeability synthetic membrane followed by soil over the contaminated area.	RETAINED. Long-term reliability of membrane is unknown. Insufficient drainage may cause erosion of the soil cover or damage the membrane. Maintenance required.

Table 9-3. Initial screening of remedial technologies for the source areas and soils (continued).

Technology	Process Option	Process Description	Comments
Capping (continued)	RCRA multilayer	Placement of compacted clay, native soil, or clay mixed with native soil, followed by installation of a synthetic membrane (including associated base and drainage material). A final soil layer is then placed over the membrane.	RETAINED. Long-term reliability of membrane is unknown. Clay layer provides additional containment. Maintenance required.
Horizontal barriers	Grout Injection	Pressure injection of grout through drilled holes in a pattern to provide a horizontal barrier of low permeability.	REJECTED. Not effective for soils beneath source areas. These soils are non-homogeneous mixtures of coal tar, sludge, clay, and sand that make it impossible to ensure that an adequate barrier has been installed.
	Block displacement	The contaminated area is surrounded by a perimeter barrier, after which grout is pressure injected into bore holes that have been strategically placed within the contaminated area.	REJECTED. Not effective for the source areas. These areas are non-homogeneous mixtures of coal tar, sludge, soil, and debris. The areas lack the mechanical strength to remain intact while being lifted.
Removal	Excavation	Removal of source area material by conventional earth-moving equipment.	RETAINED. Would be used in conjunction with treatment or disposal technologies. Requires restoration of the site with treated waste and/or clean fill.
Onsite biological treatment	Landfarming	Contaminated material is first excavated and then spread over a controlled area. The soil is then tilled concomitantly with moisture and nutrient addition to allow microbial destruction of the contaminants. May require seeding with appropriate microorganisms.	RETAINED. The abundant debris mixed with the source area materials would make implementation onsite difficult. Landfarming may not be effective for treating the pure coal tar found in the source areas, but has been effective in full-scale applications for PAH- and BTEX-contaminated soil.
	Composting	Contaminated material is placed in piles 3 to 6 feet high and aerated by turning or forced aeration. May occur in an enclosed vessel. Nutrients and moisture are added as necessary.	REJECTED. Costs are higher than landfarming. Composting may not be effective for treating the pure coal tars found in the source areas.
	Bioreactor	Contaminated material is placed in a bioreactor with sufficient water to create a slurry. The slurry is seeded with microorganisms, then aerated and mixed. Nutrients are added as necessary.	REJECTED. Costs higher than composting and landfarming.

Table 9-3. Initial screening of remedial technologies for the source areas and soils (continued).

Technology	Process Option	Process Description	Comments
Onsite chemical treatment	Oxidation	An oxidizing agent (e.g., hydrogen peroxide, hypochlorite, ozone) is added to the material. The contaminants are then oxidized to either intermediate compounds or ultimately to carbon dioxide and water.	REJECTED. Not a proven in application to PAH-contaminated material. May result in degradation of non-targeted compounds. Contaminants may degrade into products more toxic than their precursors. Hydrogen peroxide may decompose before reaching targeted compounds.
	Reduction	A reducing agent is added to the material to lower the contaminant's oxidation state and render it less toxic or more treatable.	REJECTED. Effectiveness in treating organics has not been proven. Most commonly used in treating heavy metals.
Onsite thermal treatment	Rotary kiln incinerator	Solid waste is fed into the upper end of a kiln, which rotates to mix the waste with combustion air as it passes through the kiln.	RETAINED. Extensive materials handling required to sort/size debris contained in source areas. Space onsite might be too limited for temporary storage, materials handling requirements, and incineration equipment. Refractory lining permits high operating temperatures. No moving parts within the combustion zone. Low thermal efficiency and high capital costs.
	Multiple hearth furnace	Solid waste is fed into the furnace roof from the top and pushed through drop holes into a series of vertically stacked refractory hearths.	REJECTED. Not recommended for hazardous wastes, due to low operating temperatures. Extensive materials handling required to sort/size debris contained in source areas. Space onsite might be too limited for temporary storage, materials handling requirements, and incineration equipment.
	Fluidized bed incinerator	Wastes are injected above a preheated granular bed, which is fluidized by bubbling air through a distributor plate located below the bed.	RETAINED. Extensive materials handling required to sort/size debris contained in source areas. Space onsite might be too limited for temporary storage, materials handling requirements, and incineration equipment. Refractory lining permits high operating temperatures. No moving parts within the combustion zone. Low thermal efficiency and high capital costs.

Table 9-3. Initial screening of remedial technologies for the source areas and soils (continued).

Technology	Process Option	Process Description	Comments
Onsite thermal treatment (continued)	Circulating bed incinerator	Similar to fluidized bed incineration, but the fluid moves at much higher velocities. Fluidized material is recirculated through the feed section.	RETAINED. Extensive materials handling required to sort/size debris contained in source areas. Space onsite might be too limited for temporary storage, materials handling requirements, and incineration equipment. Advantages similar to the fluidized bed, but less susceptible to corrosion. It also has a less complicated scrubber system and can maintain close temperature control, which permits heat recovery.
	High-temperature fluid waste reactor	Waste is destroyed in a reactor consisting of a tubular core of refractory material that emits radiant energy supplied by large electrodes in the jacket of the vessel.	REJECTED. Process has only been tested on a pilot-scale system. Full-scale technology not yet available. High energy consumption and extensive exhaust emission cleanup requirements.
	Infrared incinerator	Waste is conveyed by a temperature-resistant alloy belt through two heating modules. In the first module, the contaminants are combusted by infrared radiant heat provided by horizontal rows of electric powered silicon carbide rods at temperatures up to 1850° F. The infrared or gas-fired secondary combustion chamber is capable of reaching temperatures of 2300° F.	RETAINED. Extensive materials handling required to sort/size debris contained in source areas. Space onsite might be too limited for temporary storage, materials handling requirements, and incineration equipment. Full-scale system has been used on a CERCLA site.
	Molten salt incinerator	Wastes and air are injected into a bed of molten alkali metal salts, where the contaminants are destroyed by a combination of incineration, absorption, and chemical reaction.	REJECTED. Pilot scale only. Has been used successfully on highly toxic inorganic or halogenated organic wastes, but no full-scale demonstrations have been completed on PAH-contaminated material.
	Thermal extraction	Low temperature thermal pretreatment in which contaminated material is heated under anaerobic conditions to extract the contaminants in a vapor stream. Has been used (pilot scale) to remove oil from tar sands.	REJECTED. Still experimental for the removal of contaminants from material. Contaminants in source areas are already relatively concentrated. Extracted contaminants still require treatment or disposal.
	Vitrification	Wastes and glass are heated in a closed container to an extremely high temperature that melts the mix. The resulting mass is then quickly cooled and a glass-like solid is formed. Pretreatment of wastes may be required.	REJECTED. Due to extremely high costs, this technology is only applicable to radioactive or extremely dangerous wastes.

Table 9-3. Initial screening of remedial technologies for the source areas and soils (continued).

Technology	Process Option	Process Description	Comments
Onsite physical/ chemical treatment	Lime-fly ash pozzolan solidification process	Wastes are mixed with a siliceous-and-aluminous material (pozzolan) and with a lime-fly ash mixture to produce a strong and low-permeable solid.	REJECTED. Oil and grease interfere with bonding. Not proven to decrease the mobility of PAHs.
	Pozzolan-portland cement solidification processes	Wastes are mixed with a siliceous-and-aluminous material (pozzolan) and with portland cement to produce a strong and low-permeable solid.	REJECTED. This process will increase the volume of waste by as much as 100 percent. More expensive than the lime-fly ash pozzolan process, but less subject to leaching. Impurities such as metal salts, organic matter, and fine silts may increase setting times.
	Organic contaminant solidification/ stabilization processes	Organic wastes are blended with synthetic binders (many processes use proprietary chemicals) and the waste/binder material is mixed with either lime-fly ash or fly ash-cement to produce a strong low-permeability solid.	REJECTED. Process is applicable to organic wastes. Still a relatively new process. Not proven to decrease the mobility of PAHs.
	Microencapsulation	Heated dried wastes are mixed with an asphalt bitumen, paraffin, or polyethylene matrix resulting in a solid waste mass for landfill disposal.	REJECTED. Method is only applicable to small quantities of hazardous wastes that are complex and difficult to treat.
	Surface encapsulation	Includes several processes in which wastes are isolated by sealing them in an organic binder or resin.	REJECTED. High cost compared to other solidification techniques. Usually applied to very soluble toxic wastes.
Onsite physical treatment	Solids separation/sizing	Separation and sizing of source area materials by conventional materials handling equipment.	RETAINED. Would be used in conjunction with treatment or disposal technologies to ensure a homogeneous waste stream.
	Decontamination	Cleaning to remove contaminants by use of a steam jenny.	RETAINED. Would be used in conjunction with solids separation/sizing. Decontaminated material would be disposed of in a solid waste landfill as a special waste. Decontamination wash water would be treated by groundwater treatment.
Offsite thermal treatment	RCRA-approved offsite incinerator	Destruction of contaminants by incineration in an offsite RCRA-approved commercial incinerator.	RETAINED. Proven technology for destruction of organic contaminants.
	Coal fired utility boiler	Wastes are fed into a coal fired utility boiler along with the fuel.	RETAINED. Provides good mixing and long residence times.
Offsite biological treatment	Approved offsite facility	Destruction of the contaminants by biodegradation.	REJECTED. This type of treatment facility is not currently available.

Table 9-3. Initial screening of remedial technologies for the source areas and soils (continued).

Technology	Process Option	Process Description	Comments
In-situ biological treatment	Bioremediation	Enhancement of indigenous microbial activities by injecting oxygen and nutrients into the subsurface. Additional hydrocarbon degrading microorganisms may also be added if necessary.	RETAINED. Not effective for the source areas, which consist of non-homogeneous mixtures of coal tars, soil, and miscellaneous debris. However, can enhance soil remediation.
In-situ chemical treatment	Oxidation	An oxidizing agent is applied to or injected into the source area. The media within the source area is then cultivated to promote contact between the oxidizing agent and the waste. Wastes are subsequently oxidized to less toxic byproducts.	REJECTED. Not a proven in application to PAH-contaminated material. May result in degradation of non-targeted compounds. Some contaminants produce degradation products more toxic than their precursors, since the source areas consist of a non-homogeneous mixture of coal tar, soil, agent, and the contaminants.
In-situ physical/ chemical treatment	Stabilization	Powdered activated carbon or another chemical agent is mixed with the material in place. Contaminant adsorbs onto agent, or reacts with it, thereby restricting migration of the contaminant.	REJECTED. Not proven, especially with regard to long-term effectiveness on organic contaminants. Periodic reapplication of the agent is required.
	Soil flushing	A flushing solution (solvent or surfactant) is used to flood the site or is injected into the contaminated area. Sorbed contaminants are solubilized, emulsified, or chemically react with the flushing solution and thus become mobile. The contaminated elutriate is collected by pumping or through an underdrain system.	REJECTED. Limited by site conditions, including waste location and type and hydrogeology. Contaminated elutriate must be treated or disposed. It is not possible to ensure adequate contact between the flushing agent and the contaminants, since the source areas consist of non-homogeneous mixtures of coal tars, soil, and miscellaneous debris.
In-situ thermal treatment	Vitrification	An array of electrodes is inserted into the subsurface, and an electric potential is applied between the electrodes. The flowing current then heats the adjacent soils and causes the silicates to melt. The contaminants are either trapped within the melted mass as it cools or they volatilize. Contaminants that volatilize are captured by an off-gas treatment system.	REJECTED. Pilot-scale application has only been tested on radioactive and inorganic wastes. Would not be effective on the source areas, which consist of non-homogeneous mixtures of coal tars, soil, and miscellaneous debris.
Onsite disposal	Onsite landfill	Permanent onsite storage facility.	REJECTED. Not practical due to the volume of waste to be disposed of and the limited space available onsite. Would require long-term operation and maintenance and security. Not desirable in an urban area.

Table 9-3. Initial screening of remedial technologies for the source areas and soils (continued).

Technology	Process Option	Process Description	Comments
Offsite disposal	RCRA solid waste landfill/recycling facility	Disposal of treated or decontaminated waste in a solid waste landfill (as a special waste).	RETAINED. Would be used in conjunction with other technologies. Treated material would be required to meet the remedial action objectives before it could be disposed of.
	RCRA hazardous waste landfill	Disposal of contaminated waste in a RCRA-approved hazardous waste landfill.	RETAINED. Would not directly reduce toxicity or mobility of the contaminants or volume of the contaminated material. Additional remedial action might ultimately be required. This process option is retained only for miscellaneous debris that might not be effectively treated by other technologies.

Table 9-4. Initial screening of remedial technologies for contaminated groundwater/DNAPL.

Technology	Process Option	Process Description	Comments
No action	None	Site is left in its existing state.	RETAINED. The National Contingency Plan requires the no action alternative to be carried through the detailed analysis of alternatives and be considered as a baseline.
Groundwater use restriction	Absolute ownership with deed restrictions	All property over the contaminated portion of the aquifer would be purchased and groundwater usage would be restricted.	REJECTED. Area of contaminated plume is too large for effective implementation.
	State imposed use restrictions	NYSDEC restricts use of contaminated groundwater. Restrictions are incorporated into property deed.	RETAINED. Would be used in conjunction with groundwater monitoring and remedial technologies.
	Prior application	Common law and statutory schemes have authority to allocate groundwater rights and use.	REJECTED. Very difficult to implement and administer.
Groundwater monitoring	Monitor wells	Long-term monitoring of groundwater.	RETAINED. Would be used in conjunction with other remedial technologies.
Capping	All processes	Placement and maintenance of a cap of low permeability material over the area occupied by the plume of contaminated groundwater in order to minimize infiltration of surface water.	RETAINED. Capping over the plume except for where buildings stand is possible. Capping will limit infiltration and allow a more stable groundwater recovery system.
Vertical barriers	Soil-bentonite slurry wall	A trench is excavated around the contaminated area and filled with a bentonite-water slurry. The trench is later backfilled with a soil-bentonite mix.	RETAINED. Keyed into silty clay confining layer, will contain DNAPL and can be used with extraction for groundwater containment.
	Cement-bentonite slurry wall	A trench is excavated around the contaminated area and filled with a vintonite-water slurry. The trench is later backfilled with a cement-bentonite mix.	RETAINED. Same as above.
	Grout curtain	Pressure injection of grout along the contaminant boundary in a pattern of drilled holes.	REJECTED. Not generally used for containment in unconsolidated material, such as the non-homogeneous mixture of coal tars, soil, and debris in the source areas.

Table 9-4. Initial screening of remedial technologies for contaminated groundwater/NAPL (continued).

Technology	Process Option	Process Description	Comments
Vertical barriers (continued)	Sheet Piling	Installation of sheet piling along the contaminant boundary. Interlocking piles are placed with pile driver or drop hammer.	RETAINED. Integrity of the barrier is not as satisfactory as with slurry walls, due to the difficulty of sealing the piling interlocks. However, requires less space to implement and has fewer short-term impacts than slurry walls, since it requires much less excavation.
Horizontal barriers	Grout injection	Pressure injection of grout through drilled holes in a pattern to provide a barrier of low permeability.	REJECTED. Not practical due to large area of plume. Primarily used for small, shallow applications.
Gradient control	Extraction wells	Control of groundwater flow by pumping from wells to create new hydraulic gradient.	RETAINED. Standard extraction technology. Close spacing may be required due to relatively low hydraulic conductivity and aquifer thickness.
	Well points	A group of closely spaced wells, within the contaminated area, are connected to a header pipe and pumped. System is best suited for shallow aquifers.	REJECTED. Fine soils and insoluble contaminants may clog well points. Not effective for aquifers deeper than 20 feet.
	Subsurface drains	Perforated pipe or tile within a gravel-filled trench is used to remove or redirect contaminated groundwater. Drains are installed near the bottom of the aquifer.	REJECTED. Subsurface drains are generally not cost-effective compared to extraction wells. Insoluble contaminants heavier than water may clog the drains. Additionally, the more permeable strata are too deep for effective implementation of drains.
Extraction	Extraction wells	Removal of groundwater by pumping from wells.	RETAINED. Would not effectively remove all contaminated groundwater to below MCLs in a reasonable period of time due to low hydraulic conductivity of water bearing units. Would provide only limited removal of DNAPL.
	Extraction-injection wells	A system of wells for removal and reinjection of groundwater.	RETAINED. Reinjection may enhance removal.

Table 9-4. Initial screening of remedial technologies for contaminated groundwater/NAPL (continued).

Technology	Process Option	Process Description	Comments
Onsite biological treatment	Activated sludge	Organic wastes are metabolized by microorganisms in a mixed aerobic reactor. The solids retention time is controlled by recirculating the biomass from the clarification process back to the aerobic reactor.	REJECTED. Flow rate too low for cost effective use.
	Trickling filter	Liquid wastes are trickled over a bed of rocks or synthetic packing medium on which a biofilm is developed. Organics from the waste stream diffuse into the biofilm and are subsequently degraded.	RETAINED. Process may need to be enclosed to prevent release of volatile organics.
	Rotating biological contactors (RBCs)	Liquid wastes flow through troughs in which closely spaced partially submerged discs are rotated. Biological growth becomes attached to the surface of the discs and forms a biofilm. The rotation of the discs through the liquid waste stream and atmosphere allows organics and oxygen to diffuse into the biofilm. Microorganisms within the biofilm then degrade the organic wastes.	RETAINED. Process may need to be enclosed to prevent release of volatile organics.
	Fluidized bed reactor	Microorganisms are attached to inert particles within a vertical column reactor. The particles are kept in suspension by the upward flow of the liquid waste stream. The organic wastes are then degraded via microbial activity.	RETAINED. Process may need to be enclosed to prevent release of volatile organics.
	Submerged fixed film reactor	A biofilm is developed on a bed of packing or rocks, which is kept submerged and aerated. Organics from the waste stream diffuse into the biofilm and are subsequently degraded.	RETAINED. Process may need to be enclosed to prevent the release of volatile organics. Can treat dilute organic waste stream.
	Aerated lagoons	Microbial degradation of wastes in an aerated surface impoundment (oxidation pond).	REJECTED. Not enough land available onsite.
	Anaerobic lagoons	A surface impoundment with a low surface area-to-volume ratio (i.e., narrow and deep) is used to increase degradation action by anaerobic bacteria.	REJECTED. Not applicable to site contaminants.

Table 9-4. Initial screening of remedial technologies for contaminated groundwater/NAPL (continued).

Technology	Process Option	Process Description	Comments
Onsite biological treatment (continued)	Anaerobic sludge digestion	Microorganisms react with high strength wastes in a closed tank devoid of oxygen. Hydrolysis and fermentation of wastes produce methane and carbon dioxide.	REJECTED. Not applicable to site contaminants.
	Anaerobic reactors	Microorganisms react with liquid wastes in closed tanks in the absence of oxygen.	REJECTED. Not applicable to site contaminants.
	Bioharvesting	Use of plant or animal species to accumulate contaminants in their tissues. Species are harvested and disposed of in an approved fashion. Most commonly used for heavy metal contamination.	REJECTED. Not applicable to site contaminants.
Onsite physical treatment	Phase separation	Removal of physically distinct phases from the waste stream by flotation, skimming, decanting, coagulation, flocculation, and/or sedimentation.	RETAINED. May be used in conjunction with other technologies.
	Filtration	Removal of suspended particles by passing the liquid waste stream through a granular or fabric medium. Conventional treatment method.	RETAINED. May be used in conjunction with other technologies.
	Air, gas, or steam stripping	Mixing of large volumes of air, gas, or steam with the waste stream in a packed column or through diffused aeration to promote transfer of volatile organics to the air.	REJECTED. Not effective in removing PAHs due to their very low vapor pressures.
	Distillation	Separation of substances by their boiling points. Waste stream is heated to separate the more volatile components which then may be cooled to recover pure products.	REJECTED. Not practical for dilute waste streams.
	Ultrafiltration	Removal of medium to high molecular weight solutes from solution by a semi-permeable membrane under a low pressure gradient.	REJECTED. Not applicable to site contaminants. Not efficient for low level concentrations of toxic substances. Most volatile organics will pass through membranes.
	Reverse osmosis	Removal of low to medium molecular weight solutes from solution by a semi-permeable membrane under a high pressure gradient.	REJECTED. Not applicable to site contaminants. Not efficient for low level concentrations of toxic substances. Most volatile organics will pass through membranes.

Table 9-4. Initial screening of remedial technologies for contaminated groundwater/NAPL (continued).

Technology	Process Option	Process Description	Comments
Onsite physical treatment (continued)	Carbon adsorption	Carbon from materials such as wood or coal is generally placed into a fixed-bed reactor. The liquid waste stream is then passed through the bed and the organic contaminants are removed via adsorption mechanisms.	RETAINED. Effective on all organic site contaminants. Benzene is anticipated to be the first compound to break through the column based on the characteristics discussed in Section 5.2.
	Resin adsorption	Process is similar to carbon adsorption with a resin replacing the carbon as the absorbent.	REJECTED. Current data is insufficient to determine the reliability of the process in treating site contaminants.
	Ion exchange	The liquid waste stream is passed over an ion exchange resin in which ions bound to the resin are exchanged for ions within the waste stream which have a similar charge to that of the ions within the resin. This process is typically used to remove inorganic ions.	REJECTED. Not applicable to site contaminants.
Onsite chemical treatment	Neutralization	A chemical reagent is added to the waste stream to alter the pH.	REJECTED. Not applicable to site contaminants.
	Oxidation	An oxidizing agent, alone or in combination with other oxidizing agents (i.e., ozone, hydrogen peroxide, permanganate), is introduced into a contactor and mixed with the waste stream. The contaminants are then oxidized to either intermediate compounds or, ultimately, carbon dioxide and water. Most commonly used to remove phenols, cyanides, and heavy metals from the waste stream.	RETAINED. Would be used in conjunction with other technologies, such as carbon adsorption.
	Reduction	A reducing agent is introduced into a contactor where it is mixed with the waste stream to lower the oxidation state of the waste and render it less toxic or more treatable. Most commonly used for heavy metal removal.	REJECTED. Not generally applicable to site contaminants.
	Precipitation	A chemical agent is mixed with the waste stream to form an insoluble product that can be removed from the waste stream by settling. Most commonly used to remove heavy metals from the waste stream.	REJECTED. Not generally applicable to site contaminants.

Table 9-4. Initial screening of remedial technologies for contaminated groundwater/NAPL (continued).

Technology	Process Option	Process Description	Comments
Onsite chemical treatment (continued)	Chemical decomposition	A chemical agent such as sodium or sodium naphthalide is introduced into a contactor, where it is mixed with the waste stream to strip halogen atoms from chlorinated hydrocarbons. UV photolysis can be used as a catalyst or initiator.	REJECTED. Not applicable to site contaminants.
	Hydrolysis	Waste stream is reacted with water in the presence of chemical agents at elevated temperatures and pressures in order to form nonhazardous byproducts. Most commonly used to detoxify waste streams containing pesticides.	REJECTED. Not applicable to site contaminants.
	Solvent extraction	Waste stream is mixed with solvents in a contactor. The elutriate is collected and treated or disposed.	REJECTED. Not practical for dilute, aqueous wastewaters. Contaminated solvent must be treated or disposed of after use.
	Electrolytic processes	Waste stream is subjected to an electric current to either extract or destroy the contaminants. Most commonly used to treat waste streams containing heavy metals.	REJECTED. Not applicable to site contaminants.
Onsite thermal treatment	Evaporation	The contaminated waste stream is placed in large drying beds. Its volume is then reduced or eliminated through vaporization by the induction of heat from the sun.	REJECTED. Not practical due to frequent precipitation and low net evaporation rate (2 inches/year net). Additionally, there is not a sufficient amount of land available for the drying beds.
	Incineration (all process options)	All processes involving combustion of the waste stream.	REJECTED. Not practical for dilute, aqueous waste streams.
	Wet air oxidation	Oxidation of organics in an aerator under high temperature and pressure.	REJECTED. Achieving and maintaining elevated temperatures and pressures of an aqueous stream would be prohibitively expensive compared to conventional physical treatment.
	Supercritical water oxidation	Oxidation of the wastes in a supercritical environment (314° F and 218 atm).	REJECTED. Cost of achieving and maintaining supercritical conditions would be prohibitively expensive compared to conventional physical treatment.
Offsite thermal treatment	RCRA incinerator	Destruction of the contaminants by incineration at an offsite RCRA licensed incinerator.	REJECTED. Not practical for dilute aqueous waste streams.
	Coal fired utility boiler	Incineration of the wastes in a high efficiency boiler.	REJECTED. Not practical for dilute aqueous waste streams.

Table 9-4. Initial screening of remedial technologies for contaminated groundwater/NAPL (continued).

Technology	Process Option	Process Description	Comments
Offsite biological/ physical/chemical treatment	Approved offsite facility	Destruction of the contaminants by biodegradation, physical, or chemical methods at an approved facility.	REJECTED. Not practical for dilute aqueous wastestreams when onsite treatment is a viable option. Availability of offsite treatment capacity is limited.
In-situ biological treatment	Bioremediation/ sparging	Optimization of environmental conditions by injecting oxygen, nutrients, and microorganisms into the subsurface to enhance microbial degradation of the contaminants.	RETAINED. Might enhance remediation when used in conjunction with gradient control/extraction technologies by addressing adsorbed-phase constituents. Would not be effective in removing the DNAPL observed in cohesive unit 1 and the interbedded granular and cohesive unit. Biological degradation is also not very effective on PAHs containing four or more benzene rings. These include most of the carcinogenic PAHs.
In-situ physical/ chemical treatment	Permeable treatment beds	Trenches are filled with a permeable medium that reacts with or traps contaminants entering the trench as groundwater passes.	REJECTED. Not practical because of the depth of trench required.
	Chemical treatment	Chemicals are injected into the groundwater to neutralize, precipitate, or destroy the contaminants of concern.	REJECTED. Chemical processes limited by the low hydraulic conductivity of the soil. Not a proven technology for all site contaminants.
Discharge	Surface water	Discharge of treated waste stream to an onsite surface water body.	RETAINED. Permitting with treatment required to discharge to Scajaquada Creek.
	Injection wells	Discharge of treated waste stream by injection through onsite wells.	RETAINED. Might be used in conjunction with other technologies such as in-situ bioremediation, and to enhance recovery.
	Recharge trench	Discharge of treated water by introduction into gravel-filled trenches.	RETAINED.
	POTW	Discharge of treated waste stream to local publicly owned treatment works.	RETAINED. City pretreatment requirements must be met.
	Irrigation	Discharge of treated water for irrigation.	REJECTED. No user near the site. Demand is too seasonal.
	Water Supply	Piping the treated groundwater to the drinking water supply system.	REJECTED. Not practical for the low quantities of treated water that are anticipated.

Table 9-4. Initial screening of remedial technologies for contaminated groundwater/NAPL (continued).

Technology	Process Option	Process Description	Comments
Discharge (continued)	RCRA deep well injection	Disposal of the waste stream by injection into an offsite RCRA licensed deep well facility.	REJECTED. Not practical for dilute aqueous waste streams when onsite treatment is a viable option. Availability of offsite facilities is limited.

9.5 SUMMARY OF THE PROCESS OPTIONS THAT PASSED THE INITIAL TECHNOLOGY SCREENING

Process descriptions of options passing initial screening are listed in Table 9-5. According to the initial screening results, these technologies are suggested for the possible treatment remedies of contaminated soil and were evaluated in the final screening.

Process descriptions of options passing initial screening for addressing the groundwater and DNAPL are listed in Table 9-6. This table lists the initial screening results, and suggests the technologies for the possible treatment remedies of contaminated groundwater to be evaluated in this FS.

9.6 FINAL SCREENING OF RETAINED PROCESS OPTIONS FOR THE REMEDIATION OF THE SOURCE AREAS/SOIL

This section describes the final screening of technologies and process options that were retained in the initial screening for the remediation of the source areas/soil. The final screening is conducted on the basis of the effectiveness, implementability, and relative cost of each process option. The effectiveness of a process option is determined by considering the following:

- Can the process option effectively handle the volume of media to be treated?
- Can the process option achieve the remedial action objectives?
- Is the process option a proven and reliable method with respect to the contaminants and site conditions?
- What are the impacts to human health and the environment using the construction and implementation phases and can these impacts be minimized?

After evaluation of each of the process options listed in Section 9-5, process options were grouped as viable options for use in this feasibility study. Table 9-7 presents final screening of remedial technologies for source areas/soils.

Table 9-5. Process descriptions of remedial technologies passing initial screening for soils and source areas.

Remedial Technology	Process Option
No Action	None
Capping	Concrete, Asphalt, Clay, Synthetic Membrane, Multilayer RCRA
Offsite Disposal	Solid Waste Landfill, Hazardous Landfill
Onsite Biological Treatment	Landfarming
Onsite Thermal Treatment	Rotary Kiln, Fluidized Bed, Circulating Bed, Infrared
Onsite Physical Treatment	Separation, Decontamination
Offsite Thermal Treatment	Utility Boiler, Incinerator
Offsite Biological Treatment	Landfarming
In-situ Biological Treatment	Bioventing

Table 9-6. Process descriptions of the preliminary remedial technologies passing initial screening for contaminated groundwater and DNAPL.

Remedial Technology	Process Option
No Action	No Action
Access Restrictions	Land Use Restrictions
Capping	All Types
Vertical Barriers	All Types
Gradient Control/Removal	Extraction Wells, Injection Wells
Onsite Physical Treatment	GAC, Phase Separation, Filtration
Onsite Biological Treatment	Trickling Filter, Fluidized Bed, Submerged Fixed Film, RBCs
In-situ Biological Treatment	Bioremediation
Onsite Chemical Treatment	Oxidation
Discharge	Surface Water, POTW, Reinjection

Note: RBC is rotating biological contactors.

Table 9-7. Final screening of remedial technologies for the source areas/soils.

General Response Action	Remedial Technology	Process Option	Effectiveness	Screening Criteria Implementability	Relative Cost
No action	None	None*	Would not meet remedial action objectives.	Not applicable.	None.
Institutional control	Site access and land use restrictions	Site access restrictions*	Would be effective in conjunction with other remedial technologies, such as capping.	Implementation is easy. Would require long-term security activities.	Low capital. Low maintenance.
		Fencing and temporary barriers*	Would be effective in conjunction with other remedial technologies, such as capping.	Implementation is easy and has already begun. Would require long-term security and maintenance activities.	Low capital. Low maintenance.
	Environmental monitoring	Monitoring*	Would be effective in evaluating the effectiveness of remedial actions, such as capping or onsite incineration.	Implementation is easy and has already begun. Conventional technology. Equipment, personnel, and services readily available.	Low capital. Low maintenance.
Containment	Capping	Asphalt	Would effectively minimize the potential for direct contact with contaminated material, if properly maintained. Moderately effective in reducing infiltration. Susceptible to deterioration due to poor weathering characteristics, photosensitivity, brittleness with age, and cracking.	Easily implementable. Conventional technology. Equipment, personnel, and services readily available. Requires restrictions on future land use and long-term maintenance.	Low capital. Moderate maintenance.

* Process option selected for alternative development.

Table 9-7. Final screening of remedial technologies for the source areas/soils (continued).

General Response Action	Remedial Technology	Process Option	Effectiveness	Screening Criteria Implementability	Relative Cost
Containment (continued)	Capping (continued)	Concrete	Would effectively minimize the potential for direct contact with contaminated material, if properly maintained. Moderately effective in reducing infiltration. Potential for cracking due to freeze-thaw and drying action.	Easily implementable. More durable than asphalt and less maintenance required than gravel- or soil-clay caps. Conventional technology. Equipment, personnel, and services readily available. Requires restrictions on future land use and long-term maintenance.	Moderate capital. Moderate maintenance.
		Gravel- or soil-clay*	Would effectively minimize the potential for direct contact with contaminated material, if properly maintained. Moderately effective in reducing infiltration. Subject to erosion.	Easily implementable. Conventional technology. Equipment, personnel, and services readily available. Requires restrictions on future land use and long-term maintenance.	Moderate capital. Moderate maintenance.
		Soil-synthetic membrane	Would effectively minimize the potential for direct contact with contaminated material, if properly maintained. More effective than asphalt, concrete, or gravel-soil caps at reducing infiltration. Susceptible to tearing or puncture. Long-term reliability of the membrane uncertain.	Implementable. Conventional technology. Equipment, personnel, and services are readily available. Requires restrictions on future land use and long-term maintenance.	Moderate capital. Moderate maintenance.
		RCRA multilayer	Would effectively minimize the potential for direct contact with contaminated material, if properly maintained. Most effective cap for reducing infiltration.	Implementable. Conventional technology. Equipment, personnel, and services are readily available. Requires restrictions on future land use and long-term maintenance. Difficult to tie into existing structures.	High capital. Moderate maintenance.
Removal	Excavation	Excavation*	Proven, reliable technology. Would effectively reduce the potential threat to human health and the environment. Short-term impacts include noise and fugitive dust emissions.	Easily implementable. Conventional technology. Equipment, personnel, and services readily available.	Low to moderate capital.

* Process option selected for alternative development.

Table 9-7. Final screening of remedial technologies for the source areas/soils (continued).

General Response Action	Remedial Technology	Process Option	Effectiveness	Screening Criteria Implementability	Relative Cost
Onsite treatment	Biological	Landfarming*	Not proven for coal tar contaminated soil but effective for general TPH removal. Will require pilot testing.	Limited space available. Extended time required for treatment.	Moderate capital. Moderate maintenance.
Onsite treatment (continued)	Thermal	Rotary kiln	Effective and proven method for destruction of organic contaminants. Short-term impacts would include noise and potential air emissions. Relatively low thermal efficiency.	Implementable. Extensive performance and permitting requirements must be met. Extensive materials handling required to separate source area debris. Onsite space available might be insufficient for temporary storage of excavated source area materials, in addition to incineration and materials handling equipment. Might not be acceptable in a residential area.	High capital. Moderate maintenance.
		Fluidized bed	Effective and proven method for destruction of organic contaminants. Short-term impacts would include noise and potential air emissions. Low operational temperature.	Implementable. Same as above.	High capital. Moderate maintenance.
		Circulating bed	Effective and proven method of destruction of organic contaminants. Short-term impacts would include noise and potential air emissions. Efficient heat recovery.	Implementable: Same as above.	High capital. Moderate Maintenance.

* Process option selected for alternative development.

Table 9-7. Final screening of remedial technologies for the source areas/soils (continued).

General Response Action	Remedial Technology	Process Option	Effectiveness	Screening Criteria Implementability	Relative Cost
Onsite treatment (continued)	Thermal (continued)	Infrared	Effective and proven method of destruction of organic contaminants. Short-term impacts would include noise and potential air emissions. Low particulate emissions.	Implementable. Same as above.	High capital. Moderate maintenance.
	Physical	Solids separation/* sizing	Effective when used to provide a more homogeneous waste stream. Does not decrease toxicity or mobility of the wastes. Reduces volume through decontamination and would be used in conjunction with other technologies such as incineration.	Easily implementable. Services, personnel, and equipment readily available.	Low capital. Low maintenance.
		Decontamination*	Effective and proven method of treating some source area materials. Would be used in conjunction with other treatment and disposal technologies. Would decrease the toxicity and volume of contaminated materials.	Easily implementable. Services, personnel, and equipment readily available. Decontamination wash waters would require treatment or disposal.	Low capital. Low maintenance.
In-situ treatment	Biological	Bioremediation* (bioventing)	Proven effective for BTEX and light PAHs in soil. Not demonstrated for 4- and 5-ring PAHs.	Easily implementable. Venting wells and equipment available. May require air emissions notification.	Low capital. Low maintenance.
Offsite treatment	Thermal	RCRA incinerator	Effective and proven method for destruction of organic contaminants. Transportation to offsite facility required. Short-term impacts include dust and noise associated with waste excavation.	Implementable. Permitting may be required for transport. Facility must be in compliance with RCRA and state regulations.	Very high capital. Low maintenance.

* Process option selected for alternative development.

Table 9-7. Final screening of remedial technologies for the source areas/soils (continued).

General Response Action	Remedial Technology	Process Option	Effectiveness	Screening Criteria Implementability	Relative Cost
Offsite treatment (continued)	Thermal (continued)	Coal fired utility boiler*	Effective and proven method for destruction of organic contaminants. Transportation to offsite facility required. Short-term impacts include dust and noise associated with waste excavation and increased traffic at the site.	Implementable. Ash from boiler would not be a hazardous waste. Facility to accept material must be located.	Moderate capital. Low maintenance.
Offsite disposal		RCRA solid waste landfill/recycling facility	Proven, effective method of disposing of treated soils and decontaminated rubble. Transportation to offsite facility required.	Implementable. Treatment or decontamination certification of material required before transport and disposal due to TCLP benzene.	Moderate capital. Low maintenance.
		RCRA hazardous waste landfill	Proven, effective method of disposing of some contaminated materials. Would be used in conjunction with other technologies. Transportation offsite required.	Implementable. Permitting may be required for transport. Facility must be in compliance with RCRA and receiving state regulations.	High capital. Low maintenance.

* Process option selected for alternative development.

Each technology is evaluated for the extent to which it will eliminate significant threats to public health and the environment through reductions in toxicity, mobility, and volume of hazardous wastes at the site, and to comply with ARARs. Both short-term and long-term effectiveness are evaluated; short-term referring to the construction and implementation period, and long-term referring to the operational period after the remedial action is in place and demonstrated to be effective.

Implementability is a measure of both the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. Technical feasibility refers to the ability to construct, reliably operate and meet technical specifications or criteria, and the availability of specific equipment and technical specialists to operate necessary process units. It also includes operation, maintenance, replacement, and monitoring of technical components of an alternative, if required, into the future after the remedial action is complete. Administrative feasibility refers to compliance with applicable rules, regulations and statutes and the ability to obtain approvals from other offices and agencies. Additionally, it reflects the availability of treatment, storage, and disposal services and capacity.

Determination that technology is not technically feasible and not available for implementation will preclude it from further consideration unless steps can be taken to change the conditions responsible for the determination. Technologies that are clearly ineffective or unworkable at the site are eliminated in the initial screening process. Because of this, the evaluation is based primarily on the institutional aspects of implementability, which take into account the following:

- Can the necessary approvals for the implementation of the process be obtained from the governmental agencies which are to oversee the remediation of the site?

- Are the necessary skilled personnel and equipment available to implement the technology?

Cost plays a limited role in the screening of process options. Relative capital and O & M costs were used rather than detailed estimates.

The cost analysis is made on the basis of engineering judgment, and each process was evaluated as to whether costs were high, low, or medium relative to other process options.

The results of the final screening and descriptions of the process options selected for use in the development of the remedial action alternatives for the source areas/soils are listed in the following subsections.

9.6.1 No Action

According to the "no action" remedial alternative, the site will be left in its existing state. No funds would be expended to remediate, monitor or control the contaminated source areas. No action would fail to meet the goals of the remedial action objectives, as it would not reduce the potential for contaminated source area material to migrate from the site, or minimize or eliminate the potential hazards associated with the source area contamination at the site. No action is selected as a technology to be used in remedial alternatives due to CERCLA guidance for comparison purposes.

9.6.2 Institutional Controls

Site access, land use restrictions, and soil monitoring are all institutional controls in place that affect the remediation of source areas. The institutional controls are all to be employed in alternative assembly as portions of all alternatives. Land use restrictions would be placed on the site to limit future use of the site by either recording deed restrictions which state that potentially hazardous materials were disposed of or have migrated onto the properties, or that use restrictions have been imposed on the properties. Because contamination at the site is subsurface, such use restrictions would substantially limit any intrusive activities, such as boring or excavating that would involve disturbing the subsurface soil.

Land use restrictions would limit future use of the site until potentially hazardous materials and all contaminated structures, equipment, and soil were removed from the site (40 CFR 265.119). These restrictions alone, however, would not meet the remedial action objectives. When used in conjunction with other remedial action technologies, land use restrictions can be effective in attaining remedial action objectives. In order to effectively enforce land use restrictions, long-term security measures would have to be implemented. Construction of a fence around the contaminated areas and periodic site inspections are examples of security measures that can be implemented at a low cost.

Depending on the selected remedial alternative, soil monitoring would involve possible investigative and confirmatory soil borings and soil sampling. Soil sampling would be performed in order to ensure that the remedial action objectives were being met and would be used in conjunction with other technologies, such as excavation.

Soil monitoring is a proven, reliable method for assessing the degree of soil contamination and the effectiveness of remedial actions. Onsite and offsite samples have been collected on several occasions, and the equipment and personnel necessary to implement soil monitoring are readily available. Low construction costs are associated with implementing a soil monitoring program because sampling would not be repeated once the source areas have been remediated.

9.6.3 Containment

9.6.3.1 Capping

Capping consists of placing a permanent layer or layers of low permeability material over the contaminated source areas. Restrictions on future site use to prevent damage to the cap and a groundwater monitoring program to monitor the effectiveness of the cap would be required. In addition, for the cap to remain effective over an extended period, cap inspection and maintenance programs would have to be implemented.

Five capping technologies were retained after the initial screening. Since all five options are approximately equal in protectiveness, the gravel or soil-clay cap was selected as the representative option for development and evaluating the alternatives in Chapter 10 on the basis of site considerations, low maintenance, and ease of installation. It should be noted that, if capping were selected as a remedial technology, any of the five capping technologies could be implemented during the remedial action.

The gravel- or soil-clay cap would consist of a layer of clay ($\leq 1 \times 10^{-7}$ cm/sec permeability) below soil and/or gravel. Capping is a proven and conventional practice for the long-term containment of hazardous wastes. However, this process does not treat or destroy the contaminants, nor does it reduce the toxicity or volume of the contaminated material. Capping would minimize the potential for direct contact with the contaminated material, as long as the cap was properly maintained. It would also minimize leachate generation by reducing infiltration into the contaminated source areas. Caps with synthetic membranes are most effective in reducing infiltration and would be selected if infiltration were a major concern at the site.

The equipment and services necessary to carry out this technology are readily available. The costs involved in implementing a capping technology vary depending on the complexity of the cap and the material used to construct it. However, capping construction and O&M costs are much lower, on the average, than the costs of excavation of the source areas and subsequent treatment or disposal.

9.6.4 Removal

9.6.4.1 Soil Excavation

This technology involves using relatively simple mechanical excavation processes and conventional earth-moving equipment such as bulldozers, front-end loaders, and backhoes to remove the contaminated source area material. The material to be removed would include surface soil, gravel, and concrete, as well as subsurface soil, miscellaneous debris, and coal tar.

Excavation is an effective and proven method for material removal. Removing the material from the source areas would have several advantages, including reduction of potential future human and environmental contact with the contaminants and minimization of future migration of the contaminants into the environment. However, the source area is widespread at the IG/WS site and mainly under structures, making complete removal infeasible. This remedial technology is selected for alternative assembly, since it is to be used in conjunction with the application of treatment or disposal technologies. Potential short-term risks associated with excavation involve worker exposure to the contaminants. The community and the environment may also be exposed to volatilized contaminants, contaminants adsorbed to fugitive dust particles, or contaminants transported by surface runoff. Minor potential short-term impacts during excavation include noise and exhaust emissions from the construction equipment.

Excavation away from buildings could be easily implemented. The equipment, services, and personnel are readily available. Arrangements must be made for the temporary storage and subsequent transport, treatment, and disposal of the excavated material. If the material were not returned to the excavated area after treatment, backfilling with clean soil or fill and application of a gravel layer to prevent erosion would be necessary. The costs associated with implementation of this technology, not including disposal costs, are moderate.

9.6.5 Onsite Treatment

9.6.5.1 Biological

This technology involves the bacterial degradation of organic contaminants. Only the landfarming technology passed the initial technology screening and thus will be used for alternative assembly.

Landfarming has not been proven effective in treating PAH-contaminated solids. Pilot testing would be required to evaluate whether the pure phase coal tars and four- and five-ring PAHs could be successfully remediated/degraded to action levels by the biological treatment process option. In addition, extensive materials handling would be required to separate and size the source area rubble to the pea gravel size necessary to provide a homogeneous media for biological treatment. The limited space available onsite in uncontaminated areas would limit the size of the treatment area, and require processing of a large number of small soil volume batches. The time required to treat all the batches of contaminated source area materials is excessive compared to other treatment technologies. Long-term biological treatment onsite might also not be acceptable in a residential area.

9.6.5.2 Thermal

This remedial technology consists of incinerating the contaminated media in a mobile incinerator temporarily located at the site. Four onsite incineration process options passed the initial screening: rotary kiln, fluidized bed, circulating bed, and infrared. Each of these technologies is described briefly on Table 9-2. Although onsite thermal incineration is a proven and effective technology for converting hazardous organic contaminants into nonhazardous components through the application of thermal energy, none of the process options passing the initial screening has been selected for the development and evaluation of technologies in Chapter 10 for the following reasons:

- Available space onsite in uncontaminated areas is extremely limited. There may be insufficient space for the required temporary storage of excavated materials in addition to the space required for materials handling and incineration equipment.

- Onsite incineration might not be acceptable in a residential area.

- Offsite incineration in a coal-fired utility boiler is equally effective and available at a significantly lower cost.

9.6.5.3 Solids Separation/Sizing

This technology involves using simple material handling methods such as screens and shredders to separate the large pieces of debris from the source area material and reduce the pieces to a homogeneous size.

Solids separation/sizing is a proven and effective method of handling contaminated materials. While no reduction in toxicity of contaminated material is achieved, solids separation/sizing produces a homogeneous waste stream that can be treated more efficiently and reduces volume through decontamination. The technology would be used in conjunction with offsite treatment and/or disposal technologies. Potential short-term risks include site worker exposure to the contaminants and possible fugitive dust or volatile emissions from the machinery.

Solids separation/sizing could be easily implemented. The equipment, personnel, and services to conduct it are available. Arrangements would have to be made for the temporary stockpiling of excavated and separated material. Since separated material would be periodically transported offsite for treatment and/or disposal, the area required for storage could be fairly small. The costs of implementing this technology are moderate.

9.6.5.4 Decontamination

This technology involves using simple processes, such as cleaning by steam or washing with a solvent or soap solution, to decontaminate the debris that cannot be sized.

Decontamination is a proven and effective method of treating debris. Reductions in contaminated material volume would be achieved, since the decontaminated material would be remediated. Potential short-term risks associated with decontamination include worker exposure to the contaminants and exposure of the community and the environment to contaminants adsorbed to fugitive dust, transported in water sprays, or volatilized from the contaminated material.

Decontamination could be easily implemented. The equipment, personnel, and services to conduct it are readily available. Arrangements must be made for the collection and treatment or disposal of the used decontamination solutions. The costs of implementing this technology would be low.

9.6.6 In-situ Treatment

In-situ bioremediation is a method of remediating soils and groundwater contaminated with biodegradable contaminants through the addition of oxygen, often with water enriched with nitrogen and phosphorus, into the subsurface. This results in the enhanced growth and activity of aerobic bacteria, which use the contaminants as a source of carbon and energy to convert these contaminants to carbon dioxide and water.

Although aerobic in-situ bioremediation has been applied at many sites for lighter hydrocarbons, such as gasoline and diesel fuels, there is limited information on its application at sites containing heavy organics. One report suggests that it has been at least partially successful in removing the soluble PAH constituents within a highly permeable aquifer at a creosote site in Libby, Montana (Piotrowski and Doyle, 1989).

This technology requires an injection and recovery system designed to prevent the escape of contaminated groundwater from the area of treatment, while maximizing the transport of nutrients through the most highly contaminated regions. This typically involves the additional of oxygen and nutrients along the upgradient edge of the contaminated area, using injection wells or an injection gallery, and capture of groundwater downgradient of the contamination. Selection of the best injection/ recovery design depends upon the location of the contamination, the groundwater, the hydraulic conductivity of the soil, and physical limitations of the site.

Alternatively, bioremediation by biosparging, a variant of air sparging, uses air injected into the saturated zone beneath the water table to stimulate biodegradation. Volatilization of some compounds occurs with the sparging process. Bioventing is used in combination with biosparging to deliver oxygen to the vadose zone and recover any volatile emissions caused by sparging or bioventing. Bench-scale testing will determine the need for nutrient injection. For purposes of final technology screening and alternative evaluation, the biosparging/bioventing approach is the bioremediation technology considered.

Typical applications have involved sites containing aquifers with medium to coarse sand or weathered bedrock. If phase-separated hydrocarbons are present, they are removed using recovery wells (or trenches) and pumps.

Contaminants must dissolve (even on a molecular level) prior to biodegradation. In those instances where contaminants are present as occluded droplets or as viscous liquids, dissolution can be retarded, thus reducing the rate and, potentially, the effectiveness of the process. It should also be noted, however, that microorganisms create surfactants which accelerate the process, compared to that which occurs with simple water flushing.

9.6.7 Off-site Treatment

9.6.7.1 Thermal

This technology involves transport of the contaminated material to an offsite RCRA incinerator facility or to an approved offsite coal-fired utility boiler for thermal destruction.

Thermal treatment is an effective and proven method for the destruction of organic wastes and cyanide compounds. Incineration of the contaminated media would result in a reduction of long-term risks to the public health and the environment. Short-term risks include potential worker exposure and potential releases of fugitive dust and volatile organics during the loading and transport of source area material, and increased traffic in the area of the site with subsequent increases in dust and noise.

The cost to transport and incinerate the contaminated soil by fuel blending at an electric station would be moderate. Incremental maintenance costs associated with this technology would be very low. The associated costs are expected to be substantially less than the cost of transporting and incinerating the material at a RCRA incinerator; therefore, thermal treatment by fuels blending at a utility boiler is selected for alternative assembly.

9.6.8 Offsite Disposal

Offsite disposal involves the transport of material from the site to an approved landfill offsite. Two options passed the initial screening, disposal in a RCRA Subtitle D solid waste landfill or alternative solid waste recycling facility, and disposal in a RCRA Subtitle C hazardous waste landfill. Both options were retained through initial screening, since both may be necessary to address the disposal of source area materials. Material passing TCLP testing and contaminated debris that could not be sized would be decontaminated (see Section 9.6.5.4) and shipped to a solid waste landfill as a special waste. Contaminated material that could not be sized, decontaminated, or treated would be sent to a hazardous waste landfill as a CERCLA hazardous substance. However, offsite disposal methods were not selected for alternative assembly, since thermal treatment of most excavated material is feasible, more protective, less expensive than hazardous waste landfilling, and similar or slightly higher in cost than solid waste disposal.

Offsite disposal is a conventional and proven remedy. The short-term impacts of shipping decontaminated rubble to a solid waste landfill would be similar to offsite thermal treatment except that, since the material would have been decontaminated, potential releases from fugitive dust emissions would not pose a significant risk to human health or the environment. The remedial action objectives would be met, since only decontaminated materials could be disposed of in the solid waste landfill. The short-term impacts of shipping contaminated materials to a hazardous waste landfill would be the same as for offsite thermal treatment.

Implementation of this process option ordinarily is routine. Since the material being shipped to a solid waste landfill would have been decontaminated, it usually is possible to obtain the necessary approvals from the appropriate government agencies. It should also be possible to obtain the necessary approvals for any materials shipped to a hazardous waste landfill, as long as the shipment complied with Department of Transportation (DOT) hazardous substance regulations. The construction costs to implement this option would be moderate. Since there would not be any source or material left at the site, O&M costs are be negligible.

9.7 FINAL SCREENING OF RETAINED PROCESS OPTIONS FOR REMEDIATION OF GROUNDWATER/DNAPL

This section describes the final screening of technologies and process options that were retained for the remediation of groundwater and DNAPL. The final screening is conducted on the basis of the effectiveness, implementability, and relative cost of each process option as described in Section 9.6. After evaluation of each of the process options described in Section 9.4, process options selected as viable options for use in the feasibility study are presented in Table 9-8.

The results of the final screening and descriptions of the process options selected for use in the development of the remedial action alternatives for groundwater/DNAPL are listed in the following subsections.

Table 9-8. Final screening of remedial technologies for the groundwater and DNAPL.

General Response Action	Remedial Technology	Process Option	Effectiveness	Screening Criteria Implementability	Relative Cost
No action	None	None*	No action provides no mechanism to remove or monitor if migration or degradation of contaminants is occurring, so it would not meet RAOs.	Not applicable.	None.
Institutional control	None	Groundwater use restrictions*	Would be effective in preventing ingestion of contaminated groundwater. Would be used in conjunction with other remedial actions, such as monitoring or gradient control.	Implementable. Personnel and administrative procedures are available. Implementation on site property would be routine and required.	Low capital. Low maintenance.
	Groundwater monitoring	Monitoring*	Monitoring would be effective in protecting human health and the environment by verifying that contaminants were not continuing to migrate.	Currently being implemented under the interim groundwater removal and treatment program. Equipment, personnel, and services are available.	Low capital. Moderate maintenance.
Containment	Vertical barriers	Soil-bentonite slurry wall	Would effectively reduce horizontal infiltration of contaminants. Proven, reliable technology. Short-term impacts include noise and potential fugitive dust emissions.	Implementable, but requires large working area. Conventional technology. Equipment, personnel, and services are readily available. Requires restrictions on future groundwater use.	Moderate capital. Low maintenance.
		Cement-bentonite slurry wall	Effective in reducing horizontal infiltration of contaminants. Proven, reliable technology. Short term impacts include noise and potential fugitive dust emissions.	Implementable, but requires large working area. Requires restrictions on future groundwater use.	Moderate capital. Low maintenance.

* Process option selected for alternative development.

Table 9-8. Final screening of remedial technologies for the groundwater and NAPL (continued).

General Response Action	Remedial Technology	Process Option	Effectiveness	Screening Criteria Implementability	Relative Cost
Containment (continued)	Vertical barriers (continued)	Sheet piling*	Effective in reducing horizontal infiltration of contaminants with grouting at joints, although not as effective as slurry walls. Proven, reliable technology. Short-term impacts include noise and dust.	Most easily implemented vertical barrier technology. Equipment, personnel, and services are readily available. Requires restrictions on future groundwater use.	Moderate capital. Low maintenance.
	Capping	All types*	Effective in minimizing infiltration for a more stable extraction; however, prevents flushing of contaminants.	Implementable. Conventional technology, services readily available.	Moderate capital. Moderate maintenance.
Containment and removal	Gradient control and extraction	Extraction wells*	Effective in reducing lateral migration of contaminants. Proven, reliable technology. Would be used in conjunction with groundwater treatment.	Easily implementable. Equipment and services readily available.	Low capital. Moderate maintenance.
Onsite treatment	Biological	Trickling filter	Can effectively remove aromatic hydrocarbons. Larger, more complex aromatics are more difficult to metabolize. Might be used in conjunction with another treatment process, such as carbon adsorption.	Implementable. Equipment and services readily available. Growth of biofilm required. This option is susceptible to shock loading.	Moderate capital. Moderate maintenance.
		Rotating biological contactor	Can effectively remove aromatic hydrocarbons. Larger, and more complex aromatics are more difficult to metabolize. Might be used in conjunction with another treatment process, such as carbon adsorption.	Implementable. Equipment and services readily available. Growth of biofilm required. Least susceptible of biological process options to shock loadings.	Moderate capital. Low to moderate maintenance.

* Process option selected for alternative development.

Table 9-8. Final screening of remedial technologies for the groundwater and NAPL (continued).

General Response Action	Remedial Technology	Process Option	Effectiveness	Screening Criteria Implementability	Relative Cost
Onsite treatment (continued)	Biological (continued)	Fluidized bed reactor	Can effectively remove aromatic hydrocarbons. Larger and more complex aromatics are more difficult to metabolize. Might need to be used in conjunction with another treatment process, such as carbon adsorption.	Implementable. Proven technology for removal of organic contaminants. Equipment and services readily available. Most technically complex option.	Moderate capital. Moderate to high maintenance.
		Submerged fixed film reactor	Most effective process for removing hydrocarbons from dilute contaminated waste streams. Larger, and more complex aromatics are more difficult to metabolize. Might need to be used in conjunction with another treatment process, such as carbon adsorption.	Implementable. Proven technology for removal of organic contaminants from waste streams contaminated with low levels of contamination. Equipment and services readily available.	Moderate capital. Moderate to high maintenance.
	Physical	Phase separation*	Effective with site contaminants. Conventional technology. Might be used as a pretreatment for other treatment processes, such as carbon adsorption.	Implementable. The separated oil, solids, and sludges might contain concentrations of contaminants that would require further treatment or disposal.	Moderate capital. Low maintenance.
		Filtration*	Conventional technology. Would be used as a pretreatment for other treatment processes, such as carbon adsorption.	Implementable. Used filters would require disposal or cleaning.	Low capital. Moderate maintenance.
		Carbon adsorption*	Effective treatment for all organic site contaminants. Reliable, proven technology.	Implementable. Spent carbon would require disposal or regeneration.	Low capital. Moderate maintenance.
	Chemical	Oxidation	Effective option for treating most site contaminants. Not a proven technology for treating PAHs.	Implementable. Treated water may require further treatment before it could be discharged.	Low to moderate capital. Moderate maintenance.

* Process option selected for alternative development.

Table 9-8. Final screening of remedial technologies for the groundwater and NAPL (continued).

General Response Action	Remedial Technology	Process Option	Effectiveness	Screening Criteria Implementability	Relative Cost
In-situ treatment	Biological	Bioremediation/ sparging*	Might enhance remediation using gradient control/extraction technologies. However, hydraulic conductivity of water bearing units is lower than the desirable range for effective application of this technology. Would not be completely effective in treating DNAPL. Might not be effective in treating PAHs containing four or more benzene rings.	Implementable. Extracted water would require treatment prior to discharge. Permit might be required for sparging wells.	Low capital. Moderate maintenance.
Discharge		On-site injection wells	May speed remediation by enhancing recovery.	Implementable. Might require extensive maintenance at low flow rates.	Low capital. Moderate to high maintenance.
		Surface water	Effective, proven method of disposing of treated groundwater. Could be used in conjunction with other remedial technologies.	Might be difficult to implement, since an NPDES permit is required for discharge to surface water.	Low capital. Low maintenance.
		POTW*	Effective, proven method of disposing of treated groundwater. Would be used in conjunction with onsite extraction and treatment technologies.	Currently being implemented under interim groundwater program. Treated water would be required to meet City of Fairfield POTW pretreatment standards.	Low capital. Low maintenance.

* Process option selected for alternative development.

9.7.1 <u>No Action</u>

According to the "no action" remedial technology selected for alternative assembly due to CERCLA guidance, the site would be left in its existing state. No funds would be expended to remediate, monitor or control the contaminated groundwater/DNAPL. The risk assessment concludes that there are no current significant, direct exposure pathways (i.e., risk is less than 10^{-6}) associated with the groundwater/DNAPL. Based on risk, the alternative would therefore be effective in protecting human. However, the risk assessment provides no mechanism to verify that contaminants in the groundwater and DNAPL are not continuing to migrate. Additionally, the no action technology includes no active attempt to meet RAOs.

No remedial activity would be conducted, because this option does not have any short-term impacts and no personnel or equipment would be required. There are also no construction or maintenance costs associated with this technology.

9.7.2 <u>Institutional Controls</u>

9.7.2.1 Groundwater Use Restrictions

Groundwater use restrictions involve implementing restrictions for all properties above the contaminated groundwater plume and on any properties and any properties that could be impacted by pumping of the contaminated groundwater. These restrictions would be written into the property deeds to inform future property owners that the groundwater under their property might be contaminated.

Groundwater use restrictions are a proven, reliable method for preventing the ingestion of contaminated groundwater. All residents in the area are connected to the city water supply, thus short- and long-term impacts should be minimal. The only short-term impacts might include equipment noise associated with the abandonment of area wells.

The personnel and administrative procedures necessary for implementation of groundwater use restrictions are available at NYSDEC. The means for implementing this option would have low construction costs and low overhead and maintenance costs. This process option has been selected for development and evaluation of alternatives in Chapter 10.

9.7.2.2 Groundwater Monitoring

Groundwater monitoring, also selected for alternative assembly, involves monitoring existing wells, collecting and analyzing groundwater samples, and installing new monitor wells if necessary. Measurements of groundwater elevations and analysis of groundwater samples would be performed periodically to determine not only contaminant concentration levels, but whether migration of contaminants is taking place.

9.7.3 Containment and Removal

9.7.3.1 Vertical Barriers

Vertical barrier technologies involve installing a permanent barrier of low permeability materials above the Scajaquada Creek bank for an approximate length of 500 feet downgradient of existing source areas. The barrier would extend from the ground surface to the silty clay underlying the fill material. The barrier would be keyed into the silty clay for a total depth of ten to 35 feet. Three vertical barrier options passed the initial screening. These were soil-bentonite slurry wall, cement-bentonite slurry wall, and sheet piling. Sheet piling with grouting at joints was selected as the representative option for developing and evaluating alternatives in Chapter 10, because although it can be slightly more pervious, it is easier to install on a small site in an urban area than either of the slurry walls. Slurry walls require excavation of a trench to an impervious layer under the site. They also require a large working area to one side of the trench to store the excavated soil and to prepare the final mix used to backfill the trench. At the IG/WS site, this area requirement impedes the trench implementability.

Sheet piling barriers are usually metal pilings **(recent applications using HDPE sheet piling system have also been successful)** that are driven into the ground to form an impervious wall. Grout may be injected at the wall joints to enhance effectiveness. The process requires about ten feet of work space on each side of the barrier. A six- to 12-foot-deep trench is excavated and a template is used to keep the pilings vertical as they are driven into the ground. The template is long enough to hold approximately ten pilings. The pilings are set into the template by a crane and driven into the ground with a drop or steam hammer. All the pilings in the template are driven into the ground so that each of the pilings is locked to its neighbor. A piling is usually two feet wide and 30 feet long. Cathodic protection may be provided, if required, to reduce corrosion of the sheet piles and extend the life of the system. Once the piles have been driven to the desired depth, the template is moved to the next section of trench and the completed section is backfilled with an impervious soil.

The sheet piling option would be used in conjunction with a gradient control technology to prevent possible migration of contaminated groundwater around the barrier wall or through the grouted joints connecting the sheet pile sections. The extraction systems would be installed upgradient of the sheet piling. By lowering the hydraulic head upgradient of the pilings, the extraction system would ensure that all groundwater flow was upgradient from the sheet piling containment. When combined with a groundwater extraction system, sheet piling is a proven, reliable method of containment. To the extent possible, the objective would be to install the sheet piling downgradient of the source areas, along the property boundary, in order to contain them. Therefore, there should be little, if any, short-term risks to human health or the environment during implementation. There would be construction noise and some dust generated during the construction of the barrier.

This option would have moderate construction costs and low maintenance costs. It should be noted that costs for maintaining the groundwater extraction systems have not been included under this process option.

9.7.3.2 Extraction Wells.

Gradient control by the use of extraction wells and the vertical barrier allows containment of groundwater, eliminating migration to Scajaquada Creek. This process involves the installation of extraction wells to control the direction of groundwater flow. As higher volumes of water are pumped from each well, the hydraulic head in the vicinity of the well is lowered, creating a cone of depression in the groundwater surface. This radius of depression produces a capture zone. When extraction wells are installed inside the perimeter of a vertical barrier, the wells lower the head inside the barrier, enhancing the capture zone. This would be the primary objective of using extraction wells, due to the hydrogeologic conditions and containment characteristics at the IG/WS site. Gradient control is retained for use with vertical barrier technologies in this feasibility study. While gradient control is accomplished, contaminated groundwater and DNAPL would be removed from the subsurface for an effective reduction in waste toxicity and volume.

This combination of process options is a proven, reliable method of containment. Short-term impacts of this option include noise and potential worker exposure to subsurface contamination during installation of the wells. Provisions would be made for treating and discharging water from the wells.

9.7.3.3 Capping

Any of the caps retained in the initial screening will limit infiltration, especially membrane caps. The use of a gravel/clay cap will yield a lower and more stable groundwater containment system flow rate, but will provide some flushing of contaminants. As a groundwater remediation technology, capping is selected for alternative assembly; however, it is also included in the soil/source area remedial technologies for purposes of preventing dermal contact.

9.7.4 Onsite Treatment

9.7.4.1 Biological

Four biological treatment process options passed the initial screening and include trickling filter, fluidized bed reactor, rotating biological contactors, and submerged fixed film reactors. All four of these options utilized microbes to convert organic contaminants to cell mass and carbon dioxide. The treatment of organically contaminated water is a proven, effective, and conventional technology; however, none of the options passing the initial screening have been selected for the development and evaluation of technologies in Chapter 10. The extremely low expected yield from the extraction wells and relatively low concentrations of dissolved organics encountered at the site make implementation of a biological treatment option impractical.

9.7.4.2 Physical

Filtration, phase separation, and carbon adsorption are the three groundwater treatment process options that passed the initial screening. Based on proven effectiveness, all three process options have been selected for the development and evaluation in Chapter 10. As the water flows through the granular activated carbon (GAC), contaminants are adsorbed onto the surface of the carbon. Eventually the surface of the carbon becomes saturated, the contaminants are no longer removed from the water, and they break through the carbon. The carbon is then removed and either reactivated or disposed. In order to eliminate the need to continuously monitor the effluent from a carbon unit for breakthrough, a similar sized carbon unit is often placed in series with the original. Thus, when contaminants break through the lead unit, they are adsorbed by the second unit. The carbon units in the existing treatment system are arranged so that either unit can be the lead vessel. When breakthrough occurs, the carbon in the lead vessel is removed and sent to be reactivated. The backup unit is changed over to the lead position, the empty vessel is refilled with virgin or reactivated carbon, and the refilled unit is used as the backup.

Bag filter units, oil/water separators, carbon adsorption units, and clarifiers, if necessary, can be rented or purchased in a variety of sizes and capacities. These units have been combined to treat waste streams with volumes much greater than any projected for the site. If the system is properly operated, short-term impacts would be minimal. Since the treatment process will be enclosed or fenced, potential exposure would be limited to the system operators. There should not be any exposures from the carbon units, since these are enclosed and the spent carbon is removed by a vacuum truck.

Equipment for these processes is readily available from many vendors. Regulatory approvals can be obtained and regulatory requirements met. Due to the need for long-term operation, maintenance, and monitoring, O&M costs for these processes would be moderate.

9.7.4.3 Chemical

Oxidation was the only chemical treatment process that passed the initial screening. Oxidation involves the addition of an oxidant such as ozone or hydrogen peroxide to the contaminated groundwater. If oxidation is complete, the contaminants are converted to harmless or less toxic substances by raising their oxidation states. Oxidation can be used to treat cyanide and organic contaminants, but has not been proven as an effective treatment technology for PAHs. Incomplete oxidation of complex organics may result in the formation of degradation products that are more toxic than the precursors.

9.7.5 <u>In-Situ Treatment</u>

This option has been selected for alternative assembly. (See Section 9.6.6 for the technology description.)

9.7.6 <u>Discharge</u>

Three offsite discharge options passed the initial screening. They are reinjection, discharge to surface water, and discharge to a POTW. The treated water would be analyzed periodically to ensure that the treatment process is meeting any pretreatment requirements. Discharge of treated water to groundwater, surface water, or POTW, is a proven, reliable method of disposing of treated water. Due to the need for long-term discharge sampling and analysis, the O & M costs are moderate.

For POTW discharge, a discharge line from the groundwater treatment system to a sanitary sewer manhole would be required. The nearest reported acceptable discharge manhole is approximately 500 feet from the possible treatment system location. A force main would be the most practical discharge for this line, requiring a pump and hold tank. Sewerage fees will be required by the city for the discharge.

Discharge to Scajaquada Creek would require a gravity line approximately 100 feet long. An easement to install the discharge line would be required. Discharge limits would likely be more rigorous than those for POTW discharge.

Reinjection of treated water could be accomplished with a series of wells of an injection gallery with water under pressure for injection. The reinjection could enhance groundwater recovery, gradient control and remediation; however, the maintenance of a reinjection system would be much more costly than other discharge options. Discharge limits would be similar to surface water discharge.

For the purposes of alternative evaluation, POTW discharge will be used; however, an evaluation of discharge alternatives will be conducted following flow rate determination.

9.8 SUMMARY OF THE REPRESENTATIVE PROCESS OPTIONS SELECTED BY THE FINAL SCREENING

Tables 9-9 and 9-10 summarize the representative remediation alternatives chosen to remediate soils, groundwater, and DNAPL. Table 9-9 summarizes the process options chosen to remediate the source areas/soils, while Table 9-10 summarizes the representative groundwater/DNAPL remediation process options.

9.9 REFERENCES

Gas Research Institute (GRI), 1987. Management of Manufactured Gas Plant Sites, Volume I, Wastes and Chemicals of Interest, October, 1987.

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USEPA Remediation Technologies Screening Matrix Reference Guide.

Table 9-9. Process options for groundwater and DNAPL selected for alternative development during the final source area technology screening.

Technology	Process Options
No Action	None
Access	Land Use Restrictions/Deed Restrictions
Groundwater Monitoring	Monitoring
Gradient Control/Extraction	Extraction Wells
Onsite Physical Treatment	Filtration/Phase Separation Carbon Adsorption
In-situ Biological Treatment	Bioremediation
Discharge	POTW Surface Water Reinjection

Table 9-10. Process options selected for alternative development during the final groundwater and DNAPL technology screening.

Remedial Technology	Process Option
No Action	None
Site Access and Use Restrictions	Fencing, Deed Restrictions
Environmental Monitoring	Monitoring
Capping	Gravel/Soil-Clay
Vertical Barriers	Sheet Piling
Removal	Excavation
Onsite Physical Treatment	Solids Separation/ Sizing/Decontamination
Offsite Thermal Treatment	Industrial High Efficiency Boiler
Onsite Biological Treatment	Landfarming
In-situ Treatment	Bioventing

10 DEVELOPMENT AND EVALUATION OF ALTERNATIVES

The technologies and process options that appear to be the most applicable to the site contaminants and affected media were identified in Chapter 9. Alone, these technologies will not remediate the contaminated source area materials and groundwater at the site. However, the individual technologies may be combined to provide waste management options to protect human health and the environment. These waste management options are referred to as remedial alternatives.

CERCLA guidance recommends that to the extent practicable, at least one remedial alternative be developed under each of the following categories:

1. A no action alternative.

2. A treatment alternative that reduces the toxicity, mobility, or volume of the contaminants or contaminated media.

3. An alternative that involves containment of the waste with little or no treatment.

4. An alternative that completely and permanently treats the waste and eliminates the need for long-term monitoring.

The above categories have been established to facilitate developing an adequate range of remedial alternatives.

The seven alternatives developed for this feasibility study to address (in varying degrees) the RAOs and meet SARA guidance categories are as follows:

1. No action.

2. Capping source areas and soil.

3. Capping of source areas and soil/installing an impermeable vertical barrier and extraction wells with groundwater treatment system.

4. Excavating source areas and soil with disposal offsite (landfill or incineration)/installing a impermeable barrier and extraction wells with groundwater treatment system.

5. Landfarming source areas and soil/installing an impermeable barrier and extraction wells with groundwater treatment system.

6. Capping source areas and in-situ biotreatment of soil and groundwater.

7. Capping source areas and soil/in-situ biotreatment of soil and groundwater/installing an impermeable barrier and extraction wells with groundwater treatment system.

The technologies included in each of these alternatives are presented in Table 10-1. All the alternatives, other than no action, include access restrictions and groundwater monitoring. The specific objectives satisfied by each alternative, and the SARA guidance categories fulfilled by each alternative, are summarized in Table 10-2.

Following the development of the remedial alternatives, an evaluation of each alternative is performed. Since specific statutory requirements must be addressed in the Record of Decision (ROD) and supported by this FS, each remedial alternative is evaluated on its ability to:

- Be protective of human health and the environment
- Attain ARARs (or provide the basis for invoking a waiver)
- Be cost effective
- Utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable
- Satisfy the preference for treatment that reduces toxicity, mobility, or volume as a principal element

In addition, CERCLA places an emphasis on evaluating long-term effectiveness and related considerations for each of the remedial alternatives. These statutory considerations include:

Table 10-1. Range of alternatives.

General Response Action	Technology	Process Option	Area Impacted	Alternatives 1	2	3	4	5	6	7
No Action			Entire Site	X						
Institutional Controls	Fencing		Selected Areas		X	X	X	X	X	X
	Land Use Restrictions		Source Areas		X	X	X	X	X	X
	Groundwater Use Restrictions		Groundwater		X	X	X	X	X	X
Monitoring		Monitor Wells	Groundwater		X	X	X	X	X	X
Containment	Capping	Gravel-clay	Source Areas		X	X			X	X
	Vertical Barrier	Sheet Piling	Source Areas			X	X	X		X
	Gradient Control	Extraction Wells	Groundwater			X	X	X		X
Removal		Excavation	Source Areas/Soil				X	X		
		Extraction Wells	Groundwater			X	X	X		X
Onsite Treatment	Physical	Landfarming	Source Areas/Soil					X		
		In-situ Biotreatment	Soil/ Groundwater						X	X
		Filtration GAC	Gradient Control Water			X	X	X		X

Table 10-1. Range of alternatives (continued).

General Response Action	Technology	Process Option	Area Impacted	Alternatives						
				1	2	3	4	5	6	7
Onsite Treatment (cont'd)	Physical (cont'd)	Filtration	Entire Plume			X	X	X		X
		Phase Separation	Entire Plume			X	X	X		X
		Carbon Adsorption	Entire Plume			X	X	X		X
Offsite Treatment	Thermal	Coal Fired Utility Boiler	Source Areas				X			
			Soil				X			
Offsite Disposal		Solid Waste Landfill	SA Material				X			
		Hazardous Waste Landfill	Hazardous SA Material				X			
Offsite Disposal		POTW	Treated Groundwater			X	X	X		X
In-Situ Treatment	Biological	Bio-remediation	Subsurface Soil/ Groundwater						X	X

Table 10-2. Compliance of alternatives with SARA guidance and remedial action objectives.

	Alternatives						
	1	2	3	4	5	6	7
SARA Guidance Categories							
1. No Action Alternative	Yes	No	No	No	No	No	No
2. Alternative that reduces the toxicity, mobility, or volume of the contaminants or contaminated media (Source Areas/Groundwater).	No/ No	No/No	No/ Yes	Yes/ Yes	Yes/ Yes	Yes/ Yes	Yes/ Yes
3. Alternative that involves containment of the waste with little or no treatment (Source Areas/Groundwater)	No/ No	Yes/ Yes	Yes/ No	No/ No	No/ No	No/ No	No/ No
4. Alternative that completely and permanently treats the waste and eliminates the need for long term monitoring (Source Areas/ Groundwater).	No/ No	No/ No	No/ No	Yes/ No	Yes/ No	No/ No	No/ No
Remedial Action Objectives							
1. Remove or contain contaminated source area materials in order to a) minimize the potential for direct contact with the contaminants, and b) reduce the potential for further migration of contaminants from these units.	No	No	Yes	Yes	Yes	No	Yes
2. Prevent or minimize the potential for future inhalation, ingestion, or dermal contact with contaminants in groundwater in excess of NYS groundwater quality standards (TBCs) or MCLs.	No	No	Yes	Yes	Yes	Yes	Yes

- The long-term uncertainties associated with land disposal
- The goals, objectives, and requirements of the Solid Waste Disposal Act
- The persistence, toxicity, and mobility of hazardous substances and their constituents, and their propensity to bioaccumulate
- Short- and long-term potential for adverse health effects from human exposure
- Long-term maintenance costs
- The potential for future remedial action costs if the alternative remedial action in question was to fail
- The potential threat to human health and the environment associated with containment or excavation, transportation, and redisposal

In order to address the CERCLA requirements and considerations listed above and the technical and policy considerations that have proven to be important for selection among remedial alternatives, in conformance with the RI/FS guidance, the following evaluation criteria have been used in this FS:

1. Short-term effectiveness. Addresses the impacts of the alternative during the construction and implementation phase until remedial response objectives have been met. Alternatives are evaluated with respect to their effects on human health and the environment during implementation of the remedial action and until protection is achieved.

2. Reduction of toxicity, mobility, and volume. Addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substance as their principal element. This preference is satisfied when treatment is used to reduce the principal threats at the site through destruction of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media.

3. Long-term effectiveness and permanence. Addresses the results of a remedial action in terms of the risk remaining at the site after response objectives have been met. The primary focus of this evaluation is the effectiveness of the controls that will

be applied to manage risk posed by treatment residuals or untreated wastes.

4. Compliance with ARARs. This evaluation is used to determine how each alternative complies with federal and state ARARs, as defined in CERCLA Section 121.

5. Overall protection of human health and the environment. Provides a final check to assess whether each alternative meets the requirement that it be protective of human health and the environment. The overall assessment of protection is based on a composite of factors assessed under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

6. Implementability. Addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation.

7. Cost. The cost estimates for the FS are expected to provide an order-of-magnitude evaluation for comparison of alternatives and are based on the site characterization developed in the RI. Construction cost, annual cost, a present worth analysis, and a cost sensitivity analysis are part of this evaluation.

8. State acceptance. Addresses the technical and administrative issues and concerns that NYSDEC may have regarding each of the alternatives. NYSDEC will review the draft FS, and its comments will be incorporated into the final FS, as appropriate. This criterion will also be addressed in the ROD.

9. Community acceptance. Incorporates public input into the analysis of alternatives. Formal comments will be received by the NYSDEC during a public comment period. Public concerns or comments will be addressed in the responsiveness summary and ROD.

Descriptions of the alternatives and detailed evaluations of the alternatives using the first seven of the evaluation criteria identified above and on the preceding page are presented in the following subsections. The description of each of the alternatives is sufficiently detailed to present a conceptual design that integrates the technologies and process options described in Chapter 9 into a site-wide alternative. According to the RI/FS guidance, state and community acceptance criteria (evaluation criteria 8 and 9) will be evaluated following comment on the RI/FS report, and the proposed alternative and will be addressed once a final decision has been made and the ROD is being prepared. A comparative analysis of the alternatives, using the first seven evaluation criteria, is presented in Chapter 11 along with the cost sensitivity analysis.

The FS cost estimates are order-of-magnitude level estimates, which are defined by the American Association of Cost Engineers as an approximate estimate made without detailed engineering data. Examples include an estimate from cost capacity curves and estimates using scale-up or scale-down factors and/or approximate ratio estimates. It is normally expected that an estimate of this type would be accurate to +50% and -30% for given unit quantities. The actual cost of the project would depend on the final scope of the remedial action, the schedule of implementation, actual labor and material costs at the time of implementation, competitive market conditions, and other variables that may significantly impact the project costs. A summary of the procedures, elements, and assumptions used in preparing the cost estimate for each alternative is presented in Table 10-3.

10.1 ALTERNATIVE 1: NO ACTION

The no action alternative would not involve any remedial actions and the site would remain in its present condition. No funds would be expended for monitoring, control, or cleanup of the contaminated source area materials and groundwater. This alternative, which is required by the NCP and SARA, is a baseline to which the effectiveness of other alternative remedies is compared. This alternative would fulfill only Category 1 of the SARA guidance categories.

10.1.1 Short-Term Effectiveness

Since no activities would occur, protection of the community and workers would not be required. Environmental impacts due to construction or implementation would not be encountered, because there would not be any activities performed at the site. Finally, remedial action objectives would not be met.

10.1.2 Reduction in Toxicity, Mobility, or Volume

Remedial activities would not occur, so there would not be a reduction in toxicity, mobility, or volume of contaminants. The original

Table 10-3. Basis for cost estimates.

Cost Estimate Procedure

- Estimation of Capital Cost
- Estimation of Operation and Maintenance Costs
- Present Worth Analysis

Definition of Elements

- Construction Cost (materials, labor, and equipment)
  - Construction (direct cost)
  - Equipment (direct cost)
  - Site Preparation (direct cost)
  - Engineering and Design (percent of total direct costs)
  - Services during Construction (percent of total direct costs)
  - Licenses and Permits (percent of total direct costs)

- Operation and Maintenance Costs
  - Continued Monitoring
  - Routine Maintenance
  - Transport and Disposal

- Present Worth Analysis
  - Capital Costs Occur in Year 0
  - Operation and O&M Costs Occur for the Life of Remedial Action
  - Discount Rate

Assumptions

- Cost Estimates: +50% to -30% accuracy: 1993 dollars
- Economic Life of Remedial Action: 30 years
- Discount Rate: 5% per RI/FS guidance
- Inflation: 0% per RI/FS guidance

Contingencies and Allowances (per RI/FS guidance)

- Bid Contingency - 10 to 15% of construction subtotal, covers unknowns such as adverse weather, strikes, unfavorable market conditions, etc.
- Scope Contingency - 15 to 20% of construction subtotal, covers change orders, reflects specialized nature of work and lack of precise definition of scope of work.
- Permitting and Legal - Up to 5% of construction total cost.
- Construction Services - 10% of construction total cost, includes construction management, onsite observation, waste cleanup validation, change order negotiations, and engineering and design modifications during construction.
- Engineering Design - 8% of construction total cost.

type and quantity of hazardous material would remain onsite, except to the extent that the contaminants are removed by natural mechanisms.

10.1.3 Long-Term Effectiveness

Because remedial actions would not occur, the risks identified in the risk assessment would remain. In addition, since no controls would be implemented, the criterion addressing the effectiveness, adequacy, and reliability of controls is not applicable to this alternative.

10.1.4 Compliance with ARARs

This criterion refers to the three types of ARARs which the alternative should address: Chemical-specific, location-specific, and action-specific.

- Chemical-Specific ARARs. Groundwater containing contaminants in concentrations in excess of MCLs and NYS water quality limits would remain onsite and continue migrating beyond the site boundaries. Concerns associated with the application of this rule to remedial actions at the IG/WS site are addressed in the assumptions presented in Chapter 8.

- Location-Specific ARARs. Section 8 discussed potential location-specific ARARs for the IG/WS site and determined that there were no location-specific ARARs for the site.

- Action-Specific ARARs. Since no remedial activities would occur, there are no action-specific ARARs.

10.1.5 Overall Protection of Human Health and the Environment

This criterion assesses the overall protectiveness offered by an alternative. The evaluation refers to adequacy of protection, elimination of risks, and achievement of the other CERCLA evaluation criteria. Since no remedial activities occur, no risks are reduced or eliminated. Therefore, this alternative is not protective of human health and the environment.

10.1.6 Implementability

Implementability includes technical feasibility, administrative feasibility, and the availability of the required services and materials.

Since no remedial activities would be implemented under the no action alternative, these criteria are not applicable.

10.1.7 Costs

There would not be any costs incurred because no remedial activities would be performed.

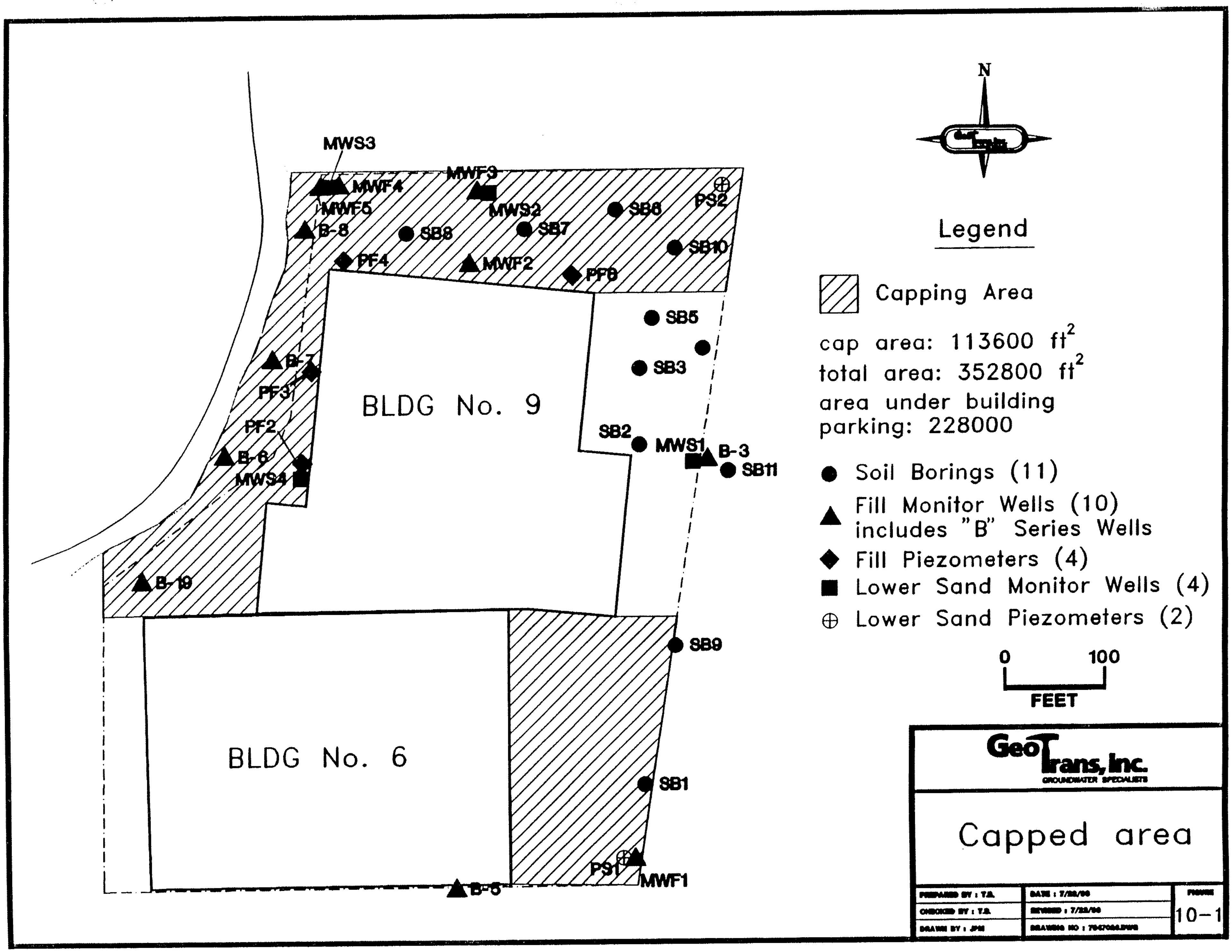
10.2 ALTERNATIVE 2: CAPPING SOURCE AREAS AND SOIL

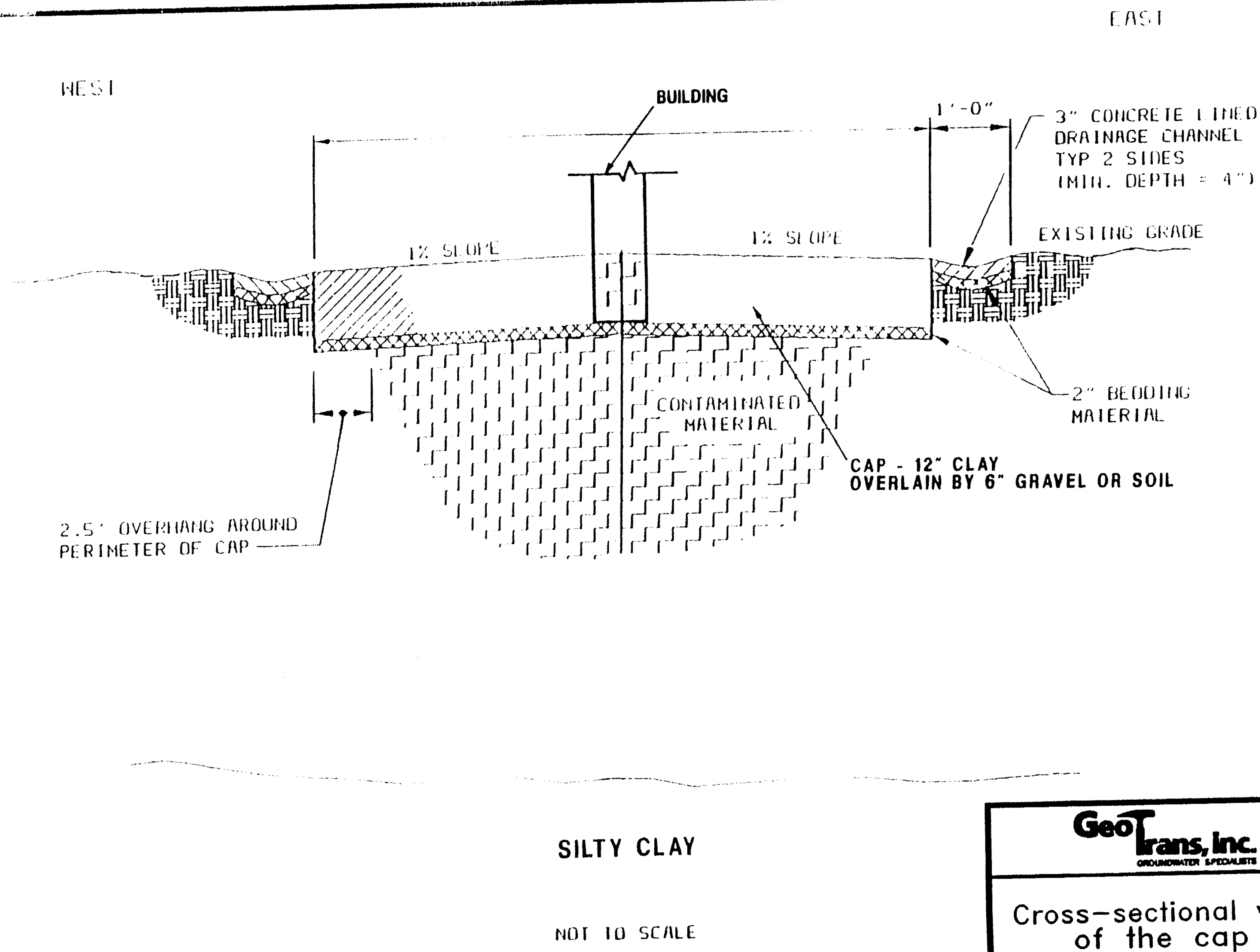
Alternative 2 would consist of the following process options and technologies:

- Gravel-clay caps above soil and source area contaminants.
- Groundwater monitoring and use restrictions, land use restrictions, and fencing.

Capping is used to isolate the source area to prevent exposure and surface water interaction, control erosion, and mitigate volatilization from contaminated waste. Since 65% of the site is covered by either building or asphalt, capping the remaining source areas at the site would be easily accomplished. Figure 10-1 shows the areas that need to be capped. The size of the capped area is estimated to be 113,600 square feet. A cross section of the cap is shown on Figure 10-2. The gravel/clay cap selected in the screening will prevent exposure to source area/soil materials, but over time will allow more infiltration than a membrane cap. A membrane cap could be considered if reduction of infiltration was the foremost RAO; however, at this site the infiltration reduction accomplished by a slightly more effective cap would have negligible effect on groundwater migration.

Following implementation of the alternative, the effectiveness of the system would be monitored periodically. Initially, monitoring might be as frequent as monthly. Close monitoring in the early stages of the project would be necessary to ensure that the groundwater plume was being contained. Monitoring would shift to quarterly or biannually thereafter and would consist of groundwater sample collection/analysis and groundwater level measurements to evaluate flow directions.


N
MWS3
MWF4
MWF5
B-8
SB8
MWF3
MWS2
SB7
SB6
PS2
SB10
PF4
MWF2
PF6
SB5
SB3
B-7
PF3
BLDG No. 9
PF2
B-6
MWS4
SB2
MWS1
B-3
SB11
B-19
SB9
BLDG No. 6
SB1
PS1
MWF1
B-5
Legend
Capping Area
cap area: 113600 ft²
total area: 352800 ft²
area under building
parking: 228000
Soil Borings (11)
Fill Monitor Wells (10)
includes "B" Series Wells
Fill Piezometers (4)
Lower Sand Monitor Wells (4)
Lower Sand Piezometers (2)
0
100
FEET
GeoTrans, Inc.
GROUNDWATER SPECIALISTS
Capped area
10-1



GeoTrans, Inc.
GROUNDWATER SPECIALISTS

Cross-sectional view of the cap

10-2

To further protect the public from contact with the contaminants and maintain the integrity of the source area containment system, the source areas would be enclosed with a chain link fence. Land use restrictions would be instituted to prevent intrusive activities that could damage the source area containment system and, thereby, to protect the public from potential contact with the source area contaminants. Groundwater use restrictions would also be instituted for all properties located within the horizontal boundaries of the contaminant plume. These restrictions would be written into the property deed to alert future owners of the restrictions.

| Alternative 2 would not strictly fulfill the objectives of Category 3 of the SARA guidance categories for the source areas and groundwater. The | caps would prevent human contact with the contaminants, would reduce | infiltration through the source areas, and would reduce the flow of groundwater through the soil beneath the source areas. Further migration of contaminants via the groundwater from the primary sources at the site would be minimized by the caps. The perimeter of the contaminant plume of dissolved contaminants would be contained by natural mechanisms.

10.2.1 Short Term Effectiveness

This criterion refers to the protectiveness an alternative offers to the community and workers during the remediation period as well as the environmental impacts and the time required to meet the remedial action objectives.

10.2.1.1 Protection of the Community and Workers

Normal construction hazards would be associated with the construction of the caps. Fencing or temporary barriers would be installed around the site to protect the community during construction by preventing access to unauthorized personnel. Source area grading and well installation and pumping might cause releases of contaminated fugitive dust and/or volatile organic vapors. Monitoring and control of these releases would be required of the construction contractor. A site safety plan, required to be followed, would be prepared prior to initiating construction. In conformance with OSHA regulations, site workers would be health and safety trained, required to wear appropriate protective equipment, and would be enrolled in a medical monitoring program.

10.2.1.2 Environmental Impacts

No significant environmental impacts would be expected during the construction of this alternative. Suitable dust control measures would be implemented as a precautionary measure during the source area regrading and guide trench excavation/backfilling operations.

10.2.1.3 Time to Achieve Remedial Response Objectives

The remedial objectives for the source areas would be achieved after the caps have been installed. The installation of the source area caps is estimated to take two to three months. The remedial action objectives for the groundwater would be achieved when the groundwater monitoring system confirms that the contaminant plume is naturally degrading and when groundwater use restrictions have been established. It is estimated that several years of groundwater monitoring would be necessary to verify that the plume of contaminated groundwater is degrading.

10.2.2 Reduction in Toxicity, Mobility, or Volume

This criterion reflects the statutory preference for treatment alternatives above nontreatment alternatives. The factors addressed include the treatment itself (process, irreversibility, the amount of hazardous materials to be treated, the quantity of treatment residuals), and the reduction in toxicity, mobility, or volume of the contaminants.

10.2.2.1 Treatment

No contaminated media are treated under this alternative.

10.2.2.2 Reduction in Toxicity, Mobility, or Volume

Since this alternative does not primarily involve treatment technologies, it would not directly and substantially reduce the toxicity, or volume of the contaminated media. The mobility of the contaminants in the source areas and in the subsoil within the caps would be reduced by the containment system. The toxicity of dissolved contaminants on the periphery of the groundwater plume is predicted to be reduced by natural biological mechanisms.

10.2.2.3 Amount of Material Contained or Treated

The area of the source area cap would be approximately 113,600 square feet.

10.2.3 <u>Long-term Effectiveness</u>

The long-term effectiveness of an alternative pertains to the risks remaining following the remedial action. Three factors to be considered are the magnitude of the residual risks, the adequacy and reliability of the controls, and the permanence of the remedy.

10.2.3.1 Residual Risk

Isolating the source areas would minimize the potential for contact with contaminants in those areas. The residual risk associated with potential future offsite use of contaminated groundwater as defined in the risk assessment would remain. However, instituting groundwater use restrictions would provide protection against the potential for future exposure to contaminated groundwater and DNAPL. Monitoring would verify that no new exposure routes were created by continued migration of contaminants in the groundwater and DNAPL. Therefore, despite the fact that the contaminants would not be treated or destroyed, the residual risks associated with this alternative would be reduced.

10.2.3.2 Adequacy and Reliability of Controls

The cap would be the main control in this alternative, while land and groundwater use restrictions and monitoring would play subordinate roles. The cap would adequately reduce the potential for contact with source area contaminants and would minimize surface infiltration. Natural mechanisms would act to contain the groundwater contaminant plume. **Although groundwater would continue to discharge to the creek and ultimately to the Niagara River,** groundwater monitoring would ensure that the controls were working as designed. Land use restrictions would limit future use of the site so that the containment system would not be breached and contaminated subsurface soil would not be disturbed. Groundwater use restrictions would prohibit future use of groundwater within the contaminant plume. Groundwater monitoring would be necessary for the life of the alternative. The caps would require maintenance for the life of the alternative.

10.2.3.3 Permanence of Remedy

The caps should last for over 30 years, especially if special precautions were taken to ensure their durability. The cost of repairing or replacing damaged caps, if necessary, would be relatively low. It is expected that the monitoring would serve for the entire life of the remedy.

10.2.4 Compliance with ARARs

This criterion examines the alternatives to determine if compliance will be achieved for the three types of ARARs.

10.2.4.1 Chemical-Specific ARARs

Groundwater containing contaminants in concentrations in excess of MCLs and NYS standards would remain onsite and beyond the site boundaries. Groundwater at the edge of the plume would meet MCLs, and monitoring would be used to verify continued containment of the plume. Soils containing contaminants above recommended NYS cleanup guidelines would remain in the subsurface, but contact would be prevented by the cap.

10.2.4.2 Location-Specific ARARs

Section 8.3 discussed potential location-specific ARARs for this site and determined that there were none for the site.

10.2.4.3 Action-Specific ARARs

During installation of the controls, protection of the workers would comply with OSHA standards. Prevention of airborne contamination by dust control and capping would maintain air quality as required by the Clean Air Act. Closure and post-closure would conform to RCRA standards.

10.2.5 Overall Protection of Human Health and the Environment

This criterion assesses the overall protectiveness offered by an alternative. The evaluation considers the adequacy of protection, elimination of risk, and achievement of the four previous evaluation criteria.

This alternative would offer **reduce risks** to both human health and the environment by minimizing potential contact with the source area wastes and contaminated groundwater, **and by reducing** migration of contaminants from the source areas. Protection would be achieved at the end of the construction period of three months. The residual risks posed by contaminated material remaining within the source areas, subsurface soils, and groundwater would not be significant, since potential exposure routes would be minimized as long as the cap system was properly maintained, use restrictions were observed, and groundwater monitoring was continued.

10.2.6 Implementability

Implementability includes three subcriteria: technical feasibility, administrative feasibility, and the availability of the required services and materials.

10.2.6.1 Technical Feasibility

Technical feasibility is evaluated on the basis of three parameters: ability to construct the alternative, the reliability of the technologies used, and ease of undertaking additional remedial actions.

- Ability to construct the alternative. All the construction required by this alternative would be basic heavy construction and should not pose any particular problems.

- Reliability of the technology. Capping is an effective and frequently used alternative.

- Ease of undertaking additional remedial actions. It is not anticipated that any future remedial actions would be necessary. If the operations building were eventually demolished, the containment system might have to be extended to include this portion of the site, requiring minimal additional effort. Implementation of a groundwater remedy, installing extraction wells, would not be hampered by the existing system.

10.2.6.2 Administrative Feasibility

Installing additional monitor wells might require access to private and city property. Land and groundwater use restrictions would also be required and might be difficult to implement.

10.2.6.3 Availability of Services and Materials

The materials, equipment, and personnel required to construct the gravel/clay caps would be readily available in Buffalo.

10.2.7 Costs

Tables 10-4 and 10-5 provide summaries of the construction and O&M costs for Alternative 2. The construction costs, including direct and indirect construction costs, would be approximately $504,240 (Table 10-4). Continued monitoring and cap maintenance contribute to the O&M costs and result in costs of $226,400 for 30 years (Table 10-5). The present worth analysis yields a total of $730,640 for this alternative.

10.3 ALTERNATIVE 3: CAP SOURCE AREAS AND SOIL/PUMP-CONTAIN-TREAT GROUNDWATER ONSITE

Alternative 3 would consist of the following process options and technologies:

- Gravel/clay caps to contain the source area contaminants
- A sheet piling vertical barrier for gradient control in the source area
- Extraction wells for gradient control and removal of the contaminated groundwater and DNAPL
- Treatment of liquids from extracted groundwater using oil-water separation, filtration, and carbon adsorption
- Groundwater monitoring, land use restrictions, and fencing

Gravel/clay caps would be constructed over the source areas. The construction of the gravel/clay caps would be as described in Alternative 2 and shown on Figures 10-1 and 10-2.

In this alternative, the source areas would be contained with a downgradient sheet piling vertical barrier combined with extraction wells for gradient control. The barrier would be driven into the silty clay unit

Table 10-4. Construction cost estimate - Alternative 2 - Cap source areas (1993 $)

Item	Quantity	Units	Unit Cost	Total Cost
FENCING				
Chain Link Fence (8' high)	100	LIN FT	$16.00	$1,600
Gate (34' opening)	1	EA	$1,200	$1,200
CAPPING	12,622	YD	$22.00	$278,000
DECONTAMINATION				
Area Construction & Equipment Rental		LS		$5,000
Operation	40	DAY	$60.00	$2,400
Washwater Disposal (10 gpd)	400	GAL	$0.10	$40
MOBILIZATION/DEMOBILIZATION				$40,000
	Construction Subtotal:		$328,240	
CONTINGENCIES				
Bid Contingencies				$50,000
Scope Contingencies				$50,000
	Contingencies Subtotal:		$100,000	
ALLOWANCES				
Permitting/Legal				$17,000
Engineering				
Design				$33,000
Construction Services				$26,000
	Allowances Subtotal:			$76,000
TOTAL CONSTRUCTION COSTS:	ALTERNATIVE 2			$504,240

Note: [1] Lin FT is linear feet.
[2] LS is lump sum.

Table 10-5. O & M costs and total present worth estimate - Alternative 2 - Cap source areas (1993 $).

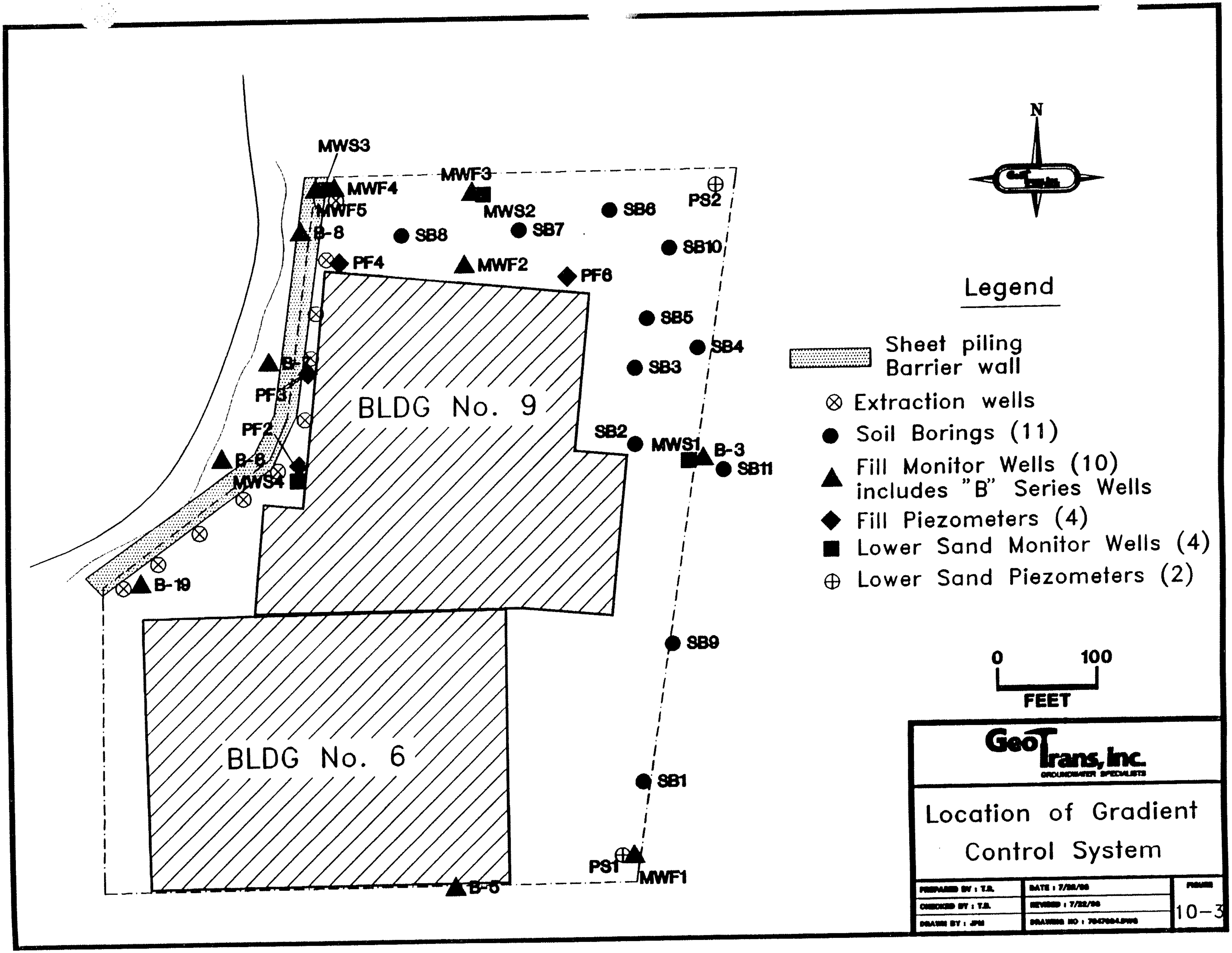
Item	Quantity	Units	Unit Cost	Total Cost
GROUNDWATER MONITORING				
Sample Collection/Cap Inspection				
First Year (bimonthly)	30/yr	MANDAYS	$600.00	$18,000
Years 2-5 (quarterly)	20/yr	MANDAYS	$600.00	$48,000
Years 6-30 (biannually)	10/yr	MANDAYS	$600.00	$150,000
Sample Analysis/Report				
First Year (bimonthly)	12/yr	EA	$1,000.00	$12,000
Years 2-5 (quarterly)	8/yr	EA	$1,000.00	$32,000
Years 6-30 (biannually)	4/yr	EA	$1,000.00	$100,000
CAP REPAIR		LS		$15,000
EQUIPMENT REPLACEMENT COSTS				
Year 15		LS		$9,000
TOTAL O&M COSTS Present Worth Annual Interest Rate $ 5.06				$226,400
TOTAL CONSTRUCTION COSTS (from Table 10-4)				$504,240
TOTAL PRESENT WORTH	ALTERNATIVE 2			$730,640

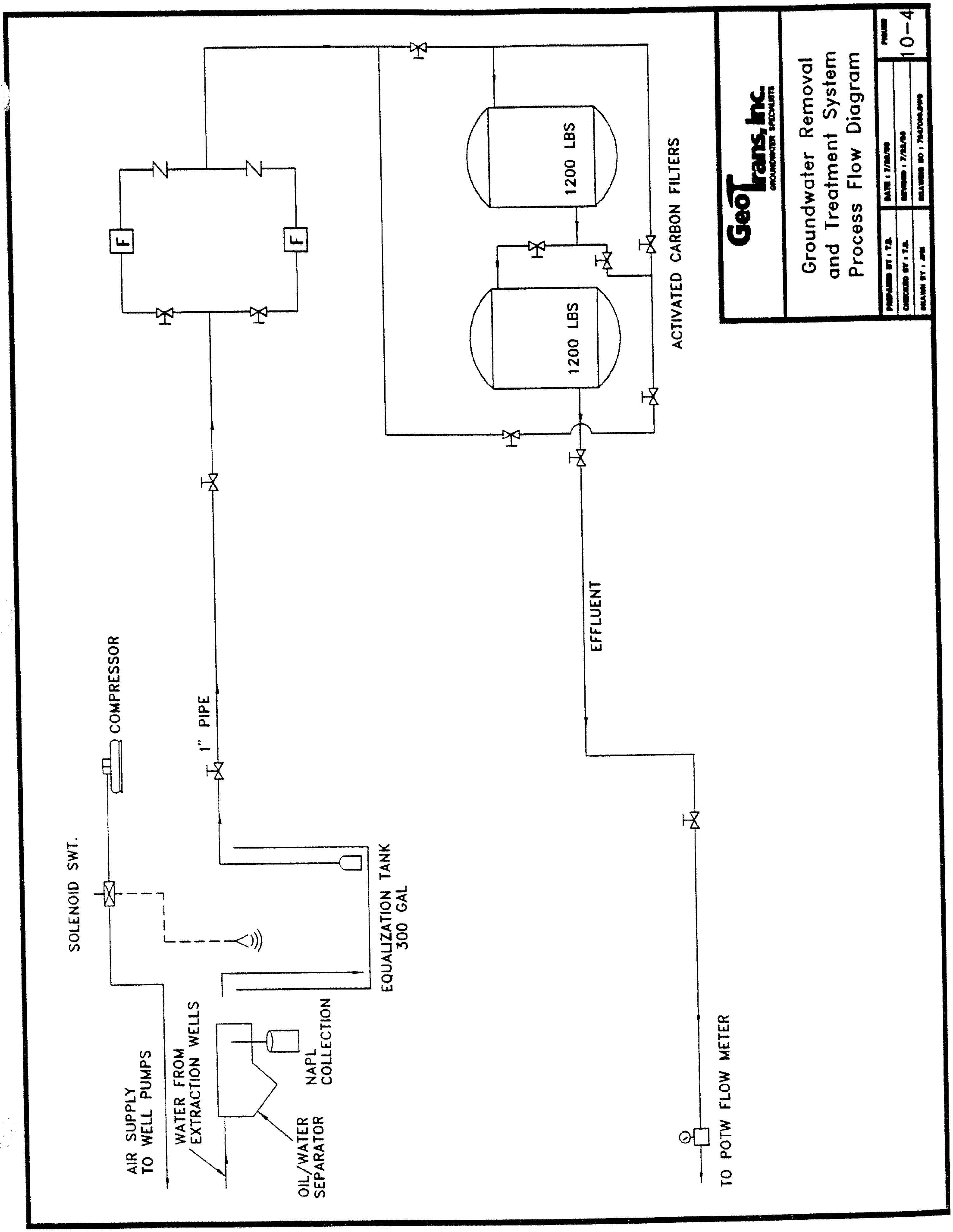
underlying the fill to an average depth of 20 feet. The width of the area to be contained would be 500 feet, as shown on Figure 10-3. An estimated ten extraction wells would be installed to provide gradient control within the barrier. These well would be screened throughout the fill unit. The sheet piling and wells would be installed downgradient from the source areas.

In conjunction with implementation of the groundwater removal and gradient control portion of this alternative, ten wells would be installed to the inside of the sheet piling vertical barrier and shown on Figure 10-3. This alternative would involve installation of a system of extraction wells for groundwater and DNAPL removal and gradient control. They would pump the groundwater, estimated to be less than five gallons per minute, to the treatment system before the water is discharged for the purposes of evaluation to the City of Buffalo system POTW. A conceptual process diagram is shown in Figure 10-4. Discharge to surface water or by reinjection should also be considered. The system of extraction wells would be designed to prevent further migration of the plume. Fencing, land use restrictions, and groundwater monitoring requirements for this alternative would be the same as for Alternative 2.

Following implementation of the alternative, the effectiveness of the system would be monitored periodically. Initially, monitoring might be as frequent as twice monthly. Close monitoring in the early stages of the project would be necessary to ensure that the groundwater plume was being contained as predicted by the groundwater modeling. Monitoring would shift to quarterly or biannually thereafter, consisting of groundwater sample collection/analysis and groundwater level measurements to evaluate groundwater flow directions. Treatment system checks would continue on a twice-monthly basis.

Alternative 3 would fulfill the objectives of Category 3 of the SARA guidance categories for the source areas. The caps, sheet piling, and extraction wells would prevent human contact with the contaminants and would minimize infiltration through the source areas. Alternative 3 also would fulfill the objectives of Categories 2 and 3 of the SARA guidance for the contaminated groundwater.


N
MWS3
MWF4
MWF5
MWF3
MWS2
B-8
SB8
SB7
SB6
PS2
SB10
PF4
MWF2
PF6
SB5
SB4
SB3
B-7
PF3
PF2
B-6
MWS4
BLDG No. 9
SB2
MWS1
B-3
SB11
B-19
SB9
BLDG No. 6
SB1
PS1
MWF1
B-5
Legend
Sheet piling Barrier wall
Extraction wells
Soil Borings (11)
Fill Monitor Wells (10) includes "B" Series Wells
Fill Piezometers (4)
Lower Sand Monitor Wells (4)
Lower Sand Piezometers (2)
0
100
FEET
GeoTrans, Inc.
Location of Gradient Control System
10-3


AIR SUPPLY
TO WELL PUMPS
WATER FROM
EXTRACTION WELLS
OIL/WATER
SEPARATOR
NAPL
COLLECTION
SOLENOID SWT.
COMPRESSOR
EQUALIZATION TANK
300 GAL
1" PIPE
F
F
1200 LBS
1200 LBS
ACTIVATED CARBON FILTERS
EFFLUENT
TO POTW FLOW METER
GeoTrans, Inc.
GROUNDWATER SPECIALISTS
Groundwater Removal
and Treatment System
Process Flow Diagram
10-4

Extracting and treating the contaminated groundwater would reduce the toxicity and volume of the contaminated material and decrease the mobility of the plume. In addition, the extraction well system would ensure that the plume of contaminated groundwater was contained.

10.3.1 Short-Term Effectiveness

This criterion refers to the protectiveness an alternative offers to the community and workers during the remediation period as well as the environmental impacts and the time required to meet the remedial action objectives.

10.3.1.1 Protection of the Community and Workers

Normal construction hazards would be associated with the construction of the caps, sheet piling, and wells. Fencing or temporary barriers would be installed around the site to protect the community during construction by preventing access to unauthorized personnel. All wells would be enclosed in lock boxes to prevent unauthorized access. Source area grading and well installation and pumping might cause releases of contaminated fugitive dust and/or volatile organic vapors. Monitoring and control of these releases would be required of the construction contractor. A site safety plan would be prepared prior to initiating construction and compliance would be enforced. In conformance with OSHA regulations, all required site workers would be health and safety trained, required to wear appropriate protective equipment, and would be enrolled in a medical monitoring program.

10.3.1.2 Environmental Impacts

No significant environmental impacts would be expected during the construction of this alternative. Although investigations at the site have not identified any significant near-surface contamination in the area of the migrating sources, suitable dust control measures would be implemented as a precautionary measure during the source area regrading operations.

10.3.1.3 Time to Achieve Remedial Response Objectives

The time estimated for design and installation of the caps and a groundwater gradient control and removal system is six to eight months. The remedial objectives for the source areas would be achieved when the caps and sheet piling were completed, while the objectives for the groundwater would be achieved when monitoring confirmed that gradient control was established and contaminant concentrations in groundwater inside and outside the site boundary were reduced to levels below NYS regulatory limits. The time estimated for well installation, system debugging, and establishing gradient control is 12 to 15 months. The time required to achieve contaminant concentration RAOs for the groundwater, however, is unknown.

10.3.2 <u>Reduction in Toxicity, Mobility, or Volume</u>

This criterion reflects the statutory preference for treatment alternatives above nontreatment alternatives. The factors addressed include the treatment itself (process, irreversibility, the amount of hazardous materials to be treated, the quantity of treatment residuals), and the reduction in toxicity, mobility, or volume of the contaminants.

10.3.2.1 Treatment

The contaminated media treated under this alternative would be liquids from the extracted groundwater, to be processed in the groundwater treatment system described in Figure 10-4. The media would be treated until the effluent met the requirements of the pretreatment agreement with the City of Buffalo. The system would generate three wastes: collected DNAPL, used filter bags and spent activated carbon, which would be disposed of according to the appropriate regulations.

10.3.2.2 Reduction in Toxicity, Mobility, or Volume

Treatment of the contaminated groundwater extracted for gradient control and removal in a system using activated carbon would reduce the mobility of the contaminants and the volume of those contaminated media by removing them from the liquid and concentrating them on the activated carbon. Contaminants adsorbed to the activated carbon would ultimately be destroyed during the process of regenerating the carbon. In addition, the mobility of the contaminants in the source areas would be indirectly reduced by the use of caps to reduce surface infiltration. The mobility of the contaminated groundwater plume would be reduced by the sheet piling vertical barrier and extraction well system. DNAPL would be removed by extraction well pumping.

10.3.2.3 Amount of Material Contained or Treated

The area of the remaining source area cap would be approximately 113,360 square feet. The volume of treated groundwater would be up to 7,200 gallons per day.

10.3.3 Long-Term Effectiveness

The long-term effectiveness of an alternative pertains to the risks remaining following the remedial action. Three factors to be considered are the magnitude of the residual risks, the adequacy and reliability of the controls, and the permanence of the remedy.

10.3.3.1 Residual Risk

Capping the source areas and the installation of the sheet piling vertical barrier and gradient control, and institutional controls would minimize the potential for direct contact with contaminants in those areas. The risk associated with potential future use of contaminated groundwater as defined in the risk assessment would be reduced by removal and treatment of groundwater containing concentrations of contaminants in excess of concentration RAOs. Concentrations of contaminants in the remaining groundwater will be slowly reduced. Extracted water would be treated to the levels required by the pretreatment agreement with the City of Buffalo before being discharged to the POTW. Therefore, despite the fact that none of the subsurface soils would be treated, the residual risks associated with this alternative would be minimal.

10.3.3.2 Adequacy and Reliability of Controls

The source area caps, sheet piling vertical barrier, and groundwater extraction wells for removal and gradient control would be the main controls of this alternative, while groundwater treatment, monitoring, and land use restrictions would play a subordinate role. The caps would adequately reduce the potential for contact with source area contaminants and would minimize surface infiltration. The sheet piling vertical barrier and extraction wells would contain the contaminated groundwater plume and would remove groundwater containing contaminants in excess of NYS groundwater quality standards for subsequent treatment. Groundwater monitoring would ensure that both main controls were working as designed. Land use restrictions would limit future use of the site so that the caps would not be breached and contaminated subsurface soil would not be disturbed. Groundwater monitoring would be necessary for the life of the alternative and the groundwater treatment system would also have to be operated for the life of the alternative. The extraction wells, their pumps and plumbing, the groundwater treatment equipment, and the caps would have to be maintained for the life of the alternative.

10.3.3.3 Permanence of Remedy

If the caps and sheet piling vertical barrier were properly designed and maintained, they would be able to adequately isolate the source areas for the life of this remedy. The cost of replacing damaged caps, if necessary, would be relatively low. If replacement of pumps or the installation of additional wells were necessary, these activities would require relatively minor additional effort and cost. The groundwater treatment plant equipment is readily replaceable, if required.

10.3.4 Compliance with ARARs

This criterion examines the alternative to determine if compliance will be achieved for the three types of ARARs.

10.3.4.1 Chemical-Specific ARARs

Groundwater containing contaminants in concentrations in excess of NYS groundwater quality standards or MCLs would be removed and treated. Under this alternative, monitoring would be used to verify continued onsite containment of the contaminated groundwater plume while the plume is remediated. Soils will not be actively remediated to RAOs, but potential contact will be minimized.

10.3.4.2 Location-Specific ARARs

Section 8.3 discussed potential location-specific ARARs for the IG/WS site and determined that there were none for the site.

10.3.4.3 Action-Specific ARARs

During installation of the controls, protection of the workers would comply with OSHA standards. Prevention of airborne contamination by dust control and capping would maintain air quality, as required by the Clean Air Act. Closure and post-closure would conform to RCRA standards. Groundwater extracted to contain the groundwater plume would meet the discharge standards agreed to in the pretreatment agreement with the City of Buffalo, as is required by the National Pretreatment Standards of the Clean Water Act.

10.3.5 Overall Protection of Human Health and the Environment

This criterion assesses the overall protectiveness offered by an alternative. The evaluation considers the adequacy of protection, elimination of risk, and achievement of the four previous evaluation criteria.

This alternative would offer protection to both human health and the environment by minimizing potential contact with the source area wastes and contaminated groundwater and preventing continued offsite migration of the plume of contaminated groundwater. Protection would be achieved at the end of the construction period of six months for the source areas. The time to achieve protection for the groundwater is 12 to 15 months. The extracted groundwater would be treated by the existing treatment plant to required levels. All exposure routes in the area of the site would be eliminated, provided the caps and gradient control system were properly operated and maintained and use restrictions were observed. Therefore, the residual risks posed by the contaminated material remaining within the source areas and the groundwater would not be significant.

10.3.6 Implementability

Implementability includes three subcriteria: technical feasibility, administrative feasibility, and the availability of the required services and materials.

10.3.6.1 Technical Feasibility

Technical feasibility is evaluated on the basis of three parameters: ability to construct the alternative, the reliability of the technologies used, and ease of undertaking additional remedial actions.

- Ability to construct the alternative. All the construction required by this alternative would be basic heavy construction and should not pose any particular problems.

- Reliability of the technology. Capping, sheet piling, and groundwater containment by gradient control are effective and frequently used technologies. Although sheet piling is not completely impermeable due to joint leakage, it is effective with joint grouting for this purpose. Oil-water separation/filtration, and carbon adsorption have been proven effective in treating groundwater contaminated with organic contaminants.

- Ease of undertaking additional remedial actions. It is not anticipated that any further remedial action would be necessary. If the operations building were eventually demolished, the source area caps might have to be extended to include the portion of the site currently occupied by this building, requiring minimal additional effort. If monitoring indicated that the gradient control system was failing to contain the contaminant plume onsite, implementation of another groundwater remedy or installing additional extraction wells would not be hampered by the existing system.

10.3.6.2 Administrative Feasibility

Installing the additional extraction and monitor wells would require access to private and city property. Land use restrictions would also be required and might be difficult to implement.

10.3.6.3 Availability of Services and Materials

The material, equipment and personnel for constructing the gravel/clay caps would be readily available in Buffalo. The construction, well drilling, and plumbing services necessary to implement this alternative could be easily obtained.

10.3.7 Costs

Tables 10-6 and 10-7 provide summaries of the construction and operation and maintenance costs for Alternative 3. The construction costs, including direct and indirect construction costs, would be approximately $1,162,800 (Table 10-6). Continued monitoring, cap maintenance, and groundwater extraction and treatment contribute to the O&M costs and result in cost of $586,700 for 30 years (Table 10-7). The present worth analysis yields a total of $1,749,500 for this alternative.

10.4 ALTERNATIVE 4: EXCAVATION AND OFFSITE DISPOSAL (LANDFILL OR INCINERATOR) SOURCE AREAS AND SOIL; AND IMPERMEABLE BARRIER, EXTRACTION WELLS WITH OIL/WATER SEPARATION AND GROUNDWATER GAC TREATMENT

Alternative 4 would consist of the following process options and technologies:

- Excavation, temporary storage, separation and sizing, and offsite disposal of source area solids/soils
- A sheet piling vertical barrier and extraction wells for gradient control in the source areas
- Extraction wells for groundwater removal and gradient control
- Oil-water separation, filtration, and carbon adsorption for treatment of groundwater
- Groundwater monitoring and use restrictions, land use restrictions, and fencing.

The contaminated material around the warehouse building would be excavated as shown on Figure 10-5. Excavated material separation and storage areas would also be set up when remediation begins.

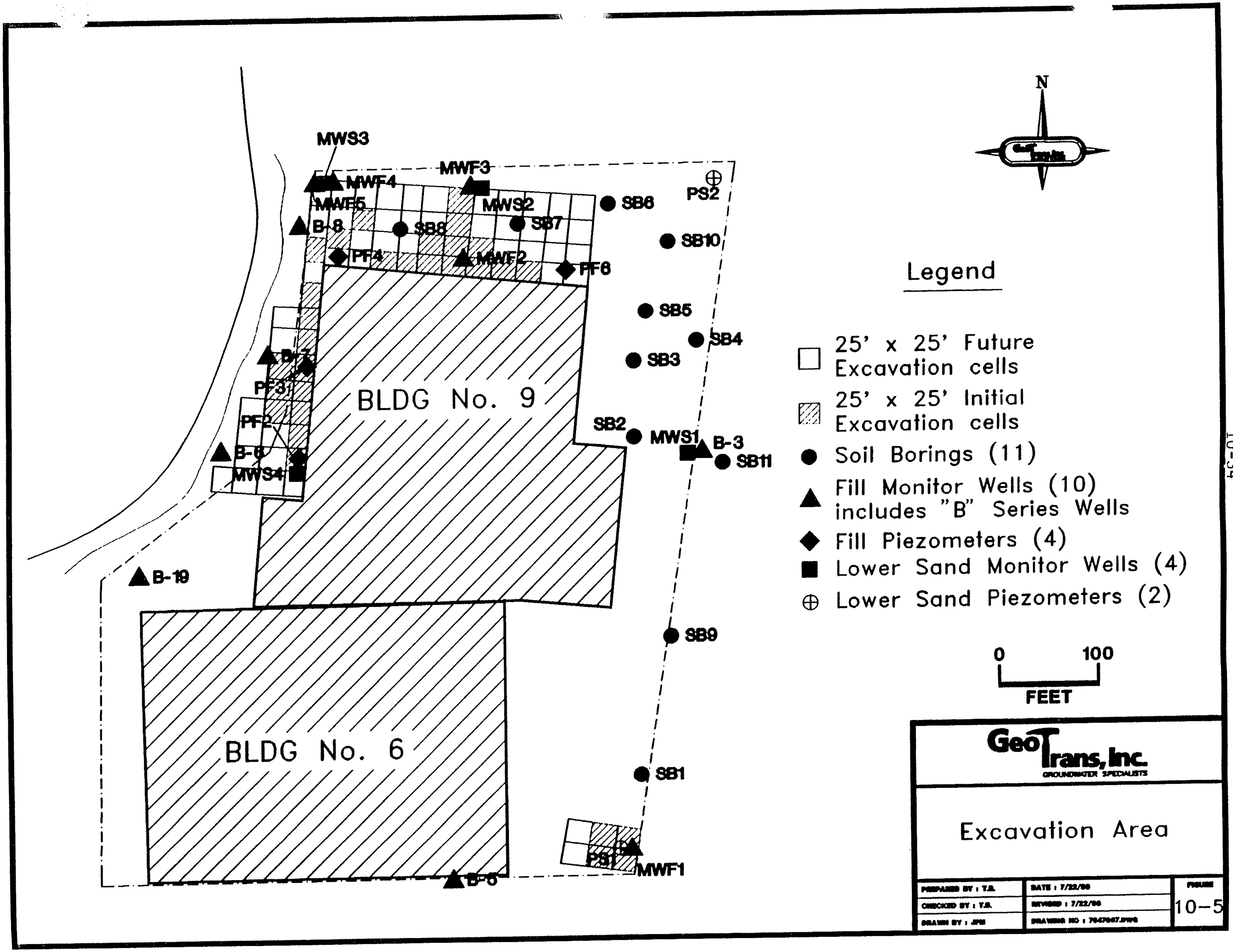
In this alternative, it is assumed that soil would be excavated to a depth of 15 feet or the water level. Continuous excavation could be revised, based on field observation and sampling during implementation of this remedial action. Excavation of limited waste material below the water table could be conducted, but soil removal would be pointless, as fill

Table 10-6. Construction cost estimate - Alternative 3 - Cap and contain source areas/pump-contain-treat groundwater (1993 $).

Item	Quantity	Units	Unit Cost	Total Cost
FENCING				
Chain Link Fence (8' high)	100	LIN FT	$16.00	$1,600
Gate (34' opening)	1	EA	$1,200.00	$1,200
Sheet Piling	10,000	SQ FT	$25.00	$250,000
CAPPING	12,620	SQ YD	$22.50	$278,000
WELL INSTALLATION				
Extraction	10	EA	$9,000.00	$90,000
DECONTAMINATION				
Area Construction & Equipment Rental, Operation		LS		$20,000
GROUNDWATER TREATMENT				
Treatment Equipment (O/W Sep, GAC, Valves, Gauges)		LS		$30,000
Piping - (1000' Air Line, 1500' Water)		LS		$45,000
Electric		LS		$ 5,000
MOBILIZATION/DEMOBILIZATION				$40,000
	Construction Subtotal:		$760,800	
CONTINGENCIES				
Bid Contingencies				$114,000
Scope Contingencies				$114,000
	Contingencies Subtotal:		$228,000	
ALLOWANCES				
Permitting/Legal				$38,000
Engineering				
Design				$76,000
Construction Services				$60,000
	Allowances Subtotal:		$174,000	
TOTAL CONSTRUCTION COSTS:	ALTERNATIVE 3			$1,162,800

Table 10-7. O & M costs and present worth estimate - Alternative 3 - Cap source areas/pump-contain-treat groundwater (1993 $).

Item	Quantity	Units	Unit Cost	Total Cost
GROUNDWATER MONITORING				
Sample Collection/Inspection				
Years 1-30 (bimonthly)	30/yr	MANDAYS	$600.00	$540,000
Sample Analysis/Report				
First Year (bimonthly)	12/yr	EA	$1,000.00	$12,000
Years 2-5 (quarterly)	8/yr	EA	$1,000.00	$32,000
Years 6-30 (biannually)	4/yr	EA	$1,000.00	$100,000
CAP REPAIR		LS		$15,000
ELECTRIC POWER (15 hp)	30	YR	$8,000	$240,000
EQUIPMENT REPLACEMENT COSTS (Incl. GAC)				
Years 1 to 30		EA/YR	$5,000	$150,000
Year 15		LS		$25,000
TOTAL O & M COSTS Present worth annual interest rate @ 5%				$586,700
TOTAL CONSTRUCTION COSTS (from Table 10-6)				$1,162,800
TOTAL PRESENT WORTH		ALTERNATIVE 3		$1,749,500


N
MWS3
MWF4
MWF5
MWF3
MWS2
B-8
SB8
SB7
SB6
PS2
SB10
PF4
MWF2
PF6
SB5
SB4
SB3
B-7
PF3
BLDG No. 9
PF2
SB2
MWS1
B-3
SB11
B-6
MWS4
B-19
SB9
BLDG No. 6
SB1
PS1
MWF1
B-5
Legend
25' x 25' Future Excavation cells
25' x 25' Initial Excavation cells
Soil Borings (11)
Fill Monitor Wells (10) includes "B" Series Wells
Fill Piezometers (4)
Lower Sand Monitor Wells (4)
Lower Sand Piezometers (2)
0
100
FEET
GeoTrans, Inc.
GROUNDWATER SPECIALISTS
Excavation Area
FIGURE
10-5

material would immediately be contaminated by groundwater and DNAPL. Excavation of "hot spots" only could be considered; however, analysis to date has indicated relatively homogenous soil contaminant concentrations.

In order to minimize dust generation and thereby prevent potential recontamination of clean areas during excavation and materials handling, chemical dust suppressants and/or water would be applied as required. Monitoring would be conducted for volatile emissions during excavation and materials handling. If necessary, workers would be required to wear appropriate respiratory protection and steps would be taken to reduce volatile emissions by enclosing the work areas. Berms would be constructed to control surface runon and runoff, and sumps would be used to collect rain water that might fall on the contaminated areas during the excavation process. Collected water would be treated by the groundwater treatment system described with Alternative 3. These measures would minimize possible migration of the contaminants into the air, surface water or groundwater.

To avoid drainage problems, clean soil or other appropriate fill would be used to fill the excavated area as soon as possible after contaminated soil was excavated from a given location. Clean fill would only be placed in areas where contaminated soil had been excavated and removed. Following filling, compaction, and grading to return the area to its preremoval elevation, crushed stone would be applied to minimize soil erosion. All materials excavated would be separated at the solids separation area. All material smaller than two inches in diameter (soil) would be temporarily stored on the soil storage pad until it could be disposed of offsite. Material larger than two inches would be sent to the sizing area and shredded until it was less than two inches in diameter. Sized material would be mixed on the soil storage pad with the soil awaiting shipment. Tars and sludges would also be mixed with soil on the soil storage pad. Any material that could not be sized, or any metal debris, would be decontaminated using a steam jenny and disposed of as a special waste in a permitted solid waste landfill.

The solid debris separation pad, the debris sizing pad, and the soil storage pad would all be bermed areas with synthetic liners (20 mil, or thicker, PVC or PE). The separation pad would be approximately 40 by 40 feet, the sizing pad 40 by 55 feet, and the soil storage area 130 by 85 feet. All water that collected on the pads (from precipitation or from soil excavated below the water table) would be treated by the groundwater treatment plant and discharged to the city sewer. All stored materials would be covered by a 10 mil PVC or PE liner.

The excavated soil and sized material would be transported to the offsite disposal facility (coal-fire utility burner). Transportation would conform to all Department of Transportation regulations. Prior to leaving the loading area, the exterior of the trucks would be decontaminated using a high-pressure steam cleaner, if necessary.

Fencing and groundwater monitoring and use restriction would also be implemented. In order to protect the public from contact with the contaminants, and protect the extraction wells and associated plumbing, the treatment system area would be enclosed with a chain link fence. Groundwater use restrictions would also be instituted for all properties located within the horizontal boundaries of the contaminant plume.

The source areas would be contained by a system consisting of sheet piling and extraction wells for gradient control. Groundwater removed for gradient control from within the sheet piling barrier would be treated in the groundwater treatment system onsite. Additional monitor wells would be installed to the site and samples from these wells and existing monitor wells would be collected and analyzed periodically to verify that contaminants were not migrating beyond the perimeter of the existing groundwater contaminant plume.

In this alternative, the groundwater would be contained with a sheet piling vertical barrier combined with the extraction wells as shown in Figure 10-3. Gradient control to supplement the sheet piling barrier would be established by pumping ten extraction wells. The extracted water would be treated in the proposed groundwater treatment system. The groundwater treatment system is described in Figure 10-4 and in Alternative 3. The lack of a surface cap in this alternative will have little or no effect on the design and operation of the groundwater treatment system.

Since part of the source area is under Building No. 9, the building itself serves as a cap to prevent surface water infiltration, control erosion, and mitigate volatilization from contaminated waste. Furthermore, the parking lot/loading area on the eastern site is covered by asphalt. Seventy to 80 percent of ground surface is covered by either the building or asphalt. Only the north side, west side, and southwest corner have not been covered.

Alternative 4 would fulfill the objectives of Categories 2 and 3 of the SARA guidance categories for the source areas and groundwater. Excavation and removal would prevent human contact with the source area contaminants, and would minimize the continuing contamination of groundwater through the soil beneath the source areas. Further migration of contaminants via the groundwater from the primary sources at the site would be minimized by the building, vertical barrier, and gradient control system. The perimeter of the contaminant plume of dissolved contaminants would be contained by pumping.

10.4.1 Short-Term Effectiveness

This criterion refers to the protectiveness an alternative offers to the community and workers during the remediation period as well as the environmental impacts and the time required to meet the remedial action objectives.

10.4.1.1 Protection of the Community and Workers

Normal construction hazards would be associated with the construction of the vertical barriers, excavation, and wells. Fencing or temporary barriers would be installed around the site to protect the community during construction by preventing access to unauthorized personnel. All wells would be enclosed in lock boxes to prevent unauthorized access. Source area excavation and well installation and pumping might cause releases of coal tar material, contaminated fugitive dust and/or volatile organic vapors. Monitoring and control of these releases would be required of the construction contractor. A site safety plan would be prepared prior to initiating construction and compliance enforced. In conformance with OSHA regulations, site workers would be health and safety trained, required to wear appropriate protective equipment, and would be enrolled in a medical monitoring program.

10.4.1.2 Environmental Impacts

No significant environmental impacts would be expected during the construction of this alternative. Suitable dust control measures would be implemented as a precautionary measure during source area regrading and sheet piling guide trench excavation/backfilling operations.

10.4.1.3 Time to Achieve Remedial Response Objectives

The remedial objectives for the source areas would be achieved after the excavation, estimated to take six to eight months. The remedial action objectives for the groundwater would be achieved when the gradient control/ extraction system is installed and the groundwater monitoring system confirms that contaminant plume is not migrating, contaminant concentrations are reduced to below NYS limits, and when groundwater use restrictions have been established. It is estimated that the first two years of groundwater monitoring would be sufficient to verify that the plume of contaminated groundwater is being contained following 12 to 15 months of system installation. The time required to achieve contaminant concentration RAOs for the groundwater is unknown.

10.4.2 Reduction in Toxicity, Mobility, or Volume

This criterion reflects the statutory preference for treatment alternatives above nontreatment alternatives. The factors addressed include the treatment itself (process, irreversibility, the amount of hazardous materials to be treated, the quantity of treatment residuals), and the reduction in toxicity, mobility, or volume of the contaminants.

10.4.2.1 Treatment

The contaminated media treated under this alternative would be excavated soil and liquids from the groundwater extracted for gradient control. The water would be treated in the treatment plant described in Figure 10-4 until the effluent met the requirements of the pretreatment agreement with the city. The excavated soil would be incinerated in fuel blending or sent to a designated landfill. The system would generate three non-RCRA wastes: contaminated soil, used filter bags, and spent activated carbon.

10.4.2.2 Reduction in Toxicity, Mobility, or Volume

The contaminated groundwater removal and gradient control with treatment using activated carbon would reduce the mobility of the contaminants and the volume of these contaminated media by removing the contaminants from the liquid and concentrating on the activated carbon for subsequent destruction. The volume of contaminated soil will be reduced at the source area and if burned in fuels blending, would be destroyed.

10.4.2.3 Amount of Material Contained or Treated

The volume of groundwater treated would be up to 7,200 gallons per day indefinitely. The volume of soil removed from the site would be 14,000 cubic yards.

10.4.3 Long-Term Effectiveness

The long-term effectiveness of an alternative pertains to the risks remaining following the remedial action. Three factors to be considered are the magnitude of the residual risks, the adequacy and reliability of the controls, and the permanence of the remedy.

10.4.3.1 Residual Risk

Excavating and incinerating the source area materials would eliminate the potential for direct contact with contaminants in concentrations exceeding the cleanup criteria for PAHs in these areas. These actions would also eliminate these areas as continuing sources of groundwater contamination. Monitoring would verify that no new exposure routes were created by continued migration of contaminants in the groundwater. Extracted gradient control water would be treated to required standards, and the residual risks associated with this alternative would be minimal.

10.4.3.2 Adequacy and Reliability of Controls

The excavation, vertical barriers, and groundwater removal would be the main controls in this alternative, while land and groundwater use restrictions, and monitoring would play subordinate roles. The building would adequately reduce the potential for contact with source area contaminants and would minimize surface infiltration; source areas away from the building would be removed so no contact would be possible. The vertical barrier and extraction wells would minimize the migration of contaminants from the source areas and subsoils within the containment perimeter. Groundwater monitoring would ensure that the controls were working as designed. Land use restrictions would limit future use of the site so that the containment system would not be breached and contaminated subsurface soil would not be disturbed. Groundwater use restrictions would prohibit future use of groundwater within the contaminant plume. Groundwater monitoring would be necessary for the life of the alternative, and the groundwater treatment system would also have to be operated for the life of the alternative. The extraction wells and treatment equipment would require maintenance for the life of the alternative.

10.4.3.3 Permanence of Remedy

Since sheet piling is used in many construction projects with service lives of over 30 years, it should be able to function for the life of this remedy. Gradient controls would provide a mechanism for compensating for minor failures in the sheet piling by increasing the pumping rate. It is expected that the monitoring and extraction wells would serve for the entire life of the remedy with periodic cleaning and maintenance. The groundwater treatment plant is enclosed and the equipment is readily replaceable, if necessary.

10.4.4 Compliance with ARARs

This criterion examines the alternative to determine if compliance will be achieved for the three types of ARARs.

10.4.4.1 Chemical-Specific ARARs

Accessible source areas/soils would be removed above the water table based on NYS soil standards. Following groundwater recovery/treatment system installation monitoring would be used to verify continued containment of the plume and reduction of contaminant concentrations to NYS groundwater quality standards or MCLs.

10.4.4.2 Location-Specific ARARs

The last section discussed potential location-specific ARARs for the IG/WS site and determined that there were none for the site.

10.4.4.3 Action-Specific ARARs

During installation of the controls, protection of the workers would comply with OSHA standards. Prevention of airborne contamination by dust control and capping would maintain air quality as required by the Clean Air Act. Closure and post-closure activities would conform to RCRA standards. Groundwater extracted for gradient control of the source areas would meet the discharge standards agreed to in the pretreatment agreement with the City of Buffalo, as is required by the National Pretreatment Standards of the Clean Water Act.

10.4.5 Overall Protection of Human Health and the Environment

This criterion assesses the overall protectiveness offered by an alternative. The evaluation considers the adequacy of protection, elimination of risk, and achievement of the four previous evaluation criteria.

This alternative would offer protection to both human health and the environment by eliminating potential contact with the source area wastes by removal and minimizing migration of contaminants from the source areas. Protection would be achieved at the end of the construction period of eight months. The residual risks posed by contaminated material remaining within groundwater would not be significant. All potential exposure routes would be minimized if use restrictions were observed and pumping and groundwater monitoring were continued.

10.4.6 Implementability

Implementability includes three subcriteria: technical feasibility, administrative feasibility, and the availability of the required services and materials.

10.4.6.1 Technical Feasibility

Technical feasibility is evaluated on the basis of three parameters: ability to construct the alternative, the reliability of the technologies used, and ease of undertaking additional remedial actions.

- Ability to construct the alternative. All the construction required by this alternative would be basic heavy construction and should not pose any particular problems.
- Reliability of the technology. Excavation, containment, and gradient control are effective and frequently used alternatives. Filtration and carbon adsorption have been proven effective in treating groundwater contaminated with organic contaminants.
- Ease of undertaking additional remedial action. It is not anticipated that any future remedial actions would be necessary. If the operations building were eventually demolished, the containment system might have to be extended to include this portion of the site, and source area would be excavated. If monitoring indicated that the existing system was failing to contain the contaminant plume, implementation of another groundwater remedy or installing additional extraction wells would not be hampered by the existing system.

10.4.6.2 Administrative Feasibility

Access to City of Buffalo property would be necessary to install the sheet piling. Installing additional wells might require access to private and city property. Land and groundwater use restrictions would also be required and are not expected to be difficult to implement.

10.4.6.3 Availability of Services and Materials

The materials, equipment, and personnel required to do the soil excavating would be readily available in Buffalo. The steel sheet pilings could be readily purchased. The sheet piling construction, well drilling, and plumbing services necessary to implement this alternative could be obtained.

10.4.7 Costs

Tables 10-8 and 10-9 provide summaries of the construction and operation and maintenance (O&M) costs for Alternative 4. The construction

Table 10-8. Construction cost estimate - Alternative 4 - Excavate soil and incinerate offsite/impermeable barrier/pump-contain-treat groundwater (1993 $).

Item	Quantity	Units	Unit Cost	Total Cost
FENCING				
Chain Link Fence (8' high)	100	LIN FT	$16.00	$1,600
Gate (34' opening)	1	EA	$1,200.00	$1,200
Sheet Piling	10,000	SQ FT	$25.00	$250,000
EXCAVATION	14,000	CU YD	$10.00	$140,000
BACKFILL	14,000	CU YD	$10.00	$140,000
HDPE LINER (60 mil) for Stockpiling	30,000	SQ FT	$0.60	$18,000
GROUNDWATER TREATMENT				
Treatment Equipment		LS		$30,000
Piping		LS		$45,000
Electric		LS		$ 5,000
TRANSPORTATION (@ 200 miles)	825	TRIP	$900.00	$742,500
OFFSITE INCINERATION				
Material Handling Equipment		LS		$75,000
Incineration (As fuel at utility)	14,000	CU YD	$100	$1,400,000
Ash Disposal	14,000	CU YD	$50	$700,000
WELL INSTALLATION				
Extraction	10	EA	$5,000.00	$50,000
DECONTAMINATION				
Area Construction & Equipment Rental/Operation		LS		$20,000
MOBILIZATION/DEMOBILIZATION				$40,000
	Construction Subtotal:		$3,658,300	
CONTINGENCIES				
Bid Contingencies				$350,000
Scope Contingencies				$540,000
	Contingencies Subtotal:		$890,000	
ALLOWANCES				
Permitting/Legal				$18,000
Engineering				
Design				$350,000
Construction Services				$300,000
	Allowances Subtotal:		$830,000	
TOTAL CONSTRUCTION COSTS:	ALTERNATIVE 4			$5,378,300

Table 10-9. O & M costs and present worth estimate - Alternative 4 - Excavate soil and incinerate offsite/impermeable barrier/pump-contain-treat groundwater (1993 $).

Item	Quantity	Units	Unit Cost	Total Cost
GROUNDWATER MONITORING				
Sample Collection/Cap Inspection				
Years 1-30 (bimonthly)	30/yr	MANDAYS	$600.00	$540,000
Sample Analysis/ Report				
First Year (bimonthly)	12/yr	EA	$1,000.00	$12,000
Years 2-5 (quarterly)	8/yr	EA	$1,000.00	$32,000
Years 6-30 (biannually)	4/yr	EA	$1,000.00	$100,000
ELECTRIC POWER (15 hp)	30	YR	$8,000.00	$240,000
EQUIPMENT REPLACEMENT COSTS				
Years 1-30	30	YR	5,000	$150,000
Year 15		LS		$25,000
TOTAL O & M COSTS Present worth annual interest rate @ 5.0%				$572,500
TOTAL CONSTRUCTION COSTS (from Table 10-8)				$5,378,300
TOTAL PRESENT WORTH		ALTERNATIVE 4		$5,950,800

costs, including direct and indirect construction costs, would be approximately $5,378,300 (Table 10-8). Continued monitoring and groundwater extraction and treatment contribute to the O&M costs and result in costs of $572,500 for 30 years (Table 10-9). The present worth analysis yields a total of $5,950,800 for this alternative. If excavated soil is sent to a RCRA permitted incineration facility, the unit price of incineration per cubic yard of soil will be approximately $1,500. For offsite solid waste landfill which likely could not accept much of the water, the unit price of disposal per cubic yard of soil will be approximately $50, and for an RCRA permitted landfill, approximately $175 per cubic yard.

10.5 ALTERNATIVE 5: LANDFARMING SOIL ONSITE AND INSTALLATION OF IMPERMEABLE BARRIER, EXTRACTION WELLS WITH OIL/WATER SEPARATION, FILTRATION, AND GAC TREATMENT

Alternative 5 would consist of the following process options and technologies:

- Landfarming of contaminated soil from the source areas
- A sheet piling vertical barrier and extraction wells for gradient control in the source areas
- Extraction wells for groundwater removal and gradient control
- Oil/water separation, filtration, and carbon adsorption for treatment of groundwater
- Groundwater monitoring; use and access restrictions

Contaminated soil in the accessible source areas that contained concentrations of contaminants in excess of the RAOs for carcinogenic and total PAHs would be excavated and treated at an onsite land treatment facility located on the property. The volume of such soil is conservatively estimated to be 14,000 cubic yards.

The land treatment facility would be constructed by grading or excavating a site and creating berms and ramps to prevent runon or runoff. One foot of compacted clean fill would be placed within the berms, followed by a 60 mil HDPE liner and a one-foot drainage layer of permeable fill, which will also protect the liner. A sump would be installed to capture water that percolates into the drainage layer. This water would be used to irrigate the treatment area, as needed. In addition, an irrigation system would be constructed to provide additional moisture as required. Excess water from the drainage layer would be treated through the groundwater treatment system prior to discharge. The soil treatment facility would be constructed to control volatile emissions in compliance with applicable air quality regulations. A treatability study would be performed to determine the appropriate types and amounts of nutrients to add to the system to enhance biodegradation. Engineered organisms would also be investigated to evaluate whether they would enhance the land treatment process.

Contaminated soil would be placed on to the clean fill within the treatment area to a depth of eight inches. Assuming moderately contaminated soils (500 to 5000 ppm total PAHs) and a half-life of five weeks for PAHs at these concentrations in soil, two eight-inch lifts of 750 cubic yards each could be treated for 20 weeks (four half-lives) in a single treatment season. Based on these assumptions, the area required for the land treatment facility would be less than one acre.

The contaminated eight-inch soil lift would be tilled weekly using conventional agricultural equipment. Agricultural lime and fertilizer would be added as needed to achieve a Carbon: Nitrogen: Phosphorus (C:N:P) ratio of 80:2:1 (or as required by treatability testing) and to maintain soil pH in the range of 6.5 to 8. Irrigation would be used to control the moisture level in the soil at 50 to 80 percent of field capacity (moist but not saturated).

The treatment area would be subdivided into six areas for operational monitoring. A soil composite made up of four discrete soil samples would be collected from each area on a monthly basis for analysis of PAHs, nitrogen, phosphorus and soil pH. Microbial enumerations or oxygen uptake measurement would be performed as needed. Treated soil could be removed and used as fill material or disposed of as a special waste in a solid waste landfill once treatment effectiveness had been confirmed.

A sheet piling vertical barrier would be used for gradient control in the source area. The contaminated groundwater plume would be contained, extracted, and treated as described in previous alternative. Fencing and groundwater monitoring would be implemented as described in previous alternatives.

Alternative 5 should fulfill the objectives of Category 2 of the SARA guidance categories for the source areas and soil. Removal and treatment of the source area materials and soil would permanently reduce the toxicity, mobility, and volume of contaminants in these materials. Alternative 5 would fulfill the objectives of Categories 2 and 3 of SARA guidance for the contaminated groundwater. Extracting and treating the contaminated groundwater would reduce the toxicity and volume of the contaminated material and decrease the mobility of the plume. In addition, the extraction well system and the sheet piling vertical barrier would ensure that the plume of contaminated groundwater and DNAPL remained contained.

10.5.1 Short-Term Effectiveness

This criterion evaluates the protectiveness the alternative offers the community and site workers during the implementation period as well as the environmental impacts of implementation and the amount of time required to meet the remedial action objectives.

10.5.1.1 Protection of the Community and Site Workers

Normal construction hazards would be associated with the excavation of the source areas and the construction of the required wells. Some of the remedial activities to be conducted on property would require erection of temporary barriers to prevent unauthorized access to the work areas. Excavating the source areas and soil, sizing source area materials, and landfarming excavated soil might cause releases of volatile organics and contaminated fugitive dust. Contaminants (especially volatile organic contaminants) might be released during well drilling and groundwater treatment activities. Monitoring and control of releases would be required of the construction contractor during activities in the area of the site. Releases of volatile organics during landfarming of the soil would be controlled, if necessary, to comply with applicable air quality regulations. These releases are not anticipated to be significant, based on existing data. A site safety plan, would be prepared prior to initiating activities and compliance enforced. In conformance with OSHA regulations, all workers would be health and safety trained, required to wear appropriate protective equipment, and would be enrolled in a medical monitoring program.

10.5.1.2 Environmental Impacts

No significant environmental impacts would be expected during the implementation of this alternative. Suitable controls would be implemented to prevent releases of volatile organics and contaminated fugitive dust during remedial activities at the site. Suitable runon and runoff controls would also be implemented during excavation to prevent transport of contaminants by surface runoff or infiltration. Releases of volatile organics are not anticipated to be significant based on existing data and would be controlled, if necessary, to comply with applicable air quality regulations. The land treatment facility would be fenced and designed with a containment system to prevent releases of contaminants via leaching.

10.5.1.3 Time to Achieve Remedial Action Objectives

The remedial action objectives for the source areas and soil would be accomplished when all removal and treatment of the source areas is completed. The removal and treatment is estimated to take 12 to 16 months for landfarming. The remedial action objectives for the groundwater would be achieved when monitoring confirmed that gradient control was established and contaminant concentrations in groundwater were reduced below contaminant concentration RAOs (NYS limits). The time estimated for well installation, system debugging, and establishing gradient control is 12 to 18 months. However, the time required to achieve contaminant concentration RAOs for the groundwater is unknown.

10.5.2 <u>Reduction in Toxicity, Mobility, or Volume</u>

This criterion reflects the statutory preference for treatment alternatives above nontreatment alternatives. The factors addressed include the treatment itself (the process used, its irreversibility, the amount of hazardous materials to be treated, and the quantity of treatment residuals), and the reduction in toxicity, mobility, or volume of the contaminants.

10.5.2.1 Treatment

The majority of the organic contaminants in the landfarmed soil would be permanently transformed, immobilized, and degraded by biological processes. However, biodegradation would not achieve the complete destruction of organics provided by incineration. Treated soil from landfarming could be used as fill material or disposed of as a special waste in a solid waste landfill, provided the cleanup criteria for total/carcinogenic PAHs were met. The contaminants in the groundwater would be treated by the groundwater treatment plant. These processes are irreversible and would generate two treatment residuals: used filters and spent activated carbon, which would be disposed of according to the appropriate regulations.

10.5.2.2 Reduction in Toxicity, Mobility or Volume

This remedy would reduce the toxicity and mobility of the contaminants and the volume of contaminated media through landfarming, and water treatment. The majority of the organic contaminants in the landfarmed soil would be permanently transformed, immobilized, and degraded by biological processes. Treatment of contaminated groundwater using an oil/water separator and activated carbon would reduce the mobility of the contaminants and the volume of the contaminated media by removing the contaminants from the liquids and concentrating them on the carbon. Contaminants adsorbed onto the activated carbon would ultimately be destroyed during the process of regenerating the carbon. The gradient control system would also reduce the mobility of the contaminants by containing the contaminated groundwater.

10.5.2.3 Amount of Material Treated

The volume of source area material that would be treated is approximately 14,000 cubic yards. The volume of contaminated groundwater that would be treated is 7,200 gallons per day for an indefinite period.

10.5.3 Long-Term Effectiveness

The long-term effectiveness criterion addresses the residual risk after the remedy has been implemented; the adequacy and reliability of the controls; and the permanence of the remedy.

10.5.3.1 Residual Risk

Removing and treating the source area materials would eliminate the potential for direct contact with contaminants in concentrations exceeding the cleanup criteria for PAHs in these areas. These actions would also eliminate these areas as continuing sources of groundwater contamination. The risk associated with potential future use of contaminated groundwater, as defined in the risk assessment, would be reduced by removal and treatment of groundwater containing concentration of contaminants in excess of RAOs.

Extracted water would be treated to pretreatment standards required for discharge to the City of Buffalo POTW. The residual risks associated with this alternative would be minimal.

10.5.3.2 Adequacy and Reliability of Controls

Since contaminated source area materials and soil would be removed and treated, long-term controls or monitoring would not be required in these areas. Monitoring the land farm operation would ensure that contaminants were being effectively treated during operation of the facility. The groundwater removal and treatment system would be operated over the life of the alternative. Groundwater monitoring would ensure that contaminants were being contained as predicted. It would be necessary to conduct groundwater monitoring for the life of the alternative. The extraction well pumps and groundwater treatment equipment would require maintenance for the life of the alternative.

10.5.3.3 Permanence of Remedy

The source area materials and soil removed for treatment would be permanently remediated. **Groundwater removal and treatment would continue for the life of the alternative (30 years assumed), which the State of New York does not consider to be permanent.** If replacement wells or the installation of additional wells were necessary, these activities would require relatively minor additional effort and cost. The groundwater treatment plant is enclosed and its equipment is readily replaceable if required.

10.5.4 Compliance with ARARs

This criterion examines the alternative to determine if compliance will be achieved for the three types of ARARs.

10.5.4.1 Chemical-Specific ARARs

Groundwater containing contaminants in concentrations in excess of RAOs (NYS limits) would be removed and treated. Monitoring would be used to verify continued onsite containment of the contaminated groundwater plume under this alternative. Source area material and soil amounts equivalent to those in Alternative 4 would be removed and treated to meet RAOs.

10.5.4.2 Location-Specific ARARs

Section 8.3 discussed potential location-specific ARARs for the IG/WS site and determined that there were none for the site.

10.5.4.3 Action-Specific ARARs

During installation of the controls, protection of the workers would comply with OSHA standards. Prevention of airborne contamination by emission control measures in the area of the site would maintain air quality as required by the Clean Air Act. The landfarming would conform to RCRA standards. Groundwater extracted to contain the groundwater plume would meet the required discharge limits.

10.5.5 Overall Protection of Human Health and the Environment

This criterion assesses the overall protectiveness offered by an alternative. The evaluation considers the adequacy of protection, elimination of risk, and achievement of the four previous evaluation criteria.

This alternative would offer protection to both human health and the environment by completely and permanently treating the source area materials and soil containing concentrations of contaminants in excess of the cleanup criteria, preventing continued offsite migration of the contaminated groundwater plume, and by treating the extracted water. Protection would be achieved at the end of the remediation period of 16 months for the soils. The time to achieve groundwater protection is unknown. Contaminated subsurface soils would remain under the building. The residual risks posed by this contaminated material would not be significant, since potential future exposure routes would be eliminated by groundwater pumping.

10.5.6 Implementability

Implementability includes three subcriteria: technical feasibility, administrative feasibility, and the availability of the required services and materials.

10.5.6.1 Technical Feasibility

Technical feasibility is evaluated on the basis of three parameters: ability to construct the alternative, the reliability of the technologies used, and ease of undertaking additional remedial actions.

- Ability to construct the alternative. All the construction required by this alternative would be basic heavy construction and should not pose any particular problems.

- Reliability of the technology. Excavation, pumping decontamination, sizing, and gradient control are frequently used alternatives that have proven effective. Landfarming has been demonstrated in at least one full-scale application on PAH-contaminated soil. Existing data indicate that soil containing concentrations of total PAHs from 500 to 5000 ppm can be treated by landfarming to reduce total PAHs to below 500 ppm. However, the presence of DNAPL or significant concentrations of four- and five-ring PAHs might reduce the effectiveness of the land treatment process. Laboratory and field studies would be required during design to confirm the effectiveness of the process under site conditions and to determine the rate and extent of remediation expected for full-scale operation. Oil/water separation, filtration, and carbon adsorption have frequently been used and have been proven effective in treating water contaminated with organic compounds.

- Ease of undertaking additional remedial action. It is not anticipated that any future remedial actions would be necessary. Future demolition of the operations building would not be affected by any of the activities proposed under this alternative. Additional landfarming could be implemented if the buildings were removed. If monitoring indicated that the gradient control system were failing to contain the contaminant plume, implementation of another groundwater remedy or installing additional extraction wells would not be hampered by the existing system.

10.5.6.2 Administrative Feasibility

Access to private and City of Buffalo property may be necessary to install the monitor wells.

10.5.6.3 Availability of Services and Materials

The construction services to implement this alternative are easily obtained. Remedial contractors are also available with the experience necessary to implement these remedial actions.

10.5.7 Costs

Tables 10-10 and 10-11 provide summaries of the construction and operation and maintenance costs for Alternative 5. The construction costs, including direct and indirect construction costs, would be approximately $1,867,800 (Table 10-10). Continued monitoring and groundwater extraction and treatment contribute to the O&M costs and result in costs of $615,285 for 30 years (Table 10-11). The present worth analysis yields a total of $2,483,085 for this alternative.

10.6 ALTERNATIVE 6: CAPPING SOURCE AREAS, IN-SITU BIOTREATMENT SOURCE AREAS FOR SOIL AND GROUNDWATER.

Alternative 6 would consist of the following process options and technologies:

Table 10-10. Construction cost estimate - Alternative 5 - Excavate soil/ landfarm onsite/impermeable barrier/pump-contain-treat groundwater (1993 $).

Item	Quantity	Units	Unit Cost	Total Cost
FENCING				
Chain Link Fence (8' high)	100	LIN FT	$16.00	$1,600
Gate (34' opening)	1	EA	$1,200.00	$1,200
EXCAVATION	14,000	CU YD	$10.00	$140,000
WELL INSTALLATION				
Extraction	10	EA	$9,000.00	$90,000
DECONTAMINATION				
Area Construction & Equipment Rental		LS		$23,000
Operation	80	DAY	$62.50	$5,000
Washwater Disposal (800 gpd)	40,000	GAL	$0.10	$4,000
GROUNDWATER TREATMENT				
Treatment Equipment		LS		$30,000
Piping		LS		$45,000
Electric		LS		$ 5,000
LANDFARM				
SITE WORK/EQUIPMENT				
Earth Moving		LS		$300,000
Drainage/Irrigation/Fencing		LS		$200,000
Soil Loading		LS		$40,000
Building		LS		$40,000
Tilling Equipment		LS		$150,000
MOBILIZATION/DEMOBILIZATION				$20,000
	Construction Subtotal:		$1,094,800	
CONTINGENCIES				
Bid Contingencies				$150,000
Scope Contingencies				$203,000
	Contingencies Subtotal:		$353,000	
ALLOWANCES				
Permitting/Legal				$75,000

Table 10-10. Construction cost estimate - Alternative 5 - Excavate soil/landfarm onsite/impermeable barrier/pump-contain-treat groundwater (1993 $).

Item	Quantity	Units	Unit Cost	Total Cost
Engineering				
Design/Treatment				$150,000
Design/Landfarm				$120,000
Construction Services				$150,000
	Allowances Subtotal:		$420,000	
TOTAL CONSTRUCTION COSTS:	ALTERNATIVE 5			$1,867,800

Table 10-11. O & M costs and present worth estimate - Alternative 5 - Excavate soil/landfarm and onsite/impermeable barrier/pump-contain-treat groundwater (1993 $).

Item	Quantity	Units	Unit Cost	Total Cost
INCINERATION/TREATMENT				
GROUNDWATER MONITORING				
Sample Collection				
Years 1-30 (bimonthly)	30/yr	MANDAYS	$600.00	$540,000
Sample Analysis/Report				
First Year (bimonthly)	12/yr	EA	$1,000.00	$12,000
Years 2-5 (quarterly)	8/yr	EA	$1,000.00	$32,000
Years 6-30 (biannually)	4/yr	EA	$1,000.00	$100,000
ELECTRIC POWER	30	YR	$8,000	$240,000
LANDFARM (Year 1)				
Operating Labor		LS		$15,000
Analytical Costs		LS		$15,000
Utilities and Supplies		LS		$10,000
Oversight and Supervision		LS		$ 5,000
EQUIPMENT REPLACEMENT COSTS				
Years 1-30	30	YR	$5,000	$ 150,000
Year 15		LS		$25,000
TOTAL O & M COSTS Present worth annual interest rate @5.0%				$615,285
TOTAL CONSTRUCTION COSTS (from Table 10-12				$1,867,800
TOTAL PRESENT WORTH	ALTERNATIVE 5			$2,483,085

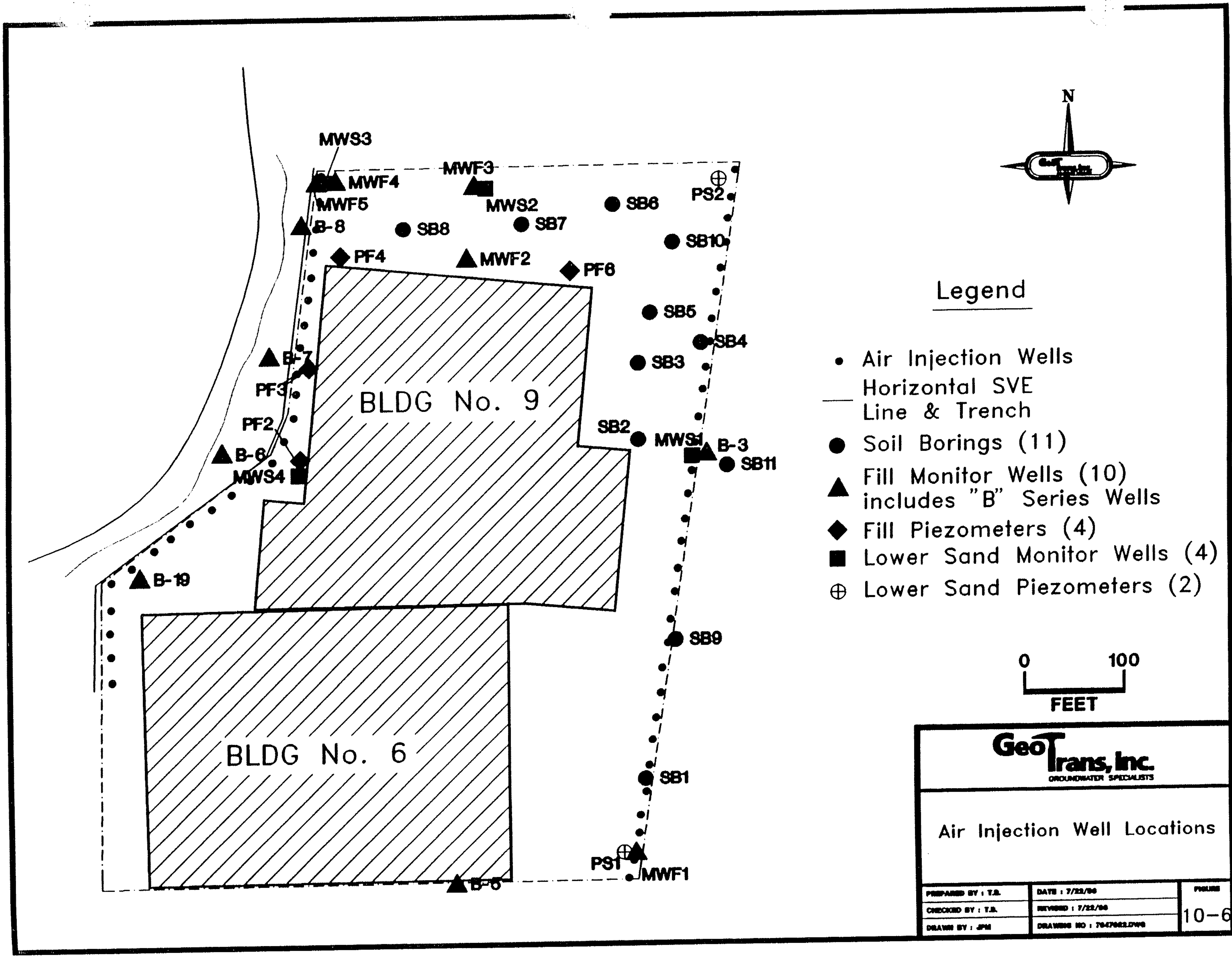
- Caps to contain the source area contaminants
- In-situ biotreatment (biosparging/bioventing) source areas for soil and groundwater
- Groundwater monitoring and use restriction, land use restrictions, and fencing

A biosparging/bioventing system would be used in this alternative for biotreatment of groundwater and soil over the whole site. Biosparging is an aeration process designed to deliver oxygen to the subsurface for use by indigenous bacteria to degrade hydrocarbons. Bench-scale testing would be employed to determine the effectiveness of biotreatment and pilot testing would be accomplished to determine site-specific radius of influence and effectiveness. For the purposes of this evaluation, it is assumed that 55 sparge points (Figures 10-6 and 10-7) would be installed along the upgradient and downgradient of the site to a depth of 20 feet, just above the surface of the clay layer. A soil venting recovery system would be installed in horizontal trenches above the water table to capture the injected air and hydrocarbon vapors generated from the biosparging system. The area would then be covered with the cap preventing short circuiting. The system would include a vapor phase activated carbon system, air compressor (for injection air and soil vapor recovery pump). The horizontal soil venting system would be operated to ensure that all the injected air is recovered.

The intent of the remedial design of Alternative 6 is to minimize the actual volatilization and concentrate on oxygen stimulated biodegradation of the hydrocarbons in situ.

Capping would also isolate the source area to prevent contact with contaminants, control erosion, and mitigate infiltration and volatilization from contaminated waste during in-situ air sparging treatment.

Alternative 6 would fulfill the objectives of Category 3 of the SARA guidance categories for the source areas. Alternative 6 would fulfill the objectives of Categories 2 and 3 of the SARA guidance for the contaminated groundwater. Treating the contaminated groundwater in situ would reduce the toxicity and volume of the contaminated material.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BLDG No. 9
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SB11
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MWS4
B-19
SB9
BLDG No. 6
SB1
PS1
MWF1
B-5
Legend
Air Injection Wells
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Fill Monitor Wells (10) includes "B" Series Wells
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GROUNDWATER SPECIALISTS
Air Injection Well Locations
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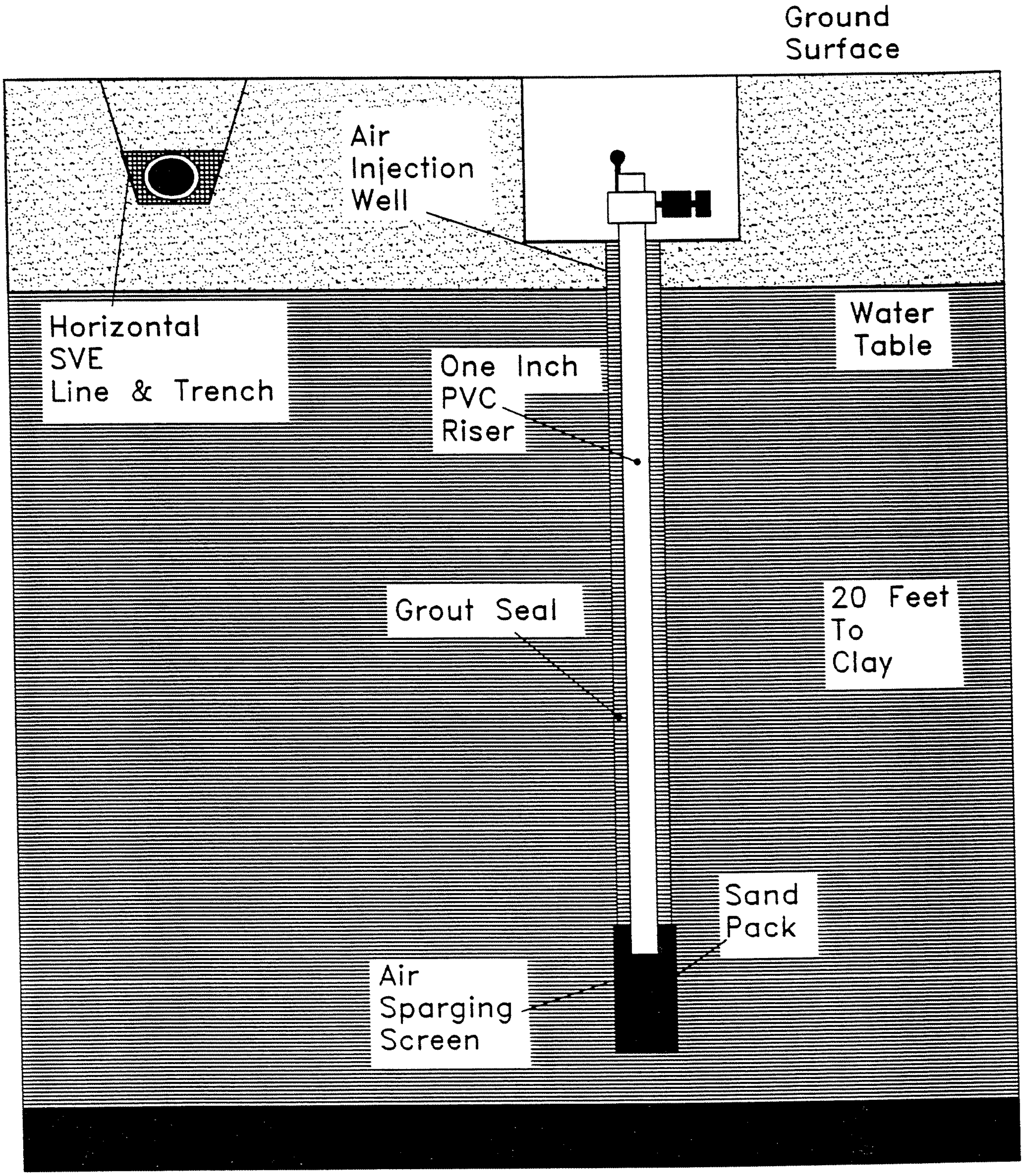

GeoTrans, inc. GROUNDWATER SPECIALISTS

Cross Sectional View of Biosparging System

PREPARED BY : T.S.	DATE : 7/22/96	FIGURE
CHECKED BY : T.S.	REVISED : 7/22/96	10-7
DRAWN BY : J.P.M.	DRAWING NO : [illegible]	

10.6.1 Short-Term Effectiveness

This criterion refers to the protectiveness an alternative offers to the community and workers during the remediation period, as well as the environmental impacts and the time required to meet the remedial action objectives.

10.6.1.1 Protection of the Community and Workers

Normal construction hazards would be associated with the construction of the caps and wells. Fencing or temporary barriers would be installed around the site to protect the community during construction by preventing access to unauthorized personnel. All wells would be enclosed in lock boxes to prevent unauthorized access. Source area contaminated fugitive dust and/or volatile organic vapors monitoring and control would be required of the construction contractor. A site safety plan would be prepared prior to initiating construction and compliance enforced. In conformance with OSHA regulations, all required site workers would be health and safety trained, required to wear appropriate protective equipment, and would be enrolled in a medical monitoring program.

10.6.1.2 Environmental Impacts

No significant environmental impacts would be expected during the construction of this alternative. Although investigations at the site have not identified any significant near-surface contamination in the area of the migrating sources, suitable dust control measures would be implemented as a precautionary measure during the source area regarding operations.

10.6.1.3 Time to Achieve Remedial Response Objectives

The time estimated for design and installation of the caps and in situ biotreatment is eight to nine months. The remedial objectives for the source areas and groundwater would require an extended time period, and would be achieved when monitoring confirmed that contaminant concentrations in groundwater were reduced to levels below RAOs. The presence of DNAPL and heavier, more recalcitrant PAHs will extend the remediation span. The time estimated for well installation and system debugging is 12 to 18 months. However, the time required to achieve NYS standards for the groundwater is unknown (and perhaps not feasible, requiring ACLs).

10.6.2 Reduction in Toxicity, Mobility, or Volume

This criterion reflects the statutory preference for treatment alternatives above nontreatment alternatives. The factors addressed include the treatment itself (process, irreversibility, the amount of hazardous materials to be treated, the quantity of treatment residuals), and the reduction in toxicity, mobility or volume of the contaminants.

10.6.2.1 Treatment

The contaminated media treated under this alternative would be the source areas and groundwater.

10.6.2.2 Reduction in Toxicity, Mobility or Volume

In-situ biotreatment treats the soil and groundwater of the source area, thereby reducing their toxicity. The most mobile, and some of the more toxic, contaminants of concern (e.g., benzene) are the most amenable to biodegradation.

This alternative does not include a gradient control technology, so contaminant migration in groundwater would continue until source area remediation was complete. The mobility of the contaminants in the source areas would be indirectly reduced by the use of caps to reduce surface infiltration.

10.6.2.3 Amount of Material Contained or Treated

The area of the source area caps would be 13,000 square yards. Approximately 14,000 cubic yards of soil would be treated.

10.6.3 Long-Term Effectiveness

The long-term effectiveness of an alternative pertains to the risks remaining following the remedial action. Three factors to be considered are the magnitude of the residual risks, the adequacy and reliability of the controls, and the permanence of the remedy.

10.6.3.1 Residual Risk

Capping the source areas would minimize the potential for direct contact with contaminants in those areas. The risk associated with potential future use of contaminated groundwater as defined in the risk assessment would be reduced by bio-treatment of groundwater containing concentrations of contaminants in excess of RAOs, if feasible. Migration of groundwater contamination is not directly addressed. **The contaminated groundwater would continue to move into the creek for an extended time period. No estimate for the time period can be given at this time.**

10.6.3.2 Adequacy and Reliability of Controls

The source area caps and groundwater and soil in-situ biotreatment would be the main controls of this alternative, while monitoring and land use restrictions would play a subordinate role. The caps would adequately reduce the potential for contact with source area contaminants and would minimize surface infiltration. Groundwater monitoring would ensure that both main controls were working as designed. Land use restrictions would limit future use of the site so that the caps would not be breached and contaminated subsurface soil would not be disturbed. Groundwater monitoring would be necessary for the life of the alternative and the in-situ bio-treatment system would also have to be operated for the life of the alternative. The air injection wells, air compressor/blower and plumbing, and the caps would have to be maintained for the life of the alternative.

10.6.3.3 Permanence of Remedy

If the gravel and clay caps were properly designed and maintained, they would be able to adequately isolate the source areas for the life of this remedy. The cost of replacing damaged caps, if necessary, would be relatively small. If replacement of blowers or the installation of additional wells were necessary, these activities would require relatively minor additional effort and cost.

10.6.4 Compliance with ARARs

This criterion examines the alternative to determine if compliance will be achieved for the three types of ARARs.

10.6.4.1 Chemical-Specific ARARs

Groundwater and soil containing contaminants in concentrations over RAOs are treated. Monitoring would be used to verify continued biodegradation of the contaminated groundwater plume under this alternative. Direct DNAPL removal would not be accomplished.

10.6.4.2 Location-Specific ARARs

Section 8.3 discussed potential location-specific ARARs for the IG/WS site and determined that there were none for the site.

10.6.4.3 Action-Specific ARARs

During installation of the controls, protection of the workers would comply with OSHA standards. Prevention of airborne contamination by dust control and capping would maintain air quality, as required by the Clean Air Act. Closure and post-closure would conform to RCRA standards.

10.6.5 Overall Protection of Human Health and the Environment

This criterion assesses the overall protectiveness offered by an alternative. The evaluation considers the adequacy of protection, elimination of risk, and achievement of the four previous evaluation criteria.

This alternative would offer protection to both human health and the environment by minimizing potential contact with the source area wastes and contaminated groundwater and permanently treating source areas/soil and groundwater. Protection by capping would be achieved at the end of the construction period of 12 months for the source areas. The time to achieve protection for the groundwater is unknown, if feasible. **Therefore, residual risks associated with the groundwater migration prior to the bioremediation becoming fully effective would exist.**

10.6.6 Implementability

Implementability includes three subcriteria: technical feasibility, administrative feasibility, and the availability of the required services and materials.

10.6.6.1 Technical Feasibility

Technical feasibility is evaluated on the basis of three parameters: ability to construct the alternative, the reliability of the technologies used, and ease of undertaking additional remedial actions.

- Ability to construct the alternative. All the construction required by this alternative would be basic heavy construction and should not pose any particular problems.
- Reliability of the technology. Capping and is an effective and frequently used technology. Bioremediation is not proven for coal tar-contaminated sites, but remediation of associated compounds and pilot testing has been favorable.
- Ease of undertaking additional remedial actions. It is not anticipated that any further remedial actions would be necessary. If the operations building were eventually demolished, the source area caps might have to be extended to include the portion of the site currently occupied by this building, requiring minimal additional effort. If monitoring indicated that the in-situ biotreatment system was failing to contain the contaminant plume onsite, implementation of another groundwater remedy or installing additional extraction wells would not be hampered by the existing system.

10.6.6.2 Administrative Feasibility

Installing the additional extraction and monitoring wells would require access to private property. Land use restrictions would also be required and might be difficult to implement.

10.6.6.3 Availability of Services and Materials

The material, equipment, and personnel for constructing the concrete caps would be readily available in Buffalo. The construction, well drilling, and plumbing services necessary to implement this alternative could be easily obtained.

10.6.7 Costs

Tables 10-12 and 10-13 provide summaries of the construction and operation and maintenance costs for Alternative 6. The construction costs, including direct and indirect construction costs, would be approximately $773,800 (Table 10-12). Continued monitoring, cap maintenance, and groundwater extraction and treatment contribute to the O&M costs and result in a cost of $586,700 for 30 years (Table 10-13). The present worth analysis yields a total of $1,320,500 for this alternative.

10.7 ALTERNATIVE 7: CAPPING SOURCE AREAS. IN-SITU BIOTREATMENT SOURCE AREAS FOR SOIL AND GROUNDWATER/INSTALL IMPERMEABLE BARRIER, EXTRACTION WELLS WITH GROUNDWATER TREATMENT SYSTEM

Alternative 7 would consist of the following process options and technologies:

- Caps to contain the source area contaminants
- In-situ biotreatment soil of soil and groundwater
- A sheet piling vertical barrier wall for gradient control in source area
- Extraction wells for gradient control and removal of the contaminated groundwater
- Treatment of liquids from extracted groundwater using oil-water separation, filtration, and carbon adsorption

Alternative 7 will include treatment technologies in Alternative 6 enhanced with the installation of impermeable sheet piling and extraction wells for DNAPL migration and gradient control and removal of the contaminated groundwater.

Alternative 7 would fulfill the objectives of Categories 2 and 3 of the SARA guidance categories for the source areas and the groundwater. Capping is used to isolate the source area to prevent surface water interaction, control erosion, and mitigate volatilization from contaminated waste. Treatment of the source area materials would permanently reduce the toxicity, mobility, and volume of contaminants in the source area materials. Extracting and treating the contaminated groundwater enhanced

Table 10-12. Construction cost estimate - Alternative 6 - Cap source areas/in-situ biotreatment source areas for soil and groundwater.

Item	Quantity	Units	Unit Cost	Total Cost
FENCING				
Chain Link Fence (8" high)	100	LIN FT	$16.00	$1,600
Gate (34' opening)	1	EA	$1,200.00	$1,200
SOIL BORING (@12' depth)	12	EA	$1,000.00	$12,000
CAPPING	12,620	SQ FT	$22.00	$278,000
WELL INSTALLATION				
Air Injection well	10	EA	$1,500.00	$15,000
SOIL VENTING RECOVERY SYSTEM				
Well Vent	600	FT	$80.00	$48,000
Carbon		EA	$10,000	$10,000
Blower		EA	$5,000.00	$5,000
Air Piping	3,000	FT	$20.00	$60,000
Installation		LS		$18,000
DECONTAMINATION		LS		$20,000
MOBILIZATION/DEMOBILIZATION				$10,000
	Construction Subtotal:		$478,800	
CONTINGENCIES				
Bid Contingencies				$72,000
Scope Contingencies				$72,000
	Contingencies Subtotal:		$144,000	
ALLOWANCES				
Permitting/Legal				$24,000
Engineering				
Design				$48,000
Construction Services				$39,000
	Allowances Subtotal:		$111,000	
TOTAL CONSTRUCTION COSTS:	ALTERNATIVE 6			$733,800

Table 10-13. O & M costs and present worth estimate - Alternative 6 - Cap source areas/in-situ biotreatment source areas for soil and groundwater.

Item	Quantity	Units	Unit Cost	Total Cost
INCINERATION/TREATMENT				
GROUNDWATER MONITORING				
Sample Collection/Cap Inspection				
Years 1-30 (bimonthly)	30/yr	MANDAYS	$600.00	$540,000
Sample Analysis/Report				
First Year (bimonthly)	12/yr	EA	$1,000.00	$12,000
Years 2-5 (quarterly)	8/yr	EA	$1,000.00	$32,000
Years 6-30 (biannually)	4/yr	EA	$1,000.00	$100,000
CAP REPAIR		LS		$15,000
ELECTRICAL POWER (15 HP)	30	YR	$8,000	$240,000
EQUIPMENT REPLACEMENT COSTS				
Year 5	30	YR	$5,000	$150,000
Year 15		LS		$25,000
TOTAL O & M COSTS Present worth annual interest rate @5.0%				$586,700
TOTAL CONSTRUCTION COSTS (from Table 10-18				$733,800
TOTAL PRESENT WORTH		ALTERNATIVE 6		$1,320,500

with in-situ bioremediation would reduce the toxicity and volume of the contaminated material. Alternative 7 would fulfill the objectives of Categories 2 and 3 of the SARA guidance for the contaminated groundwater.

10.7.1 Protection of the Community and Site Workers

Normal construction hazards would be associated with the construction of the cap, sheet piling wall and required wells. Some of the remedial activities to be conducted on property would require erection of temporary barriers to prevent unauthorized access to the work areas. Contaminants (especially volatile organic contaminants) might be released during installation of cap and sheet piling wall, well drilling, and groundwater treatment activities. Monitoring and control of these releases would be required of the construction contractor. All wells would be enclosed in lock boxes to prevent unauthorized access. A site safety plan would be prepared prior to initiating activities and compliance enforced. In conformance with OSHA regulations, all required workers would be health and safety trained, required to wear appropriate protective equipment, and would be enrolled in a medical monitoring program.

10.7.1.2 Environmental Impacts

No significant environmental impacts would be expected during the implementation of this alternative. Suitable controls would be implemented to prevent releases of volatile organics and contaminated fugitive dust during remedial activities. The groundwater treatment system is enclosed to prevent volatilization of contaminants.

10.7.1.3 Time to Achieve Remedial Action Objectives

The remedial action objectives for the source areas would be accomplished when treatment of the source areas is completed. The treatment is estimated to a minimum of 12 months. The remedial action objectives for the groundwater would be achieved when monitoring confirmed that contaminant concentrations in groundwater were reduced below RAOs. The time estimated for well installation, system debugging, and establishing gradient control is 12 to 18 months. However, the time required to achieve RAOs for the groundwater is unknown.

10.7.2 Reduction in Toxicity, Mobility, or Volume

This criterion reflects the statutory preference for treatment alternatives above nontreatment alternatives. The factors addressed include the treatment itself (the process used, its irreversibility, the amount of hazardous materials to be treated, and the quantity of treatment residuals), and the reduction in toxicity, mobility, or volume of the contaminants.

10.7.2.1 Treatment

The contaminants in the groundwater would be treated by the groundwater treatment plant and the in-situ biotreatment process. These processes are irreversible. The treatment plant would generate three treatment residuals: DNAPL, used filters and spent activated carbon, which would be disposed of according to the appropriate regulations.

10.7.2.2 Reduction in Toxicity, Mobility, or Volume

This remedy would reduce the toxicity and mobility of the contaminants through in-situ and ex-situ water treatment. DNAPL recovery by extraction well pumping will reduce existing toxicity and remove the source for future groundwater contamination volume. Treatment of contaminated groundwater using filter and activated carbon would reduce the mobility of the contaminants from the liquids and concentrate them on the filter and carbon. Contaminants adsorbed onto the activated carbon would ultimately be destroyed during the process of regenerating the carbon. In-situ biotreatment would remove and destroy dissolved contaminants through biological processes. The extraction well system would also indirectly reduce the mobility of the contaminants by containing the contaminated groundwater. In addition, the mobility of the contaminants in the source areas would be indirectly reduced by the use of caps to reduce surface infiltration.

10.7.2.3 Amount of Material Treated

The volume of source area material that would be treated is 14,000 cubic yards, while the volume of contaminated groundwater that would be treated in the on-site treatment system is up to 7,200 gallons per day for 30 years.

10.7.3 Long-term Effectiveness

The long-term effectiveness criterion addresses the residual risk after the remedy has been implemented, the adequacy and reliability of the controls, and the permanence of the remedy.

10.7.3.1 Residual Risk

The caps would adequately reduce the potential for contact with source area contaminants and would minimize surface infiltration. Treating the source area materials and soil would eliminate the potential for direct contact with contaminants in concentrations exceeding the cleanup criteria. These actions would also eliminate these areas as continuing sources of groundwater contamination. The risk associated with potential future use of contaminated groundwater as defined in the risk assessment would be reduced by removal and treatment of groundwater containing concentrations of contaminants in excess of RAOs. Extracted water would be treated to required discharge standards.

10.7.3.2 Adequacy and Reliability of Controls

Since contaminated source area materials would be treated, no long-term controls or monitoring would be required in these areas. The groundwater removal and treatment system would be operated over the life of the alternative. Groundwater monitoring would ensure that contaminants were being contained as predicted. It would be necessary to conduct groundwater monitoring for the life of the alternative. Three soil borings would be drilled at scheduled intervals during in-situ biotreatment and sampled to evaluate the effectiveness of the process. The cap, sheet piling walls, extraction wells, air injection wells, and groundwater removal and treatment equipment would require maintenance for the life of the alternative.

10.7.3.3 Permanence of Remedy

The source area materials and the groundwater removed for treatment would be permanently remediated. The in-situ bioremediation process should enhance the effectiveness of the pump and treat portion of this project. If replacement wells or the installation of additional wells were necessary, these activities would require relatively minor additional effort and cost. The groundwater treatment system is enclosed and its equipment is readily replaceable, if required.

10.7.4 Compliance with ARARs

This criterion examines the alternative to determine if compliance will be achieved for the three types of ARARs.

10.7.4.1 Chemical-Specific ARARs.

Groundwater containing contaminants in concentrations in excess of RAOs would be removed and treated. Soil would be treated by bioremediation to RAOs. Monitoring would be used to verify continued onsite containment and treatment of the contaminated groundwater plume under this alternative.

10.7.4.2 Location-Specific ARARs

Section 8.3 discussed potential location-specific ARARs for the IG/WS site and determined that there were none for the site.

10.7.4.3 Action-Specific ARARs

During installation of the controls, protection of the workers would comply with OSHA standards. Prevention of airborne contamination by emission control measures would maintain air quality as required by the Clean Air Act. Closure and post-closure would conform to RCRA standards. Groundwater extracted to contain the groundwater plume would meet the discharge limits agreed to in the pretreatment agreement with the City of Buffalo, as is required by the National Pretreatment Standards of the Clean Water Act.

10.7.5 Overall Protection of Human Health and the Environment

This criterion assesses the overall protectiveness offered by an alternative. The evaluation considers the adequacy of protection, elimination of risk, and achievement of the four previous evaluation criteria.

This alternative would offer protection to both human health and the environment by completely and permanently treating the source area wastes containing concentrations of contaminants in excess of the cleanup criteria, preventing continued offsite migration of the contaminated groundwater plume, and by treating the extracted water. Protection would be achieved at the end of the remediation period for a minimum of one year for the source areas. The time to achieve protection for the groundwater is unknown, if feasible. Heavier, relatively non-biodegradable PAHs would remain in the source areas and soil for a longer period than lighter PAHs and VOCs. However, the immobility of these compounds precludes risk to human health at this site.

10.7.6 Implementability

Implementability includes three subcriteria: technical feasibility, administrative feasibility, and the availability of the required services and materials.

10.7.6.1 Technical Feasibility

Technical feasibility is evaluated on the basis of three parameters: ability to construct the alternative, the reliability of the technologies used, and ease of undertaking additional remedial actions.

- Ability to construct the alternative. All the construction required by this alternative would be basic heavy construction and should not pose any particular problems.

- Reliability of the technology. Capping, barrier wall, and gradient control are frequently used alternatives that have proven effective. Oil/water separation, filtration, and carbon adsorption have frequently been used and have been proven effective in treating water contaminated with organic compounds. In-situ biotreatment enhancement has not been demonstrated for sites containing coal tar waste. However, biotreatment has been demonstrated to remediate coal tar constituents and will be used to accelerate remediation at the site in this alternative.

- Ease of undertaking additional remedial actions. It is not anticipated that any future remedial actions would be necessary. Future demolition of the operations building would not be affected by any of the activities proposed under this alternative. If monitoring indicated that the gradient control system were failing to contain the contaminant plume, implementation of another groundwater remedy or installing additional extraction wells would not be hampered by the existing system.

10.7.6.2 Administrative Feasibility.

Access to private and City of Buffalo property would be necessary to install the monitoring, injection, and extraction wells and necessary plumbing, and to complete the source area excavations.

10.7.6.3 Availability of Services and Materials

The construction services to implement this alternative are easily obtained. Remedial contractors are also available with the experience necessary to implement these remedial actions.

10.7.7 Costs

Tables 10-14 and 10-15 provide summaries of the construction and operation and maintenance costs for Alternative 7. The construction costs, including direct and indirect construction costs, would be approximately $1,196,800 (Table 10-14). Continued monitoring and groundwater extraction, injection, and treatment for 30 years contribute to the O&M costs of $800,000 (Table 10-15). The present worth analysis yields a total of $1,996,800 for this alternative.

Table 10-14. Construction cost estimate - Alternative 7 - Cap source areas/in-situ biotreatment source areas for soil and groundwater/ impermeable barrier, extraction wells with groundwater treatment (1993 $).

Item	Quantity	Units	Unit Cost	Total Cost
FENCING				
Chain Link Fence (8' high)	100	LIN FT	$16.00	$1,600
Gate (34' opening)	1	EA	$1,200.00	$1,200
Sheet Piling	10,000	SQ FT	$15.00	$150,000
SOIL BORING (@12' depth)	12	EA	$1,000.00	$12,000
CAPPING	12,620	SQ YD	$22.00	$278,000
WELL INSTALLATION				
Extraction	10	EA	$5,000.00	$50,000
Air Injection Well	10	EA	$1,500.00	$15,000
SOIL VENTING RECOVERY SYSTEM				
Vent Trench	600	FT	$80.00	$48,000
Carbon		EA	$10,000	$10,000
Blower		EA	$5,000.00	$5,000
Piping	3000	FT	$26.67	$80,000
Installation		LS		$18,000
GROUNDWATER TREATMENT				
Treatment Equipment		LS		$30,000
Piping		LS		$45,000
Electric		LS		$5,000
DECONTAMINATION		LS		$20,000
MOBILIZATION/DEMOBILIZATION				$10,000
	Construction Subtotal:		$778,800	
CONTINGENCIES				
Bid Contingencies				$117,000
Scope Contingencies				$117,000
	Contingencies Subtotal:		$234,000	

Table 10-14. Construction cost estimate - Alternative 7 - Cap source areas/in-site biotreatment source areas for soil and groundwater/impermeable barrier, extraction wells with groundwater treatment (1993 $) (continued).

Item	Quantity	Units	Unit Cost	Total Cost
ALLOWANCES				
Permitting/Legal				$40,000
Engineering				
Design				$80,000
Construction Services				$64,000
	Allowances Subtotal		$184,000	
TOTAL CONSTRUCTION COSTS:	ALTERNATIVE 7			$1,196,800

Table 10-15. O & M costs and present worth estimate - Alternative 7 - Cap source areas/in-situ biotreatment source areas for soil and groundwater/impermeable barrier, extraction wells with groundwater treatment (1993 $).

Item	Quantity	Units	Unit Costs	Total Cost
GROUNDWATER MONITORING				
Sample Collection/Cap Inspection				
Years 1 to 30 (bimonthly)	30/yr	MANDAYS	$600.00	$540,000
Sample Analysis/Report				
First Year (bimonthly)	12/yr	EA	$1,000.00	$12,000
Years 2-5 (quarterly)	8/yr	EA	$1,000.00	$32,000
Years 6-30 (biannually)	4/yr	EA	$1,000.00	$100,000
CAP REPAIR		LS		$15,000
ELECTRICAL POWER (30 HP)	30	YR	$16,000	$480,000
EQUIPMENT REPLACEMENT COSTS (Incl. GAC)				
Year 5	30	LS	$10,000	$300,000
Year 15		LS		$50,000
TOTAL O & M COSTS Present worth annual interest rate @ 5.0%				$800,000
TOTAL CONSTRUCTION COSTS (from Table 10-20)				$1,196,800
TOTAL PRESENT WORTH	ALTERNATIVE 7			$1,996,800

11 COMPARATIVE EVALUATION OF ALTERNATIVES

The purpose of this section is to compare the remedial alternatives on the basis of the evaluation criteria developed and discussed in Chapter 10. These criteria include overall protection of human health and the environment; short-term effectiveness; reduction of toxicity, mobility, or volume; long-term effectiveness and permanence; compliance with ARARs; implementability; and cost. In order to facilitate the comparison of the alternatives, a summary of the detailed evaluation performed in Chapter 10 is provided in Table 11-1.

The no action alternative is not included in the comparisons in the following sections, since it would not meet any of the remedial action objectives. All six of the remaining alternatives would meet the goals and objectives of the remedial action as stated in Chapter 10. A cost sensitivity analysis of the alternatives is included at the end of this chapter.

11.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The excavation/offsite disposal Alternatives 4 and 5 offer the most long-term effectiveness for the source areas and soils, as they are removed and incinerated or landfilled offsite. However, waste material would remain below the water table and buildings for these alternatives. The alternatives incorporating capping (2, 3, 6 and 7) would not immediately remove long-term residual risk; however, they would protect human health and the environment by minimizing the potential for contact (land use restrictions would be required to maintain the caps). Alternatives 7 to 10, incorporating in-situ biotreatment, would accelerate the degradation of contaminants, thus reducing residual risk.

Groundwater monitoring and use restrictions would be incorporated with all alternatives. The alternatives 3, 4, 5, and 7 utilizing extraction wells for gradient control with a vertical barrier for enhanced capture and NAPL control, including those with infiltration reduction by capping, would minimize migration of contaminants from the source area. The remaining alternatives would eventually eliminate residual risk associated with groundwater containing contaminants in excess of cleanup

Table 11-1. Comparative evaluation of remedial action alternatives.

	Alternative						
Criteria	1	2	3	4	5	6	7
Overall protection of human health and the environment.	Not Protective.	Would not permanently eliminate residual risk, but would minimize the potential for contact with SA wastes.	Would not permanently eliminate residual risk, but would minimize the potential for contact with SA wastes and instituting groundwater use restrictions. Would also eventually eliminate residual risk associated with offsite GW containing contaminants in excess of RAOs.	Would permanently eliminate residual risk associated with wastes containing concentrations of contaminants in excess of cleanup levels. Would also eventually eliminate residual risk associated with offsite GW containing contaminants in excess of RAOs.	Would permanently eliminate residual risk associated with SA wastes and soil containing concentrations of contaminants in excess of cleanup levels. Would also eventually eliminate residual risk associated with offsite GW containing contaminants in excess of RAOs.	Would permanently eliminate residual risk associated with SA wastes and soil containing concentrations of contaminants in excess of cleanup levels and would minimize the potential for contact with SA wastes.	Would permanently eliminate residual risk associated with SA wastes and soil containing concentrations of contaminants in excess of cleanup levels and would minimize the potential for contact with SA wastes. Would also eventually eliminate residual risk associated with offsite GW containing contaminants in excess of RAOs.
Short-Term effectiveness: protection during remedial action/ environmental impacts.	Not applicable.	Site access would be limited during the remedial action to protect the public. Fugitive dust and volatile emissions would be monitored and controlled (as necessary) to protect the public and the environment during construction. OSHA regulations would be followed to protect onsite workers.	Site access would be limited during the remedial action to protect the public. Fugitive dust and volatile emissions would be monitored and controlled (as necessary) to protect the public and the environment during construction. OSHA regulations would be followed to protect onsite workers.	Site access would be limited during the remedial action to protect the public. Suitable controls would be used to minimize fugitive dust, volatile emissions, and runoff or infiltration of contaminated water during excavation and materials handling. OSHA regulations would be followed to protect onsite workers.	Site access would be limited during the remedial action to protect the public. Fugitive dust and volatile emissions would be monitored and controlled (as necessary) to protect the public and the environment during construction. OSHA regulations would be followed to protect onsite workers. Releases of volatile organics during landfarming are not anticipated to be significant based on existing data. OSHA regulations would be followed to protect workers.	Site access would be limited during the remedial action to protect the public. Fugitive dust and volatile emissions would be monitored and controlled (as necessary) to protect the public and the environment during construction. OSHA regulations would be followed to protect onsite workers.	Site access would be limited during the remedial action to protect the public. Fugitive dust and volatile emissions would be monitored and controlled (as necessary) to protect the public and the environment during construction. OSHA regulations would be followed to protect onsite workers.
Time until remedial action objectives are achieved.	Remedial action objectives would not be achieved.	Engineering design and construction of the caps, establishing groundwater use restrictions and GW monitoring to verify that the contaminant plume was being contained would require approximately 2 years.	Engineering design and construction of the caps, and establishing GW gradient control, would require approximately 18 months. Time required to reduce contaminant concentration in GW to below RAOs is unknown.	Engineering design, source area excavation and incineration/landfill, and establishing GW gradient control would require approximately 18 months. Time required to reduce contaminant concentrations in groundwater to below RAOs is unknown.	Engineering design, landfarming of soils, and establishing GW gradient control would require approximately 18 months. Time required to reduce contaminant concentration in GW to below RAOs is unknown.	Engineering design, construction of the caps, installation of in-situ biotreatment system (biosparging) would require approximately 18 months. Time required to reduce contaminant concentration in GW to below RAOs is unknown.	Engineering design, construction of the caps,installation of in-situ biotreatment system (biosparging), and establishing GW gradient control would require approximately 2 years. Time required to reduce contaminant concentration in GW to below RAOs is unknown.
Reduction of toxicity, mobility or volume treatment.	No treatment would be implemented.	No treatment would be implemented.	Only GW removed for gradient control would be treated. Treatment would be irreversible, and three wastes would be generated: recovered oil, spent carbon, and used filters. The SA solids would be either thermally treated by incineration to destroy organic contaminants, or sent to the landfill. Treatment residual would be incineration ash or SA solids.	Only GW removed for gradient control would be treated. Treatment would be irreversible, and three wastes would be generated: recovered oil, spent carbon, and used filters. The SA solids would be either thermally treated by incineration to destroy organic contaminants, or sent to the landfill. Treatment residual would be incineration ash or SA solids.	Only GW removed for gradient control would be treated. Treatment would be irreversible, and three wastes would be generated: recovered oil, spent carbon, and used filters.	Organic contaminants in the soil and GW should be reduced below cleanup criteria by in-situ biotreatment.	Only GW removed for gradient control would be treated. Treatment would be irreversible, and three wastes would be generated: recovered oil, spent carbon, and used filters. Organic contaminants in the soil and GW should be reduced below cleanup criteria by in-situ biotreatment.

Table 11-1. Comparative evaluation of remedial action alternatives (continued).

Criteria	Alternative 1	2	3	4	5	6	7
Reduction of toxicity, mobility or volume.	None.	The mobility of the SA contaminants would be indirectly reduced.	The mobility of the SA contaminants would be indirectly reduced. The toxicity and mobility of the contaminants in the GW removed for gradient control would be reduced by treatment.	The toxicity and mobility of the contaminants in the GW removed for gradient control would be reduced by treatment. The toxicity, mobility, and volume of the contaminated SA material would be completely eliminated by thermal destruction or landfill of the organic contaminants.	The toxicity and mobility of the contaminants in the GW removed for gradient control would be reduced by treatment. The toxicity, mobility, and volume of the contaminated soil should be reduced by on-site landfarming.	The mobility of the SA contaminants would be indirectly reduced. The toxicity, mobility, and volume of the contaminated soil and GW should be reduced by in-situ biotreatment.	The mobility of the SA contaminants would be indirectly reduced. The toxicity and mobility of the contaminants in the GW removed for gradient control would be reduced by treatment. The toxicity, mobility, and volume of the contaminated soil and GW should be reduced by in-situ biotreatment.
Amount of contaminants treated or destroyed.	None.	None.	All water removed from the gradient control system would be treated. This is estimated to be 7,200 gallons per day.	All water removed from the gradient control system would be treated. This is estimated to be 7,200 gallons per day. The volume of contaminated SA materials that would be treated is 14,000 cubic yards.	All water removed from the gradient control system would be treated. This is estimated to be 7,200 gallons per day. The volume of contaminated SA materials that would be treated is 14,000 cubic yards.	The volume of contaminated SA materials that would be treated is 75,000 cubic yards, and also GW contained in SA materials.	All water removed from the gradient control system would be treated. This is estimated to be 7,200 gallons per day. The volume of contaminated SA materials that would be treated is 75,000 cubic yards, and also GW contained in SA materials.
Effectiveness magnitude of residual risk.	The risks identified in the baseline risk assess-ment would remain un-changed.	Would reduce risk by minimizing the potential for direct contact with or ingestion of the SA contaminants. GW use restrictions would minimize the risk of potential future offsite use of contaminated groundwater.	Would reduce risk by minimizing the potential for direct contact with or ingestion of the SA contaminants. Residual risk associated with contaminants in offsite GW in excess of RAOs would eventually be eliminated by removal and treatment.	Risk associated with the SA contaminants in excess of cleanup levels would be eliminated by removal of the contaminated media and destruction of the contaminants through incineration. Residual risk associated with contaminants in offsite GW in excess of RAOs would eventually be eliminated by removal and treatment.	Landfarming of SA soil would minimize the risk associated with this medium through biodegradation of the contaminants. Residual risk associated with contaminants in offsite GW in excess of RAOs would eventually be eliminated by removal and treatment.	In-situ biotreatment of SA soil would minimize the risk associated with this medium through biodegradation of the contaminants. Would reduce risk by minimizing the potential for direct contact with or ingestion of the SA contaminants.	In-situ biotreatment of SA soil would minimize the risk associated with this medium through biodegradation of the contaminants. Residual risk associated with contaminants in offsite GW in excess of RAOs would eventually be eliminated by removal and treatment and would reduce risk by minimizing the potential for direct contact with or ingestion of the SA contaminants.
Adequacy and reliability of controls.	Not applicable.	GW monitoring, maintenance of the cap, and enforcement of land and GW use restrictions would be required throughout the life of the alternative to ensure that remediation measures continued to be effective.	GW monitoring, maintenance of the cap and gradient control/ water treatment system, and enforcement of land and GW use restrictions would be required throughout the life of the alternative to ensure that remediation measures continued to be effective.	GW monitoring and maintenance of the gradient control/water treatment system would be required for the life of the alternative to ensure that remediation measures continued to be effective.	GW monitoring and maintenance of the gradient control/water treatment system would be required for the life of the alternative to ensure that remediation measures continued to be effective. Monitoring of the landfarm would be required to ensure that contaminants were being effectively treated during operation of the facility.	GW monitoring, and maintenance of the cap, air injection wells, and the bioventing system would be required for the life of the alternative to ensure that remediation measures continued to be effective. Subsurface soil sampling would also be required periodically to evaluate the effectiveness of in-situ biotreatment.	GW monitoring, maintenance of the cap, extraction and air injection wells, the bioventing, and the water treatment system would be required for the life of the alternative to ensure that remediation measures continued to be effective. Subsurface soil sampling would also be required periodically to evaluate the effectiveness of in-situ biotreatment.

Table 11-1. Comparative evaluation of remedial action alternatives (continued).

Criteria	Alternative 1	2	3	4	5	6	7
Permanence of remedy.	Not applicable.	Routine replacement and repair of materials and equipment would be required during the life of this alternative. Future remedial action might ultimately be required during the life of this alternative. future remedial action might ultimately be required, since contaminants in the SA would not be permanently removed and destroyed under this alternative, and contaminant migration in the GW would be monitored rather than controlled.	Routine replacement and repair of materials and equipment would be required during the life of this alternative. Future remedial action might ultimately be required, since contaminants in the SA would not be permanently removed and destroyed under this alternative.	Routine repair and replacement of wells, pumps, and treatment equipment would be required during the life of the alternative. No future remedial action should be required.	Routine repair and replacement of wells, pumps, and treatment equipment would be required during the life of the alternative. No future remedial action should be required.	Routine repair and replacement of wells, pumps, and treatment equipment would be required during the life of the alternative. No future remedial action should be required.	Routine repair and replacement of wells, pumps, and treatment equipment would be required during the life of the alternative. No future remedial action should be required.
Compliance with ARARs.	Groundwater containing contaminants in concentrations in excess of MCLs would remain beyond the site boundary.	Groundwater containing contaminants in concentrations in excess of RAOs would remain. Would comply with all other ARARs, with the exception of requirements regarding application for remediation of the GW.	Would comply with all ARARs. Alternate concentration limits would be set based on the best available technology applied to removal of the contaminated groundwater.	Would comply with all ARARs. Alternate concentration limits would be set based on the best available technology applied to removal of the contaminated groundwater.	Would comply with all ARARs. Alternate concentration limits would be set based on the best available technology applied to removal of the contaminated groundwater.	Would comply with all ARARs. Alternate concentration limits would be set based on the best available technology applied to removal of the contaminated groundwater.	Would comply with all ARARs. Alternate concentration limits would be set based on the best available technology applied to removal of the contaminated groundwater.
Implementability, technical feasibility.	Not applicable.	Construction activities would be routine. All proposed technologies have been proven effective. Would not restrict future remedial actions.	Construction activities would be routine. All proposed technologies have been proven effective. Would not restrict future remedial actions.	Construction activities would be routine. All proposed technologies have been proven effective. Would not restrict future remedial actions.	Construction activities would be routine. With the exception of landfarming, all proposed technologies have been proven effective. Landfarming would have to be demonstrated on site soils. Would not restrict future remedial actions.	Construction activities would be routine. With the exception of in-situ biotreatment, all proposed technologies have been proven effective. In-situ biotreatment would have to be demonstrated under site conditions. Would not restrict future remedial actions.	Construction activities would be routine. With the exception of in-situ biotreatment, all proposed technologies have been proven effective. In-situ biotreatment would have to be demonstrated under site conditions. Would not restrict future remedial actions.
Administrative feasibility.	Not applicable.	Access to City and private property would be required. Land and GW use restrictions might be difficult to implement.	Access to City and private property would be required. Land and GW use restrictions might be difficult to implement.	Access to City and private property would be required. Land and GW use restrictions might be difficult to implement.	Access to City and private property might be required.	Access to City and private property might be required.	Access to City and private property might be required.
Availability of services and materials.	Not applicable.	Readily available. OSHA health and safety trained workers would be required.	Readily available. OSHA health and safety trained workers would be required.	Readily available. OSHA health and safety trained workers would be required.	Readily available. OSHA health and safety trained workers would be required.	Readily available. OSHA health and safety trained workers would be required.	Readily available. OSHA health and safety trained workers would be required.

Table 11-1. Comparative evaluation of remedial action alternatives (continued).

	Alternative						
Criteria	1	2	3	4	5	6	7
Estimated Costs (1993 $) Construction Costs	$0	$504,240	$1,162,800	$5,378,300	$1,867,800	$733,800	$1,196,800
Present Worth of Operation and Maintenance Costs		$226,400	$586,700	$572,500	$615,285	$586,700	$800,000
Total Present Worth Cost (5%, 30 Years)	$0	$730,640	$1,749,500	$5,950,800	$2,483,085	$1,320,500	$1,996,800

Notes:

SA = Source Areas
GW = Groundwater

Alternative 1. No action.
Alternative 2. Capping of source areas and soil.
Alternative 3. Capping of source areas and soil/install impermeable barrier,extraction wells with groundwater treatment system.
Alternative 4. Excavation of source areas and soil disposal offsite (landfill or incineration)/install impermeable barrier, extraction wells with groundwater treatment system.
Alternative 5. Landfarm source areas and soil/install impermeable barrier, extraction wells with groundwater treatment system.
Alternative 6. Capping of source areas and install in-situ biotreatment source areas for soil and groundwater.
Alternative 7. Capping of source areas, in-situ biotreatment source areas for soil and groundwater/install impermeable barrier, extraction wells with groundwater treatment system.

levels through enhanced or natural bioremediation. Contaminant migration is limited by subsurface geology and the Scajaquada Creek. Even with active extraction and treatment for groundwater and NAPL, remediation will require a lengthy time span.

11.2 SHORT-TERM EFFECTIVENESS

Normal construction hazards would be associated with the implementation of all six alternatives. All six alternatives would use refencing and temporary barriers to prevent unauthorized access and would implement emission control measures, as necessary, to prevent releases during construction/excavation activities. Alternatives 4 and 5 would also require runon and runoff controls to prevent releases due to surface water runoff or infiltration during excavation and materials handling. Initial releases of volatile organics during landfarming of soil under Alternative 5 are not anticipated to be significant, based on existing data, but would be controlled in compliance with applicable air quality regulations. All work under all the alternatives would be conducted in conformance with OSHA regulations to protect onsite workers.

Alternatives 2, 3, 6, and 7 would require two months to complete construction of the cap, while Alternative 4 would take four to six months to complete construction and/or removal and offsite transport of the source area materials and soil. Landfarming of the soil under Alternative 5 would be completed in a minimum of 12 to 16 months. Under Alternatives 2, and 6, which rely on natural mechanisms to contain the groundwater plume, RAOs would be met once groundwater use restrictions were implemented and monitoring confirmed that the contaminant plume was being contained and degraded. Alternatives 3 through 5, and 7, which use gradient control to contain the plume, would require 18 months of groundwater monitoring to confirm that the capture zones of the extraction wells had reached their maximum extent and that the contaminant plume was not migrating and being remediated. The time required to reduce contaminant concentrations in groundwater to below RAOs under these alternatives is unknown.

11.3 REDUCTION OF TOXICITY, MOBILITY OR VOLUME

Alternatives 4, and 5, which would involve removal of the source area materials and soil, would result in complete removal of the organic contaminants and would permanently reduce the toxicity, volume, and mobility of these media containing concentrations of contaminants above the cleanup levels. Under Alternative 5, the toxicity, mobility, and volume of contaminated soil would be reduced by landfarming. The groundwater treatment system would also be used in Alternatives 3 through 4,5, and 7 to reduce the mobility and toxicity of contaminants in the groundwater extracted for gradient control. The volume of contaminated water would, in all cases, be reduced by treatment. In-situ biotreatment under Alternatives 6 and 7 would also enhance the reduction of the toxicity, mobility, and volume of the contaminated groundwater. The gradient control measures under Alternatives 3 through 5, and 7 would reduce the mobility of the contaminants by controlling the direction of the groundwater flow. Wastes generated by the treatment processes would include recovered oil, spent carbon, filters from the water treatment system, and ash from incineration. Alternatives 2 and 6, with surface capping and no gradient control, would reduce the contaminant mobility by limiting infiltration through contaminated soil.

11.4 LONG-TERM EFFECTIVENESS AND PERMANENCE

All six **active** alternatives would remediate the site **and reduce residual risks to some degree**. All alternatives also would minimize the potential for contact with the source area contaminants by removing these areas or covering them with caps. Alternative 4 would permanently remove the organic contaminants in the excavated source areas by incineration. Landfarming of the contaminated soil under Alternative 5 should reduce organic contaminant concentrations below cleanup levels. Under most alternatives, groundwater use restrictions would minimize the risk associated with potential future use of the groundwater as a drinking water source. Residual risk associated with contaminants in offsite groundwater in excess of ACLs would eventually be eliminated by removal and treatment under Alternatives 3, 4, 5, and 7.

Alternatives 3 and 7 would require the most long-term control measures, including groundwater monitoring, maintenance of the caps and gradient control/water treatment system, and enforcement of land and groundwater use restrictions. These activities would be required throughout the life of the alternatives to ensure that remediation measures continued to be effective. Long-term groundwater monitoring would be required under all alternatives. Alternatives 3, 4, 5, and 7 would also require maintenance of the gradient control/water treatment system. Alternatives 6 and 7 would require maintenance of the in-situ biotreatment system. Monitoring of the landfarm during operation of the facility would be required under Alternative 5.

Future remedial action might be required under Alternative 2, under which, the source area materials would be contained rather than permanently removed and treated. In addition, under Alternative 6, the contaminant migration in the groundwater would be monitored, rather than controlled. Future conditions might require additional remedial actions to be taken to address the source area materials and groundwater in these cases.

11.5 COMPLIANCE WITH ARARs

With the exception of Alternative 2, all the alternatives would actively reduce contaminant concentrations in the offsite groundwater below RAOs. The six alternatives would comply with all other state and federal ARARs. Requirements regarding application of HALs and NRLs to remediation of the groundwater would be considered remediation goals.

11.6 IMPLEMENTABILITY

All the alternatives would be labor intensive, but construction activities would be routine. The necessary equipment, materials, workers, and specialists required to implement all the alternatives are readily available. With the exception of Alternatives 5 through 7, all the alternatives involve technologies that have been fully demonstrated and proven effective for the site media and contaminants. Alternatives 6 and 7 include in-situ biotreatment enhancement, which has not been demonstrated for sites containing coal tar wastes. Alternative 5 includes landfarming of soils. Although this technology has been demonstrated in full-scale applications on PAH-contaminated soil, the presence of DNAPL, or significant concentrations of four- and five-ring PAHs, might reduce the effectiveness of biodegradation processes. Therefore, both in-situ biotreatment and landfarming would require laboratory and field studies to demonstrate their effectiveness under site conditions.

Administratively, all the alternatives would be implementable. All six alternatives might require access to City and private property. Land use and groundwater use restrictions would be required for all alternatives. All the alternatives would require coordination with a variety of federal, state, and local authorities, including USEPA, NYSDEC, and the City of Buffalo. All six alternatives would be compatible with future remedial action at the site.

11.7 COSTS

The present worth costs range from a low of $730,640 for Alternative 2, to a high of $5,960,800 for Alternative 4. These present-worth costs were based on a 30-year service period and an annual discount rate of five percent. A cost sensitivity analysis based on varying discount rates and remedial activities is provided in Section 11.8.

11.8 COST SENSITIVITY ANALYSIS

The cost estimates prepared for each remedial action alternative involve approximations, assumptions, estimations, interpretations, and engineering judgment. In most cases, one or two key variables have a significant impact on the total present worth of an alternative. The purpose of a sensitivity analysis is to evaluate the impact of these key parameters on the total present worth by varying them, while holding all other factors constant. The cost of incinerating the source areas/soil at an offsite RCRA hazardous waste incinerator was also evaluated for comparison with the offsite fuels blending Alternative (4). The following paragraphs discuss the results of the sensitivity analysis for each of the remedial action alternatives. Since no costs are associated with the no-action alternative, the cost sensitivity analysis is not applicable to this alternative.

This sensitivity analysis included an evaluation of the impact of the volume of groundwater to be pumped and treated. These changes had no effect on Alternatives 2 and 6, which include no groundwater treatment. Alternatives 3 through 5, and 7, however, were not significantly affected by varying the volume of groundwater to be treated. These little changes were primarily due to the O&M costs for only low volumes of groundwater to be treated. Reducing and increasing the amount of groundwater to be removed and treated did not alter the relative ranking of the alternatives.

Alternatives which included long-term O&M costs associated with treatment of soil were most affected by the changes. The original cost estimates were based on the assumption that 14,000 cubic yards of contaminated source area material and soil debris would be excavated. The cost sensitivity analysis evaluated the impact of the volume of excavated material on the total present worth of the alternatives. For the alternatives involving landfarming of soil and source area (Alternative 5), the volumes of source area material and soil were both the same, so the proportion of soil to source area materials remained constant. Only the costs of Alternative 4 were affected by varying the source area/soil volumes. Increasing or decreasing the source area/soil volume caused large changes in the present worth of this alternative. This can be attributed to the relatively high cost for excavation and offsite incineration/landfarming of the material. Altering the volume of source area material and soil to be excavated and treated did not affect the relative ranking of the alternative with respect to cost.

Also considered in this cost analysis was the cost of offsite incineration of contaminated source area materials at a RCRA facility, instead of in a coal-fired utility boiler. This option affected Alternative 4. The impact of this option increases the present worth cost of alternative 4 by almost 4 1/2 times. This would not alter the relative cost ranking of the alternatives, Alternative 4 is still the most expensive.