FORMER RAECO PRODUCTS SITE (#828107) CITY OF ROCHESTER, MONROE COUNTY

FEASIBILITY STUDY REPORT

PREPARED FOR: NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION 625 BROADWAY ALBANY, NEW YORK 12233



PREPARED BY:





March 2010

FORMER RAECO PRODUCTS SITE (#828107) CITY OF ROCHESTER, MONROE COUNTY

FEASIBILITY STUDY REPORT

PREPARED FOR: NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION 625 BROADWAY ALBANY, NEW YORK 12233

PREPARED BY:

HDR

One Blue Hill Plaza Pearl River, NY 10965

March 2010



Table of Contents

1.0	PUR	POSE	1-1
2.0	SITI	E DESCRIPTION AND HISTORY	2-1
2.1	Sit	e Description	2-1
2.2	Sit	e Topography	2-1
2.3	Ge	eology	2-4
2.4	Ну	drogeology	2-4
2.5	Sit	e History	2-5
2.6	Re	gulatory History	2-7
3.0		IMARY OF REMEDIAL INVESTIGATIONS AND EXPOSURE/RISK ESSMENT	3-1
3.1		ture and Extent of Soil Contamination	
3	3.1.1	AOC 1 Southern Portion of Site	3-1
3	3.1.2	AOC 2 Building B	3-9
3	3.1.3	AOC 3 Central Area of Site	3-10
3.1.4 AOC 4 Former TCE Tank Area		AOC 4 Former TCE Tank Area	3-10
3.1.5 AOC 5 Former Building C and Vicinity.		AOC 5 Former Building C and Vicinity	3-11
3	3.1.6	AOC 6 Building D	3-11
3	3.1.7	AOC 7 West of Building D	3-12
3	3.1.8	AOC 8 Northern Portion of Site	3-13
3	3.1.9	AOC 9 Building E	3-14
3.2	Na	ture and Extent of Groundwater Contamination	3-14
3.3	Na	ture and Extent of Surface Water Contamination	3-15
3.4		ture and Extent of Indoor Air Contamination	
4.0		IEDIAL GOALS AND REMEDIAL ACTION OBJECTIVES	
4.1	Re	medial Action Objectives	
2	4.1.1	Soil Remedial Action Objectives	
4	4.1.2	Groundwater Remedial Action Objectives	
5.0		HERAL RESPONSE ACTIONS	
5.1		il General Response Actions	
5.2		oundwater General Response Actions	
6.0	IDE	NTIFICATION AND SCREENING OF TECHNOLOGIES	6-1

6.2.6.	6 Capping 6-18
6.2.6.	7 Cap Enhancements 6-19
6.2.7	Other Treatment 6-19
6.2.7.	1 Excavation 6-19
6.2.7.2	2 Off-Site Disposal6-20
6.2.7	3 Adsorption / Vapor-Phase VOC Control6-20
6.3 Idea	ntification and Screening of Technology for Groundwater6-21
6.3.1	In Situ Biological Treatment6-21
6.3.1.	Enhanced Bioremediation6-21
6.3.1.2	2 Monitored Natural Attenuation6-22
6.3.1.3	Phytoremediation6-22
6.3.2	In Situ Physical/Chemical Treatment
6.3.2.1	Air Sparging6-23
6.3.2.2	2 Bioslurping 6-23
6.3.2.3	Chemical Oxidation6-23
6.3.2.4	Directional Wells6-24
6.3.2.5	Dual Phase Extraction6-24
6.3.2.6	Thermal Treatment6-25
6.3.2.7	Hydrofracturing Enhancements
6.3.2.8	In-Well Air Stripping6-26
6.3.2.9	Passive/Reactive Treatment Walls6-26
6.3.3	Ex Situ Biological Treatment6-27
6.3.3.1	Bioreactors6-27
6.3.3.2	Constructed Wetlands6-27
6.3.4	Ex Situ Physical/Chemical Treatment
6.3.4.1	Adsorption6-28
6.3.4.2	Vinyl Chloride Control6-28
6.3.4.3	Advanced Oxidation Processes
6.3.4.4	Air Stripping6-29
6.3.4.5	Groundwater Pumping/Pump & Treat6-29
6.3.5	Containment6-30
6.3.5.1	Physical Barriers6-30
6352	Deep Well Injection 6 20

6.4	4 Eva	aluation of Technologies and Selection of Representative Technologies	6-31
	6.4.1	Retained Soil Technologies	6-31
	6.4.2	Retained Groundwater Technologies	6-31
7.0	DEV	ELOPMENT AND SCREENING OF ALTERNATIVES	7-1
7. 1	l Alt	ernative Screening and Development	7-1
	7.1.1	Soil Alternative Development	7-1
	7.1.1.	1 Alternative 1 – No Action	7-2
	7.1.1.	2 Alternative 2 – Capping	7-2
	7.1.1.	3 Alternative 3 – Cap and SVE	7-4
	7.1.1.	4 Alternative 4 – Cap and Chemical Oxidation	7-5
	7.1.1	5 Alternative 5 – Cap, SVE and Product Collection	7-5
	7.1.1.	6 Alternative 6 – Cap, SVE and Product Excavation	7-6
	7.1.1.	7 Alternative 7 – Cap and Product and VOC Soil Excavation	<i>7-7</i>
	7.1.1.	8 Alternative 8 – Unrestricted Site Use / Pre-Disposal Conditions	7-8
-	7.1.2	Groundwater Alternative Development	7-8
	7.1.2.	l Alternative 1 – No Action	7-9
	7.1.2.2	2 Alternative 2 – Long Term Monitoring	7-9
	7.1.2.	3 Alternative 3 – Cap and Long Term Monitoring	7-10
	7.1.2.4	Alternative 4 – Cap, Dual Phase Extraction, and LTM	7-10
	7.1.2.5	5 Alternative 5 – Cap, Chemical Oxidation, and LTM	7-11
7	7.1.3	Alternative Screening Process	7-12
	7.1.3.	Criteria for Alternative Screening	7-12
	7.1.3.2	Soil Alternative Screening	7-12
	7.1.3.3	Groundwater Alternative Screening	7-15
7.2	Eva	luation of Alternatives	7-18
7	7.2.1	Introduction	7-18
7	7.2.2	Soil Alternative Evaluation	
	7.2.2.1	•	
	7.2.2.2	1	
	7.2.2.3	33	
	7.2.2.4	•	
	7.2.2.5	Short Term Effectiveness	7-25
	7226	6 Implementability	7-25

8 N	REFERE	ENCES	Q_1
	7.2.3.8	Community Acceptance	7-31
	7.2.3.7	Cost	7-31
	7.2.3.6	Implementability	7-31
	7.2.3.5	Short Term Effectiveness	7-30
	7.2.3.4	Reduction of Toxicity, Mobility or Volume with Treatment	7-30
	7.2.3.3	Long Term Effectiveness and Permanence	7-30
	7.2.3.2	Compliance with Standards, Criteria, and Guidance	7-30
	7.2.3.1	Protection of Human Health and the Environment	7-26
	7.2.3 Gr	roundwater Alternative Evaluation	7-26
	7.2.2.8	Community Acceptance	7-26
	7.2.2.7	Cost	7-26

Table of Contents (continued)

List of Figures

-	Figure 2-1	Site Location Map	2-2
	Figure 2-2	Site Plan	2-3
-	Figure 2-3	Groundwater Flow	2-6
	Figure 2-4	Former Investigation Sample Locations	2-16
•	Figure 3-1	AOC Map	3-3
	Figure 3-2	AOC Map with Free Product and Elevated VOC Areas	3-4
-		List of Tables	
	Table 2-1	Summary of Previous Investigations – Groundwater	2-8
	Table 2-2	Preliminary Remedial Action Plan – Data Summary Tables	2-9
	Table 3-1	AOC Summary and Estimated Quantity of Contaminated Media	3-5
	Table 6-1	Summary of Remedial Technology Screening –Soil	6-3
•	Table 6-2	Summary of Remedial Technology Screening – Groundwater	6-4
	Table 7-1	Relative Comparison for Screening of Soil Alternatives	7-13
	Table 7-2	Relative Comparison for Screening of Groundwater Alternatives	7-16
	Table 7-3	Evaluation of Soil Alternatives	7-21
	Table 7-4	Evaluation of Groundwater Alternatives	7-27
		Appendices	
••••	Annondiy A	Sita Photographa	
_	• •	A – Site Photographs	
		S-City of Rochester Zoning Information	
_	**	S-Site Sewer Details	
	Appendix D	– Conceptual Feasibility Study Cost Analysis	

List of Acronyms

AST Aboveground Storage Tank
BGS Below Ground Surface

CSCO Commercial Use Soil Cleanup Objectives
EPA U.S. Environmental Protection Agency
ERM Environmental Resources Management

FS Feasibility Study

FT Feet

HDR Henningson, Durham, and Richardson Architecture and Engineering P.C.

LTM Long Term Monitoring

MCHD Monroe County Health Department

NCP National Oil and Hazardous Substances Pollution Contingency Plan

NYSDEC New York State Department of Environmental Conservation

NYSDOH New York State Department of Health POTW Publicly-owned Treatment Works

ROD Record of Decision

SARA Superfund Amendments and Reauthorization Act

SCO Soil Cleanup Objective

TCE Trichloroethene

TCLP Toxicity characteristic leaching procedure
TSDF Treatment, storage and disposal facility
USCO Unrestricted Use Soil Cleanup Objectives

UST Underground Storage Tank

This page intentionally left blank.

1.0 PURPOSE

1.1 Introduction

Henningson, Durham, and Richardson Architecture and Engineering P.C. (HDR) was retained by the New York State Department of Environmental Conservation (NYSDEC) to conduct a Feasibility Study (FS) of the Former Raeco Products Site (NYSDEC Site #828107), located in the City of Rochester, Monroe County, New York.

HDR has prepared a Feasibility Study in general conformance with Section 4 of the *Draft Technical Guidance for Site Investigation and Remediation (DER-10)* (NYSDEC Division of Environmental Remediation, December 2002). The primary objective of the FS is to ensure that appropriate remedial alternatives are identified and evaluated such that relevant information concerning potential remedial actions at the site can be presented and an appropriate remedy selected.

YU & Associates, Inc. of Elmwood Park, New Jersey, a subconsultant to HDR, assisted with the development of this FS, including the preparation of conceptual cost analysis for remedial alternatives.

For the development of this FS, the following assumptions were made:

- Vapor intrusion is not assessed directly in this FS, as it is assumed that NYSDOH / NYSDEC are coordinating site monitoring and mitigation activities with the property owner. However, the FS notes possible interactions that could exist between contemplated remedial alternatives and vapor intrusion work at the Site;
- It is assumed that a statement of future site use / activities is being solicited from the current property owner by NYSDEC, for purposes of evaluating institutional controls (i.e., deed restriction) that may be placed on the property as part of the selected remedy.
- It is assumed that no potable, process, or other domestic / commercial use wells exist at the Site (with the exception of the on-site monitoring wells), and that groundwater is not utilized by the site occupant for any reason;

- It is assumed that no active sources of contamination exist at the Site in the forms of USTs, ASTs, or other storage containers (i.e., it is assumed that on-site chemical containers were removed as part of previous site enforcement actions);
- It is assumed that the sewer main that traverses part of the site is not leaking water (or contaminated water) onto the Site. It is possible that historic sewer main installation techniques involving the removal of rock and soils may have affected groundwater flow patterns at the site;
- It is assumed that on-site soils and groundwater evaluated in this FS are not being impacted from off-site areas; and
- It is assumed that surficial petroleum spills that were noted at the April 2009 site reconnaissance are being addressed by NYSDEC Region 8 Spills. As such, the FS does not directly address the stained soil conditions observed during the site reconnaissance;

The following qualifications pertaining to this FS should be noted:

- No additional environmental sampling, pilot testing, or data/risk analysis was conducted as part of this FS. Existing data from NYSDEC (1999-2000) and ERM (2006) investigations were reviewed to develop AOCs and remedial approaches; and
- No off-site analysis was conduced to determine "background" levels of inorganics (and other parameters) that exist in shallow / surface soils in Site area.

1.2 Objectives of the Feasibility Study

The FS process (1) identifies remedial action objectives, (2) identifies potential treatment and containment technologies that will satisfy these objectives, (3) screens the technologies based on their effectiveness, implementability, and relative cost, and (4) develops potential remedial alternatives technologies and their associated costs to address the contaminated media at the site.

Remedial alternatives are developed and evaluated with eight criteria specified by the draft DER-10 technical guidance. The evaluation criteria include:

- (1) Protection of human health and the environment
- (2) Compliance with standards, criteria and guidance (SCGs)
- (3) Long-term effectiveness and permanence

- (4) Reduction of toxicity, mobility, or volume of contamination through treatment
- (5) Short-term impacts and effectiveness
- (6) Implementability
- (7) Cost effectiveness, including capital costs; operation, maintenance and monitoring (OM&M) costs; and site management costs, and
- (8) Community acceptance.

The process of alternative development, screening and evaluation is done in context with remedial action objectives developed for the Site and the quantities of contaminated materials present. Community acceptance cannot be assessed until public comments have been received on the FS report and the Proposed Remedial Action Plan (PRAP). The Record of Decision (ROD) for the Site will be developed following the finalization of the FS Report and Remedy Selection and will address community comments on the proposed remedial plan.

This page intentionally left blank.

2.0 SITE DESCRIPTION AND HISTORY

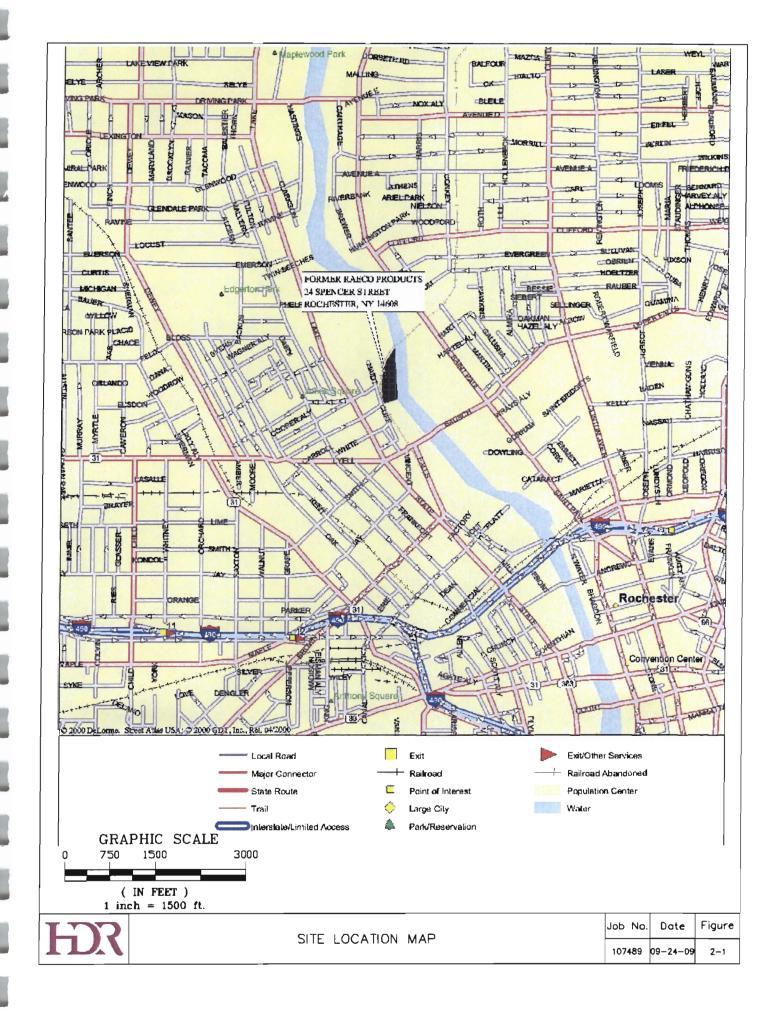
2.1 Site Description

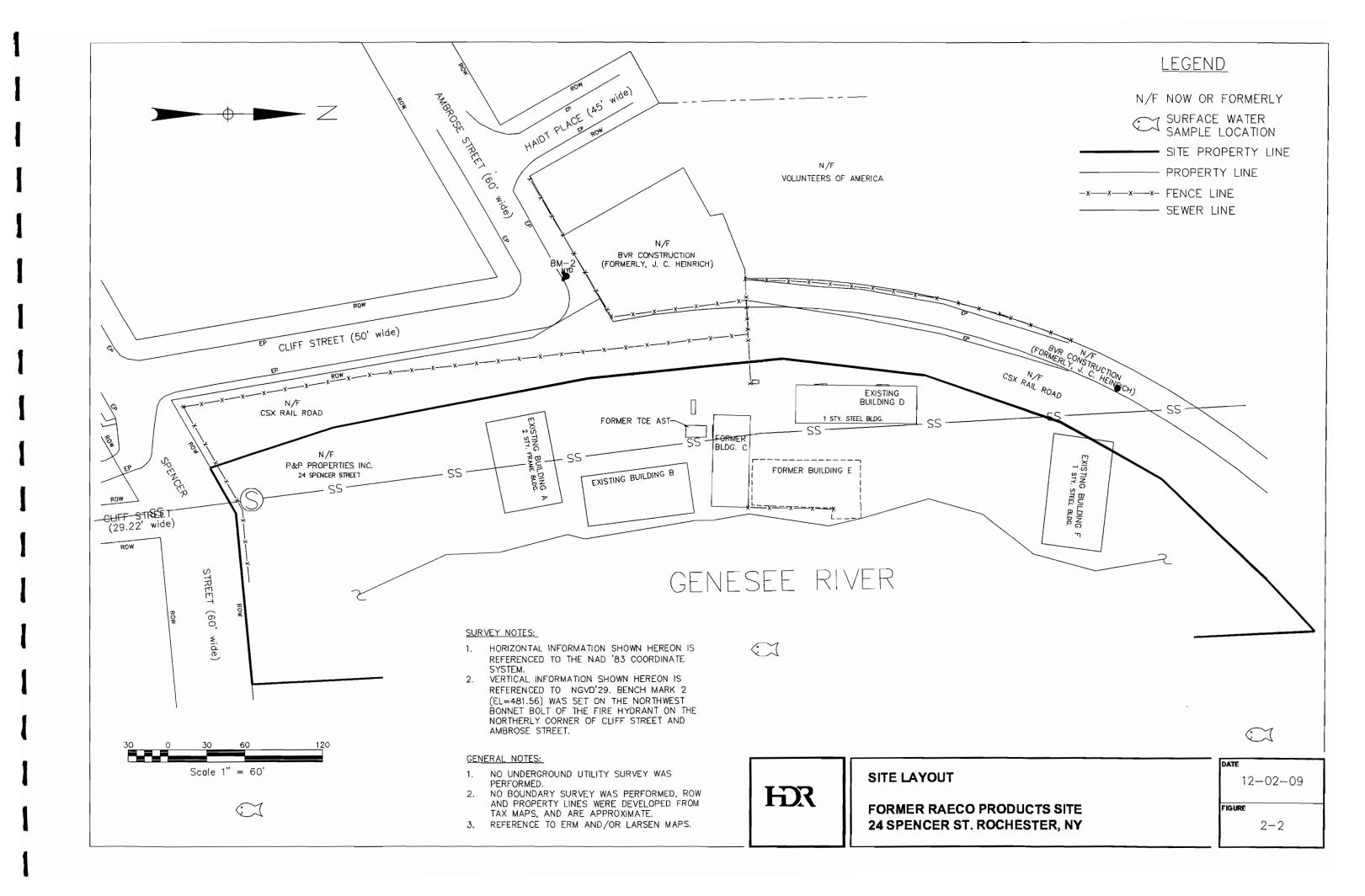
The site is located at 24 Spencer Street, City of Rochester, New York. The property is identified as Parcel ID 105.52-1-13 by the City of Rochester. The Site location is shown on Figure 2-1. The Site is located within a heavily developed light industrial and commercial area northwest of downtown Rochester. The 3.4 acres property is bordered by an abandoned railroad right of way to the north; Spencer Street to the south; the Genesee River to the east; and, Cliff Street to the west. The property is zoned as C-2, "community center district", or as a commercial area. The below site description is based on analyses conducted by NYSDEC (*Preliminary Site Investigation Report*) and ERM (*Remedial Investigation Report*, 13 February 2007, prepared for NYSDEC), and on a site reconnaissance conducted by HDR in April 2009.

There are six existing building foundations / structures located on the property. Two former buildings, identified as Buildings C and E, are no longer present. Asphalt paved/stone parking and equipment staging areas constitute the majority of the existing ground surface at the site. The asphalt paving is discontinuous and in poor condition in some areas. Stone (gravel) or bare soil exists where asphalt is not present. A vegetated area is located along the Genesee River Gorge, including areas east of Buildings / Foundations A, B, C, E, and F. A six (6) foot diameter sanitary sewer extends across the site in a north/south direction (generally parallel to Cliff Street). The sewer line was installed in the 1890s and is reportedly located approximately 35 feet below the ground surface (bgs). A layout of the Site is included in Figure 2-2. Photographs from the April 2009 site reconnaissance are included in Appendix A.

2.2 Site Topography

The Site is relatively flat with an elevation of approximately 460 ft above mean sea level (amsl). The terrain dips slightly to the east/northeast across the site. The eastern edge of the site slopes to a cliff face that forms the Genesee River gorge. The surface water of the Genesee River is approximately 70 feet below the ground surface at the site (Remedial Investigation Report).





2.3 Geology

The site consists of a few feet to over 40 feet of overburden on top of bedrock, according to the NYSDEC and ERM investigations. ERM identified bedrock from a few feet bgs at the eastern side of the site to depths exceeding 49 feet at the west/southwest portion of the Site (possibly associated with historic sewer line installation and associated rock removal that may have occurred). The overburden is comprised primarily of fill material including silty sand and gravel with some miscellaneous construction and demolition debris (brick, concrete, wood, and ash fragments were noted during previous subsurface investigations). Deeper overburden consists primarily of silty clays and silty fine sands. Gravelly sands and clays were also noted at some areas of the Site. A clay layer of varying thickness exists just above the bedrock surface. The bedrock at the Site is classified as dolomite and is comprised of frequent fractures (Preliminary Site Investigation Report, DEC, Remedial Investigation Report, ERM).

2.4 Hydrogeology

Groundwater was typically not observed in the overburden during previous site investigations, with some exceptions including gravelly intervals (where depth to bedrock exceeded 20 feet bgs) and at the non-confining clay layer situated immediately above the bedrock (Preliminary Site Investigation Report, Remedial Investigation Report). The depth to groundwater in three bedrock monitoring wells ranged from approximately 20 to 42 feet bgs. ERM reported the first significant water producing fractures were encountered at approximately 40 to 50 feet bgs (Remedial Investigation Report, ERM).

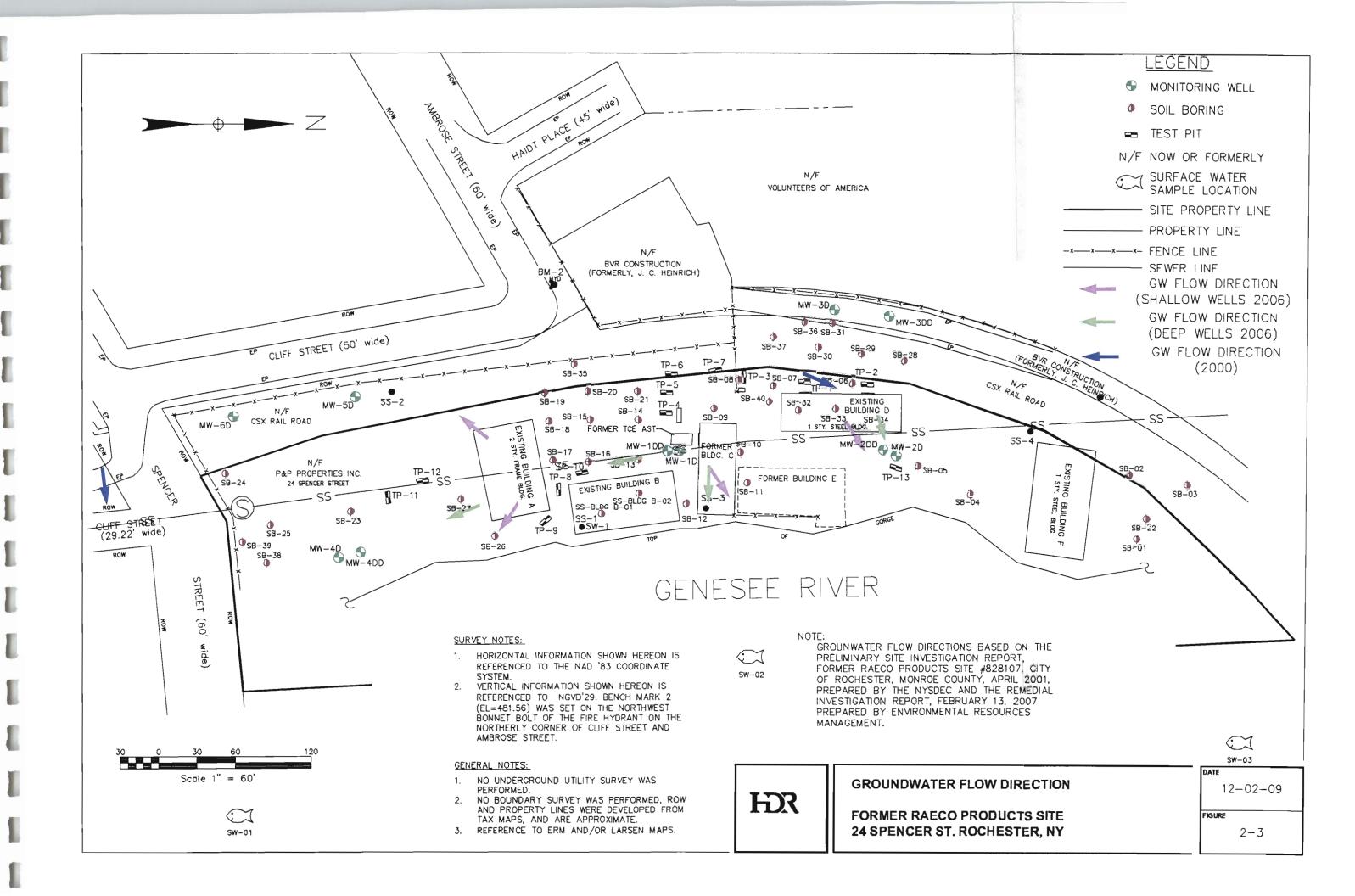
According to the NYSDEC's PSI report (2001), the groundwater flow direction identified was to the northeast, toward the Genesee River gorge. This assessment was based on groundwater elevation measurements collected from three on-site monitoring wells and from off-site wells from a nearby site. It was reported that groundwater flow in the general area of the site may range from southeast to northeast. Groundwater at the site has a strong vertically downward gradient toward the adjacent Genesee River, which is situated approximately 70 feet below the ground surface of the site (Remedial Investigation Report, NYSDEC).

According to ERM's RI report (2007), the evaluation of groundwater flow at the Site was based on two rounds of groundwater level elevations collected in March of 2006 and August / September 2006. Shallow site groundwater (assumed for this report to include groundwater present in the overburden material and clay layer above bedrock, typically encountered at depths of approximately 20 to 35 ft bgs) appears to have a source of recharge centrally located at the Site, which appears to flow radially to the Genesee River and surrounding area. This trend is also apparent in deeper, bedrock groundwater (existing at depths of 40 ft bgs or greater); however, the deeper groundwater regime appears to have a steeper gradient of flow toward the Genesee River to the east, and another strong component of flow to the south/southeast (Remedial Investigation Report, ERM).

The local source of recharge may be due to the large diameter sanitary sewer (approximately 6-feet diameter) which runs south to north beneath the entire length of the Site. Historical drawings indicate that the sewer was present as early as 1911 and was installed by tunneling horizontally into bedrock from several vertical access shafts from depths of approximately 35 to 45 feet bgs. The sewer is reported to be only partially lined with brick and concrete in some areas beneath the Site. It is possible that a significant amount of bedrock radially surrounding the shaft was removed during shaft construction. The historic removal of bedrock and backfill in these areas might be responsible for the lower groundwater elevations observed at the south end of the site, resulting in the component of flow to the south (Remedial Investigation Report). Groundwater flow information is included on Figure 2-3. Additional detail into the Site's hydrogeology can be obtained in NYSDEC's 2001 Preliminary Site Investigation Report and ERM's 2007 Remedial Investigation Report (prepared on behalf of the NYSDEC).

2.5 Site History

A 1911 Sanborn Map identifies Building D as a wholesale paint warehouse owned by F.B. Rae Company. A 1950 Sanborn Map identifies Building A as part of a separate parcel, owned by a seed company identified as L.P. Gunson & Co. Buildings B through F and several ASTs were owned by J.H. Rae Oil Co.



From the 1930s through 1987, the Site was reportedly owned and operated by J.H. Rae, Inc. (Raeco) as a bulk storage, blending, packaging and distribution facility for chemicals and petroleum products.

In 1995, the Raeco property was purchased by P&P Properties, Inc (P&P). The property was reportedly leased by IntraState Contracting (through the Spring 2009). The current owner purchased the property in approximately April 2009 and utilizes the site for equipment and vehicle storage.

2.6 Regulatory History

The site has been the subject of several regulatory investigations and inspections. Below is a brief summary of the regulatory activities at the site:

- Dye testing was conducted by Monroe County Health Department (MCHD) in 1970 to investigate three (3) pipe outlets that discharged into the gorge.
- The Rochester Police Department observed waste chemicals at the property in June 1994.
- NYSDEC, the Monroe County Health Department (MCHD), the USEPA, and the City of Rochester completed follow-up inspections of the Site in 1994, 1995, and 1996.
- USEPA removed 553 containers (drums and 5-gallon pails) from the Site in 1997.
- NYSDEC conducted a subsurface investigation of the Site in 1999 and 2000. Results
 of the investigation are presented in the April 2001 <u>Preliminary Site Investigation</u>
 <u>Report.</u>
- A Phase I and Phase II Remedial Investigation of the Site was completed by ERM on behalf of the NYSDEC in 2005 and 2006, respectively. The results were documented in the February 2007 Remedial Investigation Report.

Table 2-1 summarizes groundwater investigations and monitoring wells installed at the Site. Table 2-2 provides a summary of all environmental data collected at the site (Draft PRAP table) along with a comparison to applicable SCGs (e.g., soil cleanup objectives [SCOs]). The PSI and RI investigation sample locations are depicted on Figure 2-4 of this FS report.

A summary of the previous remedial investigation work, including a discussion of the nature and extent of the on-site contamination, is provided in the following section.

Table 2-1 Summary of Previous Investigations – Groundwater

Location	Well ID	<u>Installation</u> <u>Lead</u>
Former TCE Tank Location	MW-1D	DEC
	MW-1DD	ERM
North Portion of Site	MW-2D	DEC
	MW-2DD	ERM
West of Building D	MW-3D	DEC
	MW-3DD	ERM
Southern Portion of Site	MW-4D	ERM
	MW-4DD	ERM
	MW-5D	ERM
	MW-6D	ERM

Table 2-2 Preliminary Remedial Action Plan – Data Summary Tables

		Surface Soi	l		
Detected Constituents	Concentration Range Detected (ppm) ^a	Unrestricted SCG ^b (ppm)	Frequency Exceeding Unrestricted SCG	Commercial SCG ^b (ppm)	Frequency Exceeding Commercial SCG
VOCs					-
2-Butanone	1.9	0.12 (500)	1/4	500	0/4
4-Methyl-2-Pentanone	0.016	N/A	~-	N/A	
SVOCs					
Benzo(a)anthracene	15	1	1/4	5.6	1/4
Benzo(a)pyrene	0.490 J - 5.4 J	1	1/4	1	1/4
Benzo(b)fluoranthene	1.0 J8.2 J	1	2/4	5.6	1/4
Chrysene	$0.610 \mathrm{J} - 27$	1	1/4	56	0/4
Dibenzofuran	2.3 J	N/A		N/A	
2,4-Dichlorophenol	13 J	N/A		N/A	
Bis(2-					
ethylhexyl)phthalate	1.7 J – 7.8 J	N/A		N/A	
2-Methylnaphthalene	0.810 J - 2.4 J	N/A		N/A	
N-					
Nitrosodiphenylamine	4.4 J	N/A		N/A	
Pentachlorophenol	11 J	0.8	1/4	6.7	1/4
Metals			-		
Aluminum	3400-7060	N/A		N/A	
Antimony	1.7 BN – 6.5 BN	N/A		N/A	
Barium	80.1 – 976	350	1 / 4	400	1/4
	23,100 -		_		
Calcium	112,000	N/A		N/A	~-
Cobalt	3.2 B – 6.2 B	N/A		N/A	
Copper	24.7 – 92.4	50	1 / 4	270	0/4
Iron	10,600 – 15,400	N/A		N/A	
Lead	77.9 – 2340	63	4/4	1,000	1/4
Magnesium	4750 – 37,200	N/A		N/A	
Mercury	0.031 - 1.2	0.18	1/4	2.8	0/4
Potassium	674 – 1630	N/A		N/A	
Silver	3.5	2	1/4	1,500	0/4
Sodium	380 B - 1300	N/A		N/A	
Vanadium	7.1 B – 16.1	N/A		N/A	
Zinc	153 – 1630	109	4/4	10,000	0/4
Pesticides/PCBs					
4,4-DDD	0.16 JP	0.0033	1/4	92	0/4
4,4-DDT	0.14 JP	0.0033	1/4	47	0/4
Dieldrin	0.99 P	0.005	1/4	1.4	0/4
Endrin	0.12 BJ – 0.380 BJP	0.014	3/4	89	0/4
Endrin Aldehyde	0.064 BP	N/A		N/A	

Table 2-2 (continued)
Preliminary Remedial Action Plan – Data Summary Tables

		Subsurface S	oil		· _
Detected Constituents	Concentration Range Detected (ppm) ^a	Unrestricted SCG ^b (ppm)	Frequency Exceeding Unrestricted SCG	Commercial SCG ^b (ppm)	Frequency Exceeding Commercial SCG
VOCs					
Vinyl Chloride	0.002 - 4.4	0.02	6 / 105	13	0 / 105
Chloroethane	0.009 J	N/A		N/A	
Methylene Chloride	0.012B - 1.5 J	0.05	5 / 105	500	0 / 105
Acetone	0.007 – 44	0.05	24 / 105	500	0 / 105
Carbon disulfide	0.005 J - 0.18	N/A		N/A	
1,1-Dichloroethane	0.002 J - 4.5 J	0.27	3 / 105	240	0 / 105
1,2-Dichloroethene					-
(total)	0.0005 J - 400	N/A		N/A	
2-Butanone	0.004 J - 5.2	1.2	18 / 105	500	0 / 105
1,1,1-Trichloroethane	0.002 J - 7.6	0.68	5 / 105	500	0 / 105
Trichloroethene	0.001 J - 71	0.47	10 / 105	200	0 / 105
Benzene	0.0003 J – 1.4	0.06	7 / 105	44	0 / 105
Tetrachloroethene	0.0003 J – 18	1.3	4 / 105	150	0 / 105
	0.0005 J - 1,000			500	2 / 105
Toluene	D	0.7	13 / 105		
Ethylbenzene	0.0003 J – 130 D	11	10 / 105	390	0 / 105
Styrene	0.002 J	N/A		N/A	
Xylene (total)	0.0004 J – 650 D	0.26	27 / 105	500	1 / 105
cis-1,2-Dichloroethene	0.00055 – 47	0.25	6/91	500	0/91
Trans-1,2-			1	500	0/91
Dichloroethene	0.002 J - 0.54	0.19	1/91	_	
Trichlorofluoromethane	0.001 J	N/A		N/A	
Trichlorotrifluoroethane	0.0005 J – 0.002 J	N/A		N/A	
Cyclohexane	0.008 J - 9.7	N/A		N/A	
Methylcyclohexane	0.0009 J – 58 J	N/A		N/A	
Isopropylbenzene	0.0004 J – 5.5 J	N/A		N/A	
1,4-Dichlorobenzene	0.001 J – 4.1	1.8	1 / 105	130	0 / 105
1,2-Dichlorobenzene	0.0004 J - 95 D	1.1	4 / 105	500	0 / 105
1,2,4-Trichlorobenzene	0.002 J - 0.790 J	N/A		N/A	
SVOCs					
4-Methylphenol	0.080 - 0.55	N/A		N/A	
Naphthalene	0.041 J – 13	12	1 / 105	500	0 / 105
2-Methylnaphthalene	0.041 J – 41 E	N/A		N/A	
Dibenzofuran	0.043 J – 4.4	N/A		N/A	
N-		2 2			
Nitrosodiphenylamine	0.12 J – 2.1 J	N/A		N/A	
Carbazole	0.05 J - 2.4 J	N/A		N/A	
Butyl benzyl phthalate	0.110 J	N/A		N/A	
Benzo(a)anthracene	0.043 J – 28	1	29 / 105	5.6	5 / 105
Chrysene	0.041 J – 36	1	31 / 105	56	0 / 105

Table 2-2 (continued)
Preliminary Remedial Action Plan – Data Summary Tables

		Subsurface S	oil		
Detected Constituents	Concentration Range Detected (ppm) ^a	Unrestricted SCG ^b (ppm)	Frequency Exceeding Unrestricted SCG	Commercial SCG ^b (ppm)	Frequency Exceeding Commercial SCG
Bis(2-					
ethylhexyl)phthalate	0.098 J – 2.3	N/A		N/A	
Di-n-Octyl-Phthalate	2.2 J	N/A		N/A	
Benzo(b)fluoranthene	0.21 J – 20	1	31 / 105	5.6	6 / 105
Benzo(k)fluoranthene	0.04 J – 30	0.8	24 / 105	56	0 / 105
Benzo(a)pyrene	0.045 J – 29	11	26 / 105	1	26 / 105
Indeno(1,2,3-cd)pyrene	0.042 J – 15 J	0.5	29 / 105	5.6	4 / 105
Dibenzo(a,h)anthracene	0.044J - 4.7 J	0.33	15 / 105	0.56	9 / 105
Benzaldehyde	0.170 J	N/A	-	N/A	
Acetophenone	0.071 J	N/A		N/A	
Caprolactam	0.043 J	N/A		N/A	
1,1-Biphenyl	0.98 J	N/A		N/A	
Metals					
Aluminum	1570 – 48100	N/A		N/A	
Antimony	ND – 41.5 J	N/A		N/A	
Arsenic	ND - 88.4	13	7 / 105	16	3 / 105
Barium	10.5 J - 2530	350	6 / 105	400	5 / 105
Beryllium	ND - 19.7	7.2	2 / 105	590	0 / 105
Cadmium	ND - 3.6	2.5	1 / 105	9.3	0 / 105
Calcium	5040 - 183000 J	N/A		N/A	
Chromium	4.2 – 40.8	30	3/105	1,500	0 / 105
Cobalt	0.79 B – 17.1 J	N/A		N/A	
Copper	4.7 J – 824	50	28 / 105	270	4 / 105
Iron	2520 - 31300 J	N/A		N/A	
Lead	3.6 – 3990	63	54 / 105	1,000	4 / 105
Magnesium	2520 - 71500	N/A		N/A	
Manganese	99.5 - 2080	1600	3 / 105	10,000	0 / 105
Mercury	ND - 5.8	0.18	50 / 105	2.8	3 / 105
Nickel	1.8 B – 150	30	2 / 105	310	0 / 105
Potassium	288 J – 4120	N/A		N/A	
Selenium	ND - 5.4	3.9	2 / 105	1,500	0 / 105
Silver	ND - 2.2	2	1 / 105	1,500	0 / 105
Sodium	68.1 J - 4990 J	N/A		N/A	
Thallium	ND - 7.3 J	N/A		N/A	
Vanadium	$\frac{14D - 7.33}{2.3 \text{ B} - 32.5}$	N/A		N/A	
Zinc	5.1 - 806	109	38 / 105	10,000	0 / 105
Pesticides/PCBs	3.1 - 600	109	507105	10,000	07103
	ND 0.0055	0.0022	2 / 14	92	0 / 14
4,4'-DDD	ND - 0.0055	0.0033			
4,4'-DDT	ND - 0.064	0.0033	3 / 14	47	0 / 14
Dieldrin	ND - 0.019	0.005	6 / 14	1.4	0 / 14
Endrin	ND - 0.560 B	0.014	11 / 14	89	0 / 14
Endrin Aldehyde	ND - 0.066 BP	N/A		N/A	
Endrin Ketone	ND – 0.026 B	N/A		N/A	

Table 2-2 (continued)
Preliminary Remedial Action Plan – Data Summary Tables

Groundwater					
Detected Constituents	Concentration Range Detected (ppb) ^a	SCG ^b (ppb)	Frequency Exceeding SCG		
VOCs					
Vinyl chloride	ND – 22000 J	2	10 / 24		
Chloroethane	ND – 320	5	6 / 24		
1,1-Dichloroethene	ND – 150 J	5	3 / 24		
Acetone	ND – 1500 J	50	3 / 24		
trans-1,2-dichloroethene	ND – 130 J	5	2/18		
1,1-Dichloroethane	ND – 24000 J	5	13 / 24		
cis-1,2-dichloroethene	ND - 840000	5	8 / 18		
2-Butanone	ND - 480	50	2 / 24		
1,1,1-Trichloroethane	ND – 850 J	5	3 / 24		
Benzene	ND – 69 J	1	8 / 24		
1,2-Dichloroethane	ND - 2	0.6	1 / 24		
Trichloroethene	ND – 17000 J	5	5 / 24		
4-Methyl-2-Pentanone	ND - 360	N/A			
Toluene	ND - 710000	5	8 / 24		
Tetrachloroethene	ND - 14000	5	1 / 24		
Ethylbenzene	ND - 1100000	5	9 / 24		
Xylene	ND - 2400000	5	10 / 24		
1,2-Dichlorobenzene	ND - 6	3	1 / 24		
Cyclohexane	ND - 25	N/A			
Methyl Cyclohexane	ND – 44 J	N/A			
Isopropylbenzene	ND - 31000 J	5	3/24		
1,2-Dichloroethene (total)	ND - 110000	5	4/6		
Methylene Chloride	ND – 23 J	5	1 / 24		
SVOCs					
Phenol	ND – 1400 J	1	1/23		
2-Methylphenol	ND - 9	1	3 / 23		
4-Methylphenol	ND - 39	1	3 / 23		
2,4-Dimethylphenol	ND – 3 J	1	2/23		
Naphthalene	ND – 72000 J	10	4 / 23		
2-Methylnaphthalene	ND – 88000 J	N/A			
Acenaphthene	ND – 86000 J	20	2/ 23		
Dibenzofuran	ND – 26000 J	N/A			
Fluorene	ND – 83000 J	50	2/23		
Phenanthrene	ND - 180000	50	2/23		
Anthracene	ND – 20000 J	50	1 / 23		
Fluoranthene	ND – 92000 J	50	2 / 23		
Pyrene	ND - 95000	50	2 / 23		
Benzo(a)anthracene	ND - 41000	0.002	4/23		
Chrysene	ND - 51000 J	0.002	4 / 23		
Bis(2-ethylhexyl)phthalate	ND - 2200000	5	4 / 23		
Benzo(b)fluoranthene	ND – 3 J	0.002	3 / 23		
Benzo(k)fluoranthene	ND – 2 J	0.002	1/23		
Benzo(a)pyrene	ND – 2 J	0.002	2/23		

Table 2-2 (continued)
Preliminary Remedial Action Plan – Data Summary Tables

Groundwater					
Detected Constituents	Concentration Range Detected (ppb) ^a	SCG ^b (ppb)	Frequency Exceeding SCG		
Indeno(1,2,3-cd)pyrene	ND – 31000 J	0.002	2/23		
Benzo(g,h,i)perylene	ND – 30000 J	N/A			
1,2-Dichlorobenzene	ND – 19000 BJ	3	3/6		
Butylbenzylphthalate	ND - 74	50	1/6		
N-Nitrosodiphenylamine	ND – 5 J	N/A			
Metals					
Aluminum	ND - 10900	N/A			
Antimony	ND – 6.0 UN	3	1 / 22		
Arsenic	ND – 97.2 N	25	1 / 22		
Cadmium	ND – 6.9	5	1 / 22		
Calcium	67000 - 606000	N/A			
Chromium	ND – 204 J	50	1 / 22		
Cobalt	ND – 12.8 J	N/A			
Copper	ND – 605 J	200	1 / 22		
Iron	ND - 64000	300	18 / 22		
Lead	ND - 550	25	4 / 22		
Magnesium	40600 - 335000	35000	21 / 22		
Manganese	17.8 – 1320	300	6 / 22		
Mercury	ND – 0.78	0.7	1 / 22		
Potassium	7650 - 113000 J	N/A			
Silver	ND – 67.8 J	50	1 / 22		
Sodium	42500 - 225000	20000	21 / 22		
Thallium	ND – 10.0 U	0.5	1 / 22		
Vanadium	ND – 17.2 J	N/A			
Zinc	ND - 4030	2000	2 / 22		
Pesticides/PCBs					
4,4'-DDD	ND – 6.1	0.3	1/6		
4,4'-DDE	ND – 2.5 J	0.2	1/6		
alpha-BHC	ND – 0.65 JP	0.2	1/6		
Dieldrin	ND – 0.54 JP	0.004	1/6		
Endosulfan II (Beta)	ND – 3.4 JP	N/A			
Endosulfan Sulfate	ND – 3.5 JP	N/A			
Endrin	ND - 0.49 JP	ND			
Methoxychlor	ND – 46 P	35	1/6		
PCB-1254	ND – 74 P	0.09	1/6		

Table 2-2 (continued) Preliminary Remedial Action Plan – Data Summary Tables

Soil Vapor/Sub-Slab Vapor/Air						
Detected Constituents Soil Vapor	Concentration Range Detected (mcg/m³) ^a	NYSDOH Air Guideline Value ^b (mcg/m³)	Frequency Exceeding SCG			
Son vapor						
Sub-Slab Vapor		1471				
1,1,1-Trichloroethane	11 J – 4100	N/A				
1,1-Dichloroethane	650	N/A				
Benzene	5J	N/A				
Cis-1,2-Dichloroethene	36000	N/A				
Ethanol	3000					
m+ p Xylene	7.6 J	N/A				
n-Heptane	45 J	N/A				
Styrene	1800 J - 2100					
Tetrachloroethene	530	100	1/2			
Toluene	10 J	N/A				
Trichloroethene	34 J - 76000	5	2/2			
Indoor Air						
1,1,1-Trichloroethane	ND - 5.6	N/A				
1,1-Dichloroethane	ND - 0.99	N/A				
Acetone	4.7 – 20 J	N/A				
Benzene	1 – 1.4 J	N/A				
Chloromethane	0.98 – 1.2 J	N/A				
Cis-1,2-Dichloroethene	3.4 – 22	N/A				
Dichlorodifluoromethane	4.2 – 12	N/A				
Ethanol	3.7 – 17 J	N/A				
m + p Xylene	0.92 – 2 J	N/A				
o-Xylene	ND – 0.8 J	N/A				
Toluene	2.2 – 9.2 J	N/A				
Trichloroethene	6.6 - 50	5	3/3			
Trichlorofluoromethane	2.6 – 8.6	N/A				

Notes for Table 2-2:

Surface Soil

- a ppm: parts per million, which is equivalent to milligrams per kilogram, mg/kg, in soil.
- b SCG: Standards, criteria, and guidance values; State of New York (6 NYCRR) Part 375-6 Soil Cleanup Objective.
- B- Analyte is found in the associated method blank.
- J The result is less than the sample quantitation limit and is an estimated value.
- P Greater than 25% difference for detected concentrations between the two GC columns; the lower value is reported.
- SB site background
- N/A- not applicable

Surface soil samples were collected by the NYSDEC. Data reported on this table is based on the NYSDEC's Preliminary Site Investigation Report, April, 2001, Tables 3A, 3B, 3C and 3D for samples SS-1, SS-2, SS-3, and SS-4.

For the above data, some "ND" concentrations were noted to exceed SCGs. All "ND" concentrations were treated as such in the above summary.

Notes for Table 2-2 (continued):

Subsurface Soil

- a ppm: parts per million, which is equivalent to milligrams per kilogram, mg/kg; ppb: parts per billion, which is equivalent to micrograms per kilogram, ug/kg.
- b SCG: Standards, criteria, and guidance values; State of New York (6 NYCRR) Part 375-6 Soil Cleanup Objective.
- B analyte is found in the associated method blank.
- E The result exceeds the instrument calibration range and is an estimated value.
- J The result is less than the sample quantitation limit and is an estimated value.
- P- Greater than 25% difference for detected concentrations between the two GC columns; the lower value is reported.

N/A- not applicable

ND- not detected

Based on NYSDEC's Preliminary Site Investigation Report, April, 2001, Tables 3A, 3B, 3C and 3D for samples TP-1, TP-2, TP-3, TP-4, TP-5A, TP-5B, TP-7A, TP-7B, TP-8, TP-10, TP-12, MW-1D, MW-2D, MW-3D.

Based on ERM's Remedial Investigation Report, February 13, 2007, Tables 2-4, 2-5 and 2-6.

Groundwater

- a ppb: parts per billion, which is equivalent to micrograms per liter, ug/L, in water.
- b- SCG: standards, criteria, and guidance values; 6 NYCRR Part 703 (Class GA ambient groundwater standards)
- B- This flag is used when the analyte is found in the associated blank as well as in the sample.
- J- Indicates an estimated value.
- N- Indicates spike sample recovery is not with the control limits.
- P- Greater than 25% difference for detected concentrations between the two GC columns; the lower value is reported.
- U- Indicates compound was analyzed for but not detected. Report with the detection limit value.

N/A- not applicable

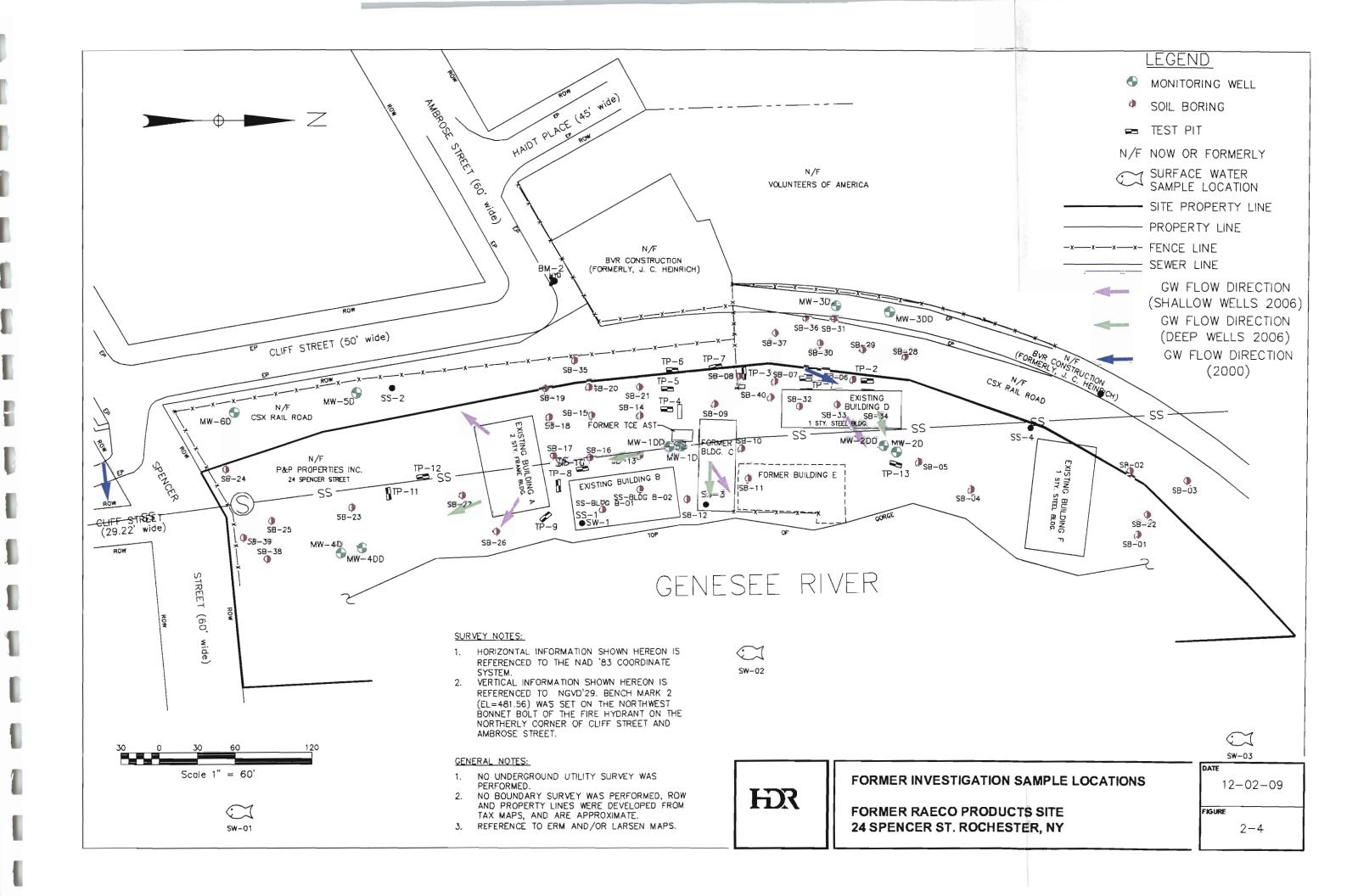
ND- not detected

Soil vapor

- a mcg/m3: microgram per cubic meter
- b SCG: Standards, criteria, and guidance values; New York Department of Health "Guidance for Evaluating Soil Vapor Intrusion in the State of New York, October 2006".
- J the value was designated as estimated as a result of the data validation criteria. Also used to indicate tentatively identified compounds (TICS) or when an organic compound is present, but the concentration is less than the Contract Required Quantitation Limit (CRQL). The value is usable as an estimated result. = Estimated value; results may be biased.

N/A - not applicable

Based on ERM's Remedial Investigation Report, February 13, 2007, Table 2-2 Summary of Air Sampling Analytical Results.



3.0 SUMMARY OF REMEDIAL INVESTIGATIONS AND EXPOSURE/RISK ASSESSMENT

3.1 Nature and Extent of Soil Contamination

In the Preliminary Site Investigation, the NYSDEC concluded that elevated levels of contaminants were located in subsurface soils in the vicinity of Buildings A, B, C and D and in surface soils at the southwest corner of the property. Two pesticide compounds were detected at concentrations above "Division of Environmental Remediation Technical and Administrative Guidance Memorandum (TAGM) 4046 Soil Cleanup Objectives" in surface soil and subsurface soil samples collected by the NYSDEC. Specific sources of contamination at the Site were not identified during the PSI (Preliminary Site Investigation Report, NYSDEC)

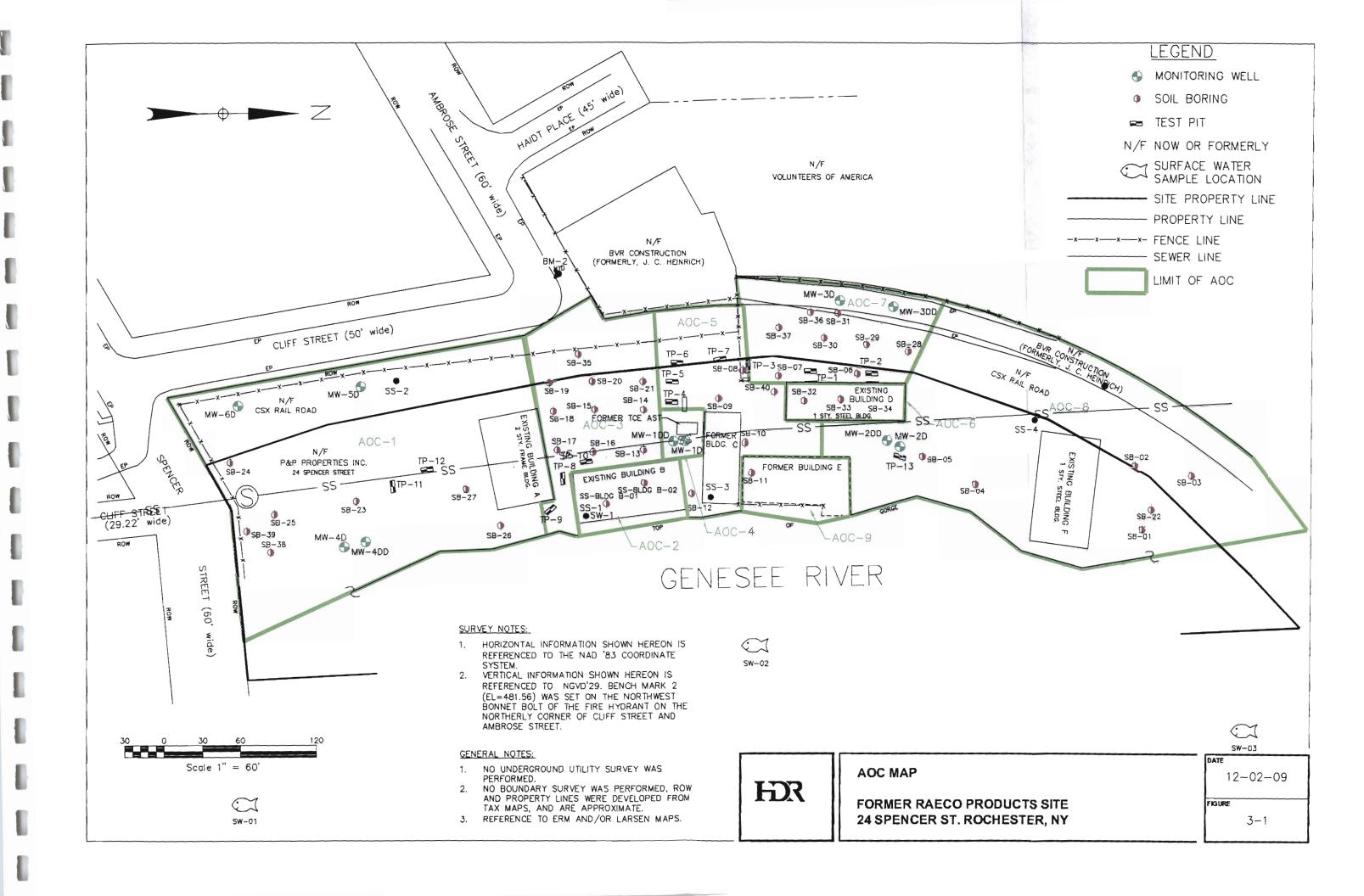
Existing data reported in NYSDEC's PSI Report (data collected 1999-2000) and ERM's RI Report (2006) were reviewed and compared by HDR to the SCOs for Unrestricted Use from 6 NYCRR Subpart 375-6. The data reported by ERM demonstrated that soil samples contain VOCs and SVOCs at concentrations that exceed the Unrestricted Use SCOs. The NYSDEC data revealed that metals were widespread and frequently exceeded the SCOS for Unrestricted Use.

Soil contamination, in exceedence of both unrestricted and commercial SCOs, has been identified throughout a widespread area of the Site. For the purposes of this FS, the property has been divided into nine (9) Areas of Concern (AOCs) in order to facilitating development and evaluation of remedial alternatives. The nine AOCs are shown on Figure 3-1 and discussed in the following sections. Table 3-1 provides a further breakdown of the AOCs and the corresponding dimensions (based on conservative assumptions made for areal limits and depths of contamination).

3.1.1 AOC 1 Southern Portion of Site

AOC 1 consists of Building A and the area south of Building A, and is bounded by the property line to the south and west, and the gorge to the east. An UST was reported to be located between Building A and the gorge. The size, type and material stored in this tank are unknown. A reported 300-400 square foot area of oil-soaked soil located due south of Building A was observed in 1987.

This page intentionally left blank.



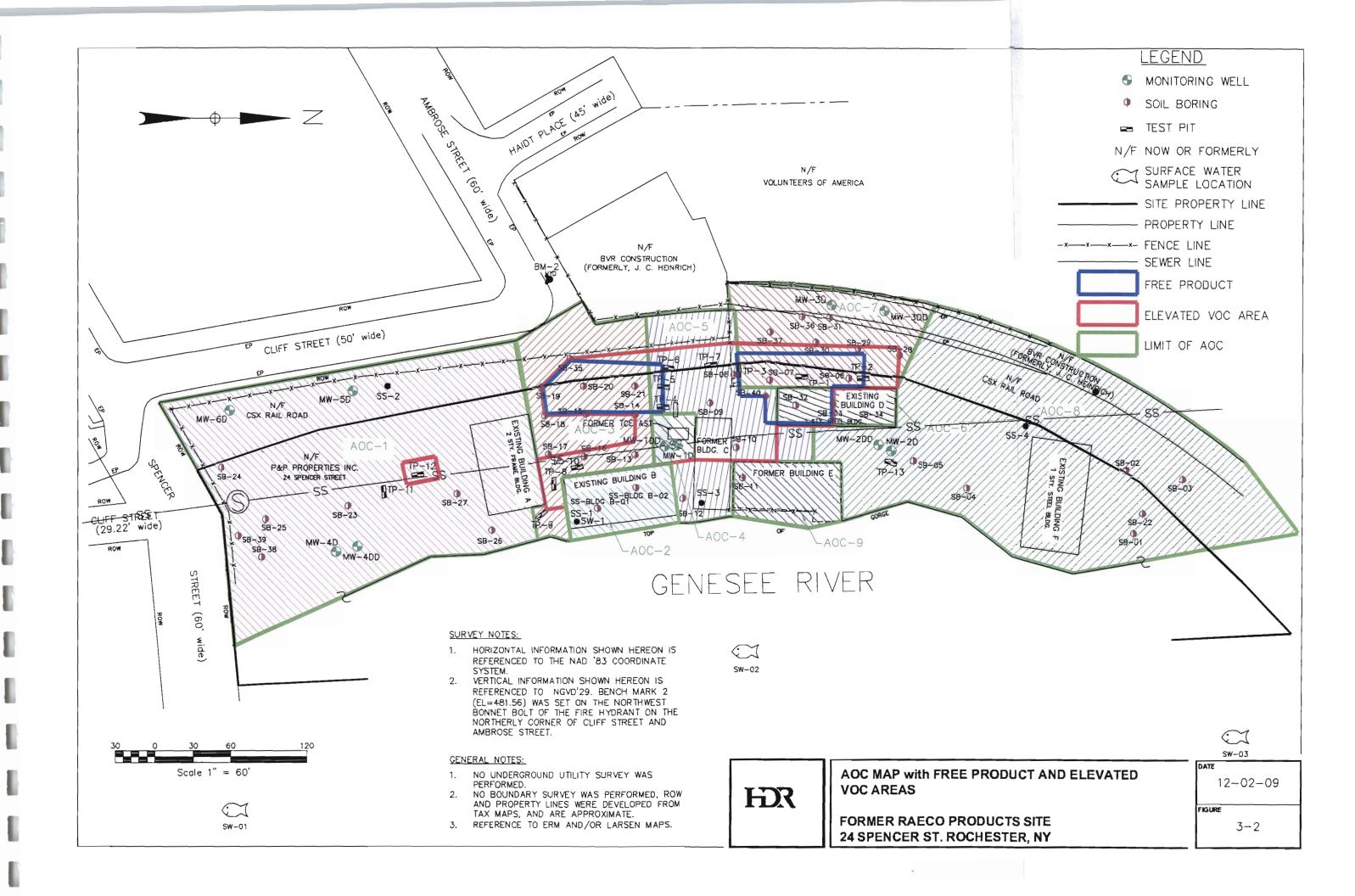


Table 3-1
AOC Summary and Estimated Quantity of Contaminated Media

AOC-1	Location	Commercial Use Cleanup Objectives (CSCO)				Unrestricted Use Cleanup Objectives (USCO)				
		VOCs	SVOCs	Metals	Free Product	VOCs	SVOCs	Metals		
	Southern Portion of Site	VOCs, SVOCs, and metals detected in area; Contaminants not delineated horizontally or vertically; SVOCS and metals were detected over a wide area and depth range; SVOCs and metals are likely associated with the historic fill material; Historic fill was detected at all locations - Fill appears to be present over entire area, therefore, assume SVOCs and metals are present over the entire area; VOCs detected in TP-12; Concrete pad encountered in TP-12 at 3 feet - assume VOCs to depth of 3 feet; Concrete dimensions are unknown - assume 20 by 20 foot for commercial and 40 by 40 foot for unrestricted.								
	Areal Limits	20 by 20 feet	150 by 200 feet	150 by 200 feet	ND	40 by 40 feet	150 by 200 feet	150 by 200 feet		
	Depth Range (bgs)	3 feet	10 to 22 feet	10 to 32 feet	ND	3 feet	10 to 32 feet	10 to 32 feet		
	Average Depth (bgs)	3 feet	20 feet	20 feet	ND	3 feet	20 feet	20 feet		
	Estimated Quantity	50 cu yd	22,000 cu yd	22,000 cu yd		180 cu yd	22000 cu yd	22,000 cu yd		
	Groundwater* (VOCs, Metals)									
AOC-2	Building B	Two surface soil samples taken beneath slab; Not delineated horizontally or vertically - assume entire footprint of building and 2 foot depth.								
	Areal Limits	NE	NE	40 by 85 feet	ND	NE	NE	40 by 85 feet		
	Depth Range (bgs)	NE	NE	2 feet	ND	NE	NE	2 feet		
	Average Depth (bgs)	NE	NE	2 feet	ND	NE	NE	2 feet		
	Estimated Quantity			250 cu yd				250 cu yd		
AOC-3	Central Area (between A, B,C)	SVOCs detected in area greater than the CSCO; Odors and PID noted in every boring. Contaminants are not delineated horizontally or vertically - therefore, assume entire area is greater than SCOs; Assume CSCO areal extent defined by SB-16, SB-17, OU-4, Building B and Building A. Assume the depth is 10 feet bgs. Product was observed in SB-20 (5-10 ft bgs) and SB-21 (12 ft bgs). Assume areal extent is bounded SB-14, SB-15, SB-18, SB-19, SB-35, TP-4, TP-5 and TP-6. Assume depth is 12 feet bgs.								

Former Raeco Products Site (#828107)

Table 3-1 (continued) AOC Summary and Estimated Quantity of Contaminated Media

AOC	Location	Commercial Use Cleanup Objectives				Unrestricted Use Cleanup Objectives			
		VOCs	SVOCs	Metals	Free Product	VOCs	SVOCs	Metals	
	Areal Limits	40 by 85 feet	40 by 85 feet	40 by 85 feet	35 by 80 feet	100 by 120 feet	100 by 120 feet	100 by 120 feet	
	Depth Range (bgs)	10 feet	10 feet	10 feet	5 to 12 feet	12 to 24 feet	12 to 24 feet	12 to 24 feet	
	Average Depth (bgs)	10 feet	10 feet	10 feet	12 feet	18 feet	18 feet	18 feet	
	Estimated Quantity	1260 cu yd	1260 cu yd	1260 cu yd	1250 cu yd	8000 cu yd	8000 cu yd	8000 cu yd	
AOC-4	Former TCE Tank Location	Extensive historical contamination at depth and AST presence. Contaminants are not delineated horizontally or vertically - therefore, assume entire area is greater than SCOs; NAPL has been observed in MW-1D, assume free product is in soil although not noted in boring log. Assume CSCO areal extent bounded by TP-4, AOC-3, Building B and former Building C. Bedrock is at 10 ft bgs - Assume the CSCO depth is 10 feet bgs.							
	Areal Limits	30 by 30 feet	30 by 30 feet	NE	30 by 30 feet	30 by 30 feet	30 by 30 feet	NE	
	Depth Range (bgs)	10 feet	10 feet	NE	10 feet	10 feet	10 feet	NE	
	Average Depth (bgs)	10 feet	10 feet	NE	10 feet	10 feet	10 feet	NE	
	Estimated Quantity	350 cu yd	350 cu yd		350 cu yd	350 cu yd	350 cu yd		
	Groundwater* (VOCs, SVOCs, Metals)								
AOC-5	Former Building C Vicinity	VOCs, SVOCs, and metals detected in area greater than the SCOs; contaminants are not delineated horizontally or vertically . PID, odors, and staining noted in boring logs. Historic presence of tanks and chemical processing in and near Building C. VOCs and SVOCs were detected greater than CSCO in SB-9(4 and 8 ft bgs), SB-10(4 ft bgs), – Conservatively assume VOC CSCO areal extent defined by OU-3, OU-4, former Building E, Building D, OU-7, and the fence line, Assume a depth of 12 feet bgs. Mercury was detected greater than CSCO in SB-9(8 ft bgs) - Metal CSCO is a sub set of the VOC CSCO Areal extent, Assume the depth is 10 feet bgs. Fill exists in area.							
	Areal Limits	60 by 80 feet	60 by 80 feet, 30 by 40 feet	60 by 40 feet	ND	60 by 80 feet	60 by 80 feet, 30 by 40 feet	75 by 150 feet	
	Depth Range (bgs)	12 feet	2 and 12 feet	10 feet	ND	12 feet	2 and 12 feet	10 feet	
	Average Depth (bgs)	12 feet	2 and 12 feet	10 feet	ND	12 feet	2 and 12 feet	10 feet	
	Estimated Quantity	2150 cu yd	350 cu yd, 540 cu yd	900 cu yd		2150	350 cu yd, 540 cu yd		

Former Raeco Products Site (#828107)

Table 3-1 (continued) AOC Summary and Estimated Quantity of Contaminated Media

AOC	Location	Commercial Use Cleanup Objectives				Unrestricted Use Cleanup Objectives				
		VOCs	SVOCs	Metals	Free Product	VOCs	SVOCs	Metals		
AOC-6	Building D	Possible tank; Historic manufacturing in Building D. SVOCs were detected greater than CSCO in SB-32(4 ft bgs), SB-33(4 ft bgs), and SB-34(4 ft bgs) - SVOCs are likely due to historic fill present beneath the building, Assume SVOC CSCO areal extent is entire footprint of Building D, Bedrock was encountered at 8 ft bgs - Assume a depth of 8 feet bgs. Fill also noted in area and beneath Building D. Free product was observed in SB-32(4-5.5 ft bgs) - Assume free product Areal extent is bounded by SB-33 and the building foot print, Assume the depth is 6 feet bgs.								
	Areal Limits	NE	30 by 90 feet	NE	30 by 40 feet	30 by 90 feet	30 by 90 feet	30 by 90 feet		
	Depth Range (bgs)	NE	8 feet	NE	6 feet	12 feet	2 and 12 feet	10 feet		
	Average Depth (bgs)	NE	8 feet	NE	6 feet	12 feet	2 and 12 feet	10 feet		
	Estimated Quantity		800 cu yd		270 cu yd	1200 cu yd	200 cu yd, 1200 cu yd	1000 cu yd		
AOC-7	West of Building D	SVOCs, and metals were detected in the area greater than the USCO; contaminants are wide spread and not delineated horizontally or vertically - therefore, assume entire area is greater than SCOs.Extensive fill noted (coal, wood, debris) along with historic rail operationsSVOCs were detected greater than CSCO in SB-7(8 ft bgs), SB-28(8 ft bgs), TP-1(2 ft bgs), - Assume SVOC CSCO Areal extent is defined by Building D, AOC-8, MW-3DD, Fence Line, SB-37 and SB-7; Assume the average depth is same as fill in area (4 to 14 ft bgs) 10' feet bgs.Metals were detected greater than CSCO in SB-6(10.5 ft bgs) — Conservatively assume metal CSCO Areal extent is bounded by Building D, SB-28, SB-29, SB-30, and TP-1; Assume the depth is 10.5 feet bgs (bedrock). Free product was observed in SB-06(5-7 ft bgs), and SB-07(1-2 ft bgs). Assume Areal extent is bounded by Building D, TP-2, SB-29, SB-30, and OU-5. Assume depth is 8 feet bgs. Elevated PID, odors, staining also observed (contamination apparently not delineated; thus, VOC contamination assumed).								
	Areal Limits	35 by 120 feet	75 by 125 feet	30 by 75 feet	35 by 90 feet	75 by 140 feet	75 by 140 feet	75 by 140 feet		
	Depth Range (bgs)	8 feet	10 feet	10 feet	2 to 8 feet	10 feet	10 feet	10 feet		
	Average Depth (bgs)	8 feet	10 feet	10 feet	8 feet	10 feet	10 feet	10 feet		
	Estimated Quantity	1250 cu yd	3480 cu yd	840 cu yd	950 cu yd	3900 cu yd	3900 cu yd	3900 cu yd		

Former Raeco Products Site (#828107)

Table 3-1 (continued) AOC Summary and Estimated Quantity of Contaminated Media

		Comme	rcial Use Cleanup O	bjectives		Unrestricted Use Cleanup Objectives							
AOC	Location	VOCs	SVOCs	Metals	Free Product	VOCs	SVOCs	Metals					
	Groundwater*												
	(VOCs, metals)							·					
AOC-8	Northern Portion of Site	SVOCs were detected greater than CSCO in SB-1(2 ft bgs), SB-4(16 ft bgs), SB-5(2 and 12 ft bgs; - Conservatively assume SVOC CSCO areal extent is the entire OU-8 area with the exception of the northern portion north of SB-02 and SB-22; Assume the average depth is same as fill in area (2 to 16 ft bgs) 10' feet bgs. Assume metals not completely delineated. Fill noted throughout AOC-8 in borings.											
	Areal Limits	NE	140 by 220 feet	NE	ND	140 by 280 feet	140 by 280 feet	140 by 280 feet					
	Depth Range (bgs)	NE	10 feet	NE	ND	10 feet	10 feet	10 feet					
	Average Depth (bgs)	NE	10 feet	NE	ND	10 feet	10 feet	10 feet					
	Estimated Quantity		11,400 cu yd			14,520 cu yd	14,520 cu yd	14,520 cu yd					
	Groundwater* (metals)												
AOC-9	Former Building E	Zinc was detected greater than USCO; Metals not delineated horizontally or vertically - assume entire footprint of building and 2 foot depth Due to presence of fill, metals and SVOCs above SCOs are assumed throughout AOC-9.											
	Areal Limits	NE	NE	NE	ND	NE	NE	35 by 85 feet					
	Depth Range (bgs)	NE	NE	NE	ND	NE	NE	2 feet					
	Average Depth (bgs)	NE	NE	NE	ND	NE	NE	2 feet					
	Estimated Quantity							220 cu yd					

Notes:

Quantities are based on conservative estimates of areal limits and average depths of soil contamination, based on existing analytical data and geological observations (fill, odors, elevated PID, staining, etc.).

Quantities of impacted groundwater were not estimated for this FS.

NE: no exceedences in SCOs.

Seven soil borings (SB-23, SB-24, SB-25, SB-26, SB-27, SB-38, and SB-39) and four monitoring wells (MW-4D, MW-4DD, MW-5D, MW-6D) were advanced within AOC 1. In addition, two test pits (TP-11 and TP-12) were excavated and one soil surface sample (SS-2) was collected from this area. The surface sample (SS-2) was collected in the vicinity of two large storage tanks (tanks have been removed from the site). The size, type and material stored in these tanks are unknown. Large concrete slabs were reported to be encountered at 1.5 to 3 feet bgs in test pits TP-11 and TP-12.

Fill was encountered at every soil investigation location in AOC 1, at thicknesses of 10 feet in the northeast portion of the area to greater than 25 feet to the south/southwest portion of the area. Fill material consisted of a mixture of silt, sand and gravel with bricks, ash, slag, and coal. No odor was detected and a small amount of staining was observed in some of the soils. PID readings were reported at less than 10 ppm. Bedrock was encountered at 10 feet bgs in the eastern portion of the area, and as deep 45 feet bgs on the western portion of the site. Groundwater was not encountered in the overburden fill in AOC-1; however, elevated levels of VOCs and metals were detected in groundwater samples in deeper wells in AOC-1.

SVOCs were detected within the fill material of AOC-1 at concentrations greater than the Part 375 commercial use SCOs at varying depths (and up to 22 feet bgs). Lead was detected at a concentration that exceeded the Part 375 commercial use SCOs in SB-39 at a depth of 32 feet.

3.1.2 AOC 2 Building B

AOC 2 consists of the area beneath and immediately near Building B (refer to Figure 3-1). The basement of Building B historically contained eight (8) empty 10,000-gallon tanks previously used for storage of mineral spirits, turpentine, and acetone.

Three surface soil samples (SS-1, SS-Bldg B-01, and SS-Bldg B-02) and one surface water sample (SW-1) were collected in the basement of Building B. One test pit (TP-9) was conducted south of Building B. Barium was detected is soil samples SS-1 and SS-Bldg B-02 at concentrations greater than the Part 375 commercial use soil clean up objectives.

3.1.3 AOC 3 Central Area of Site

AOC 3 consists of an area of the site bound roughly by Building A to the south, Building B to the east, AOC-5 to the north, and the intersection of Cliff Street and Ambrose Street to the west. (See Figure 3-1). Nine soil borings (SB-13, SB-14, SB-15, SB-17, SB-18, SB-19, SB-20, SB-21, and SB-35) were advanced and two test pits (TP-8 and TP-10) were conducted within AOC 3.

A 7 to 10 foot thick fill layer was encountered throughout most of the area. Fill material consisted of a mixture of silt, sand and gravel intermixed with bricks and coal. Silty sand and clay lenses were encountered underlying the fill. Bedrock was encountered at 12 feet bgs in the eastern portion of the area and was observed to dip to 27 feet bgs towards the western portion of the site. Groundwater does not appear to be present in the overburden of AOC-3.

Odors were noted and staining observed in every soil boring within the area. Elevated PID readings (greater than 100 ppm) were detected in each of the nine borings, and readings greater than 1,000 ppm were detected in six of the borings. The highest readings, staining and odor were generally observed at depths of 12 to 18 feet bgs. Product (nonaqueous phase liquid [NAPL]) was observed in soils from three locations (SB-19, SB-20, and SB-21) with in the area.

Benzo(a)pyrene was detected at concentrations greater than the Part 375 commercial use SCOs in test pits TP-8 and TP-10.

3.1.4 AOC 4 Former TCE Tank Area

A large TCE AST was historically located within a concrete block secondary containment structure adjacent to the southwest of Building C. This area has been designated AOC 4 (see Figure 3-1). Two groundwater monitoring wells (MW-1D, MW-1DD) were installed in this area (by NYSDEC and ERM, respectively). NAPL was also observed in MW-1D, along with elevated concentrations of VOCs, SVOCs, and metals in the groundwater samples collected from this AOC. Bedrock was encountered at 8 feet bgs in this area.

3.1.5 AOC 5 Former Building C and Vicinity

AOC 5 consists of the former Building C area and surrounding vicinity bounded to the north by Buildings D and E (and AOCs 6, 7, 8, and 9), to the south by AOCs 3 and 4 and Building B, to the east by the gorge, and to the west by the property fenceline. Building C was used historically as a chemical processing and storage area. The area between Buildings B and C reportedly contained two (2) creosote holding tanks.

Four soil borings (SB-08, SB-09, SB-10, and SB-12) were advanced, five test pits (TP-3, TP-4, TP-5, TP-6, and TP-7) were excavated, and one surface soil sample (SS-3) was collected within AOC 5. Sample SS-3 was collected from surface soils in the basement of the former Building C.

A 3-foot thick fill layer was encountered in the vicinity of SB-12. Silty sand and clay lenses were encountered throughout the overburden soil in the remainder of the AOC. A concrete slab was encountered in TP-6 at a depth of 1.5 feet bgs. Bedrock was encountered as shallow as 4 feet bgs in the eastern portion of the area, and was noted to dip to 14 feet bgs towards the western portion of the site. Groundwater was not encountered in the overburden.

High PID reading (greater than 1,000 ppm) were recorded, staining and sheen observed, and odor detected in the soils in borings SB-08 and SB-09. Product was observed in TP-3 soils. Elevated PID readings (greater than 100 ppm) were recorded in TP-3 and TP-5.

VOCs and SVOCs were detected at concentrations greater than the Part 375 commercial use SCOs in samples collected from SB-09 and SB-10. Mercury was detected at a concentration greater than the commercial use SCOs in SB-09.

3.1.6 AOC 6 Building D

AOC 6 consists of the area beneath and immediately adjacent to the south of Building D. Building D was used historically to store packaged chemicals and oils. Four borings (SB-32, SB-33, SB-34, and SB-40) were advanced within AOC 6. An access hatch/fill port identified near the foundation on the south end of Building D during the RI was reported to likely be part of a UST abandoned in place. However, a geophysical investigation did not identify any USTs beneath or in the area adjacent to Building D.

An approximate 3 foot thick fill layer was encountered beneath the concrete floor of Building D. A clay lenses was encountered from approximately 4 to 8 feet bgs. Bedrock was encountered at 8 feet bgs beneath the building. Groundwater was not encountered in the overburden.

Product (NAPL) was observed in boring SB-32, and staining was observed at locations SB-33 and SB-34. Elevated PID readings (greater than 100 ppm) were detected in all the borings in AOC 6, and readings greater than 1,000 ppm were detected in boring SB-32. SVOCs were detected at concentrations greater than the commercial use SCOs in SB-32, SB-33, and SB-34.

3.1.7 AOC 7 West of Building D

AOC 7 consists of the area west of Building D and is bounded by the property line to the west and southwest, AOC-5 to the south, and AOC-8 to the north. A former railcar loading area was historically located adjacent to Building D in AOC-7.

Eight soil borings (SB-06, SB-07, SB-28, SB-29, SB-30, SB-31, SB-36, and SB-37) were advanced, two test pits (TP-1 and TP-2) were conducted, and two groundwater monitoring wells (MW-3D and MW-3DD) were installed within AOC-5.

A fill layer, 4 to 14 feet thick (average of approximately 7 feet thick in the AOC) was encountered throughout AOC 7. The fill consisted of silty sand with the presence of brick, coal, and wood debris intermixed. An approximate 3 foot thick clay layer was observed overlying the bedrock throughout AOC 7. Bedrock was encountered at 11 feet bgs in the eastern portion of AOC-7 and as deep as 20 feet bgs towards the western part of AOC-7. Groundwater was not encountered in the overburden; however, samples collected from deeper monitoring wells identified elevated levels of VOCs and metals.

Elevated PID readings (greater than 100 ppm) were recorded and staining and odor detected in soil samples collected from all eight borings and both test pits in AOC 7. High PID reading (greater than 1,000 ppm) were recorded in boring SB-7. Product was observed in soils from borings SB-06, SB-07, and SB-30.

Benzo(a)pyrene (SVOC) was detected at concentrations greater than the Part 375 commercial use SCOs in soil samples collected from SB-7, SB-28, and TP-1 Lead and mercury were detected at concentrations greater than the commercial use SCOs in SB-6.

3.1.8 AOC 8 Northern Portion of Site

AOC 8 is located over the northern portion of the Site and includes Building F. AOC 8 is bounded by the property line to the north and west and by the gorge to the east. Building F was reported to historically house miscellaneous debris, scrap material, and drums. Deteriorated bags of lime were scattered about the Site historically, in the area between Buildings D/E and Building F. According to the PSI Report (with the original source of the information a 1970 Monroe County Health Department evaluation of the discharge points at the gorge face) staining was also observed on the building walls and ground surfaces in this area, and several drainage pipes were observed discharging into the gorge.

Six soil borings (SB-01, SB-02, SB-03, SB-04, SB-05 and SB-22) were advanced, one test pit (TP-13) was excavated, one surface soil sample (SS-4) was collected, and two groundwater monitoring wells (MW-2D and MW-2DD) were installed within AOC 8. Soil sample SS-4 was collected from areas of visible staining on the ground surface, during NYSDEC's PSI (1999-2000).

A fill layer (approximately 2 to 14 feet thick) was identified in the subsurface throughout AOC-8 during the previous investigation work. The fill consisted of silty sand with brick, coal, ash, concrete and slag intermixed. An approximate 2-foot thick clay layer was observed overlying the bedrock throughout AOC 8. Bedrock was encountered at 7.5 feet bgs in the northeastern portion of the area, dipping to 22 feet bgs and 16 feet bgs towards the western and southern portions of AOC 8, respectively. Groundwater was not encountered in the overburden; however, elevated metals concentrations were reported from deeper groundwater samples collected in AOC-8.

Elevated PID readings (greater than 100 ppm) were recorded and staining and odor detected in the soils in two borings (SB-02 and SB-03). Staining and odor were also detected in soils evaluated during the installation of MW-2D.

SVOCs were detected at concentrations greater than the Part 375 commercial use SCOs in SB-1, SB-4, and SB-5.

3.1.9 AOC 9 Building E

AOC 9 consists of the area beneath and immediately adjacent to the former Building E. Historically, the basement of Building E contained six (6) large oil storage tanks. A large oil stain was observed along the gorge wall from the building's foundation to the riverbank during the NYSDEC's Preliminary Site Investigation. One boring (SB-11) was advanced within AOC 9.

An approximate 12 foot thick fill layer was encountered beneath the concrete floor of Building E. Concrete was encountered at 7 to 8 feet bgs. Dark staining and odors were observed in the soils above the concrete. Bedrock was encountered at 13.5 feet bgs beneath the former building. Groundwater was not encountered in the overburden.

VOCs, SVOCs or metal compounds were not detected at concentrations greater than the Part 375 commercial use soil clean up objectives.

3.2 Nature and Extent of Groundwater Contamination

In the Preliminary Site Investigation, the NYSDEC concluded that elevated levels of contaminants (VOCs, SVOCs, and metals) were located in groundwater in the vicinity of Buildings A, B, C and D. Several pesticide compounds and one PCB were detected at elevated levels in one groundwater sample collected at the site (TP-3) by the NYSDEC; however, the water had accumulated at the base of the overburden and may not be representative of bedrock groundwater conditions.

ERM reported that VOCs, SVOCs and metals exceeding the Class GA groundwater standards and guidance values were detected in groundwater monitoring wells at the Site, primarily at the southern end of the property, west of Building D, and in the vicinity of the former TCE tank location.

Locations of monitoring wells that were installed and sampled during previous investigations are included on Figures 2-3 and 2-4. Table 2-1 summarizes groundwater data available for the Site.

3.3 Nature and Extent of Surface Water Contamination

Results of the surface water investigation at the Site indicated that contaminants present at the Site are not affecting the surface water quality of the Genesee River. It is assumed that no further investigation is required.

3.4 Nature and Extent of Indoor Air Contamination

Results of the sub-slab and indoor air monitoring samples collected at Building A indicate that PCE and TCE were detected at vapor intrusion concentrations that exceed the NYSDOH guidance. It is understood that potential vapor intrusion is being addressed by NYSDOH / NYSDEC, and that no further vapor intrusion or indoor air assessment is required as part of this FS.

It is understood based on previous site assessment that groundwater and soil contamination are limited to the site area (and no off-site areas need to be addressed).

This page intentionally left blank.

4.0 REMEDIAL GOALS AND REMEDIAL ACTION OBJECTIVES

4.1 Remedial Action Objectives

Remedial Action Objectives (RAOs) are developed based on contaminant-specific Standards, Criteria, and Guidance (SCGs) for the Site for the protection of public health and the environment. The SCGs will be utilized to establish soil and groundwater cleanup objectives that eliminate or mitigate the significant threat and are protective of the public health and environment.

The FS will address contaminants that have been identified in the soil and groundwater at the Site.

4.1.1 Soil Remedial Action Objectives

The general RAO's for soil at the Site are as follows:

RAO's for Public Health Protection

- Prevent ingestion/direct contact with contaminated soil.
- Prevent inhalation of or exposure from contaminants volatilizing from contaminants on soil
- It is assumed that NYSDOH / NYSDEC are addressing vapor intrusion issues at the Site. Therefore, potential exposures to contaminants volatilizing from soil and groundwater are not directly addressed in this FS.

RAO's for Environmental Protection

- Prevent migration of contaminants that would result in groundwater or surface water contamination.
- Prevent impacts to biota from ingestion/direct contact with soil causing toxicity or impacts from bioaccumulation through the terrestrial food chain.

Applicable SCGs for the Site include 6 NYCRR Part 375 – Environmental Remediation Programs. Section 6.8 of Part 375, sets forth soil cleanup objectives that will satisfy the RAO's for soil at the Site (i.e. protection of public health and the environment). Soil cleanup objectives have been developed for unrestricted and restricted uses. The types of restricted use soil cleanup objectives include: residential; restricted-residential; commercial use; industrial use; protection of groundwater; and protection of ecological resources. The unrestricted soil cleanup objectives represent the most conservative of the values and "pre-disposal" conditions.

The ultimate goal of site remediation is to restore the site to "pre-disposal" conditions and as such the unrestricted SCOs are considered for the FS. An unrestricted use scenario remedy will be evaluated in this FS for purposes of comparison. However, since the current and anticipated future use of the Site is commercial, the NYSDEC commercial restricted use soil cleanup objectives (Commercial SCOs) are also considered for the Site. VOCs, SVOCs and metals have been detected in the soils at the Site at concentrations greater than the unrestricted use and commercial restricted use cleanup objectives outlined in Part 375 Section 6.8. Fill material / debris have also been observed. Table 2-2 outlines the parameters detected in the Site soils at concentrations greater than the unrestricted and commercial soil cleanup objectives.

4.1.2 Groundwater Remedial Action Objectives

The general RAO's for groundwater at the Site are as follows:

RAO's for Public Health Protection

- Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards. It is assumed that contact with on-site groundwater via domestic, potable, or other uses is not a complete pathway due to the presence of a municipal water system in the City.
- Prevent contact with, or inhalation of volatiles, from contaminated groundwater. It is assumed that NYSDOH / NYSDEC are addressing vapor intrusion issues at the Site. Therefore, potential exposures to contaminants volatilizing from soil and groundwater are not directly addressed in this FS.

RAO's for Environmental Protection

- Restore ground water aquifer to pre-disposal/pre-release conditions, to the extent practicable.
- Prevent the discharge of contaminants to surface water.
- Remove the source of groundwater contamination.

The Class GA ambient groundwater standards include a compilation of promulgated cleanup criteria for the restoration of the groundwater aquifer to pre-disposal/pre-release conditions. VOCs, SVOCs and metals have been detected in the bedrock groundwater at the Site at concentrations greater than the groundwater class GA ambient water quality standards. Table 2.2 summarizes the parameters detected in groundwater at the Site at concentrations greater than the class GA ambient groundwater standards.

Groundwater is not used for potable or production purposes at the property since the site and vicinity are serviced by a municipal water system. Therefore, there is no direct exposure to contaminants in groundwater. However, because VOCs, SVOCs and metals have been detected in groundwater beneath the Site at concentrations greater than the groundwater standards, the following RAO's for groundwater have been developed for the Site:

- 1. To the extent practical, limit off-site migration of VOCs, SVOCs and metals in groundwater at concentrations greater than the groundwater (Class GA) ambient water standards;
- 2. To the extent practical, reduce the concentrations of VOCs and other contaminants in groundwater at the Site;
- 3. Prevent exposure to or inhalation by the public of volatilized contaminants in the groundwater; and,
- 4. To the extent practical, reduce or remove the source of groundwater contamination including, but not necessarily limited to, NAPL present at the Site.

This page intentionally left blank.

5.0 GENERAL RESPONSE ACTIONS

As described in Section 4, both the soil and groundwater have been impacted at the Site. VOCs, SVOCs, and metals have been detected in these media at concentrations exceeding applicable criteria.

5.1 Soil General Response Actions

The general response actions for impacted on-site soils include no action, institutional controls, containment, treatment, and removal.

- No Action The no action option is included as a basis for comparison with the
 active soil remediation technologies. If no action is taken, the contaminants will
 remain in place and the RAOs will no be met.
- Institutional Controls The current and anticipated future use of the Site is for commercial purposes. Restricting the Site to commercial use through institutional controls (deed restrictions, environmental easements) would likely not interfere with current Site operations and would reduce the volume of soil requiring active remediation. However, because contaminants were detected in surficial / shallow depths at concentrations greater than the commercial use SCOs, additional response action(s) will need to be employed in conjunction with institutional controls.
- Containment The in-place containment of contaminated soils may be accomplished through capping. A cap will prevent direct contact with impacted soils. An impermeable cap could also minimize inhalation or exposure to volatile contaminants but may need to be augmented with another remedial action. A low permeability cap would reduce stormwater infiltration to contaminated areas, thereby minimizing a pathway of contaminant migration to groundwater and/or surface water. A cap would not address sources of groundwater contamination, however, and may need to be used in conjunction with other technologies.
- Treatment Treatment of contaminants can be achieved either in-situ or ex-situ and includes several type of technologies that encompass biological, thermal, physical, and chemical treatment approaches.
 - Biological Enhanced biodegradation of organic contaminants (VOCs and SVOCs) is viable for on-site soils. However, biological treatment is generally not effective for addressing metal contaminants in soil.

- o Thermal Thermal treatment processes are viable strategies to mobilize and remove VOC and SVOC contamination from soils. Thermal treatment for metal contamination (such as vitrification) is typically energy intensive and would likely be logistically challenging for the Site (i.e., application of thermal treatment could result in damage to the existing structures at the Site).
- Physical Effective technologies are available for removal of VOCs and SVOCs.
 This technology is less effective for remediation of metals in soil.
- o Chemical Effective for immobilization of metal contamination and treating VOCs and SVOCs.
- Removal Excavation and off-site disposal will permanently remove contaminants
 from the Site. Soil excavation may be accomplished using conventional earthmoving
 equipment. Disposal options for excavated soils include disposal to an off-site
 landfill or treatment facility.

5.2 Groundwater General Response Actions

The general response actions for impacted groundwater include no action, institutional controls, containment, collection/treatment/disposal, and in-situ treatment.

- No Action The no action option is included as a basis for comparison with the
 active groundwater remediation technologies. No action consists of natural
 attenuation and long term monitoring of groundwater contaminants.
- Institutional Controls Effective in insuring that on-site contaminated groundwater continues to not be used for a potable or process water uses. Restricting the Site to commercial use through institutional controls (deed restrictions, environmental easements) would likely not interfere with current Site operations and could reduce the volume of groundwater requiring active remediation.
- Containment A low permeability cap would reduce stormwater infiltration to contaminated areas, thereby minimizing a pathway of contaminant migration to groundwater and/or surface water. Groundwater barriers can be effective in controlling migration of contaminants.
- Collection/Treatment/Disposal Collection is an effective technology for hydraulic control and/or removal of groundwater contamination. Various technologies are available for treating organic and inorganic contaminants in collected groundwater.
 On-site and off-site treatment/disposal options are available for the collected groundwater.

- In-situ Treatment Several types of technologies may be applicable for the in-situ treatment of groundwater, and include including biological, thermal, physical and chemical treatment.
 - Biological Biodegradation of organic contaminants (VOCs and SVOCs) is possible. However, biological treatment is generally not effective for addressing metal contaminants in groundwater.
 - o Thermal Thermal treatment processes are viable approaches to mobilize and remove VOCs and SVOCs contamination. However, they are not typically as effective for treating metal contaminants in groundwater.
 - Physical Effective physical technologies are available for removal of VOCs and SVOCs. This technology is typically less effective for removal of metals in groundwater.
 - o Chemical Effective for removal of metal, VOC, and SVOC contamination.

This page intentionally left blank.

6.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

6.1 Introduction

In this section, the specific technologies identified above for each of the general response actions are further assessed. The technologies are grouped by medium (soil and groundwater) and screened to identify those that appear to be: most appropriate to the site-specific conditions and site contamination, technically implementable, and capable of achieving the site's RAOs.

Site specific conditions, including contamination type, concentration, location (aerial extent and depth), and estimated quantity were considered during the initial screening process. A summary of the AOCs identified and estimated dimensions / quantities is included on Table 3-1. The initial screening was also based on the effectiveness for treating the contaminants present at the Site, implementability given Site-specific conditions, and relative cost.

Remedial technologies that were deemed to be not technically appropriate or cost prohibited were dropped from further consideration. Tables 6-1 and 6-2 summarize the technology identification and screening process for soil and groundwater, respectively. The tables are grouped by the general response action (i.e., in-situ treatment, ex-situ treatment, containment). Technologies that may be appropriate for addressing the contaminants at the Site and that were thus retained for further evaluation are identified on the last columns of Tables 6-1 and 6-2. Technologies that were screened out and not retained for further analysis are designated as "no" in the last columns of Tables 6-1 and 6-2.

The most promising technologies were combined into remedial alternatives, which are described in the development of alternatives section of this report.

6.2 Identification and Screening of Technology for Soil

As discussed in the previous investigation section, VOCs, SVOCs, and metals have been detected in the soil at the Site at concentrations greater than the 6 NYCRR Part 375 soil cleanup objectives. The Site has been divided into nine areas of concern to facilitate development and evaluation of remedial alternative for the Site soil. A summary of the type and estimated quantity of soil contamination at the Site is summarized in Table 3-1.

This page intentionally left blank.

Table 6-1 Summary of Remedial Technology Screening –Soil

Professional Pro						Summ	ary of Re	medial Tech	nology Sc	reening -Soil						
Professional Pro			Overall Cost and Performance Treatment Effectiveness													
Properties			Complexity	O&M	Capital		Cost	Time	Availability	VOCs		CVOCs	SVOCs	Inorganics		Retained for Alternative Evaluation
Property	In Situ Biological Treatment															
Medical Part	Bioventing	Yes	Low	Low	Low	High	Low	Medium	High	Effective	Limited	Limited	Limited	Not Effective	Yes	No
Produce Prod	Enhanced Bioremediation	Yes	Low	High	Medium	Medium	Low	Medium	High	Effective		Effective	Limited	Not Effective	No	No
Process	Phytoremediation	Yes	Low	Low	Low	Low	Low	High	Medium	Limited		Limited	Limited	Limited	No	No
Methodologic Signatural Vis. Method Methodologic Methodo	In Situ Physical/Chemical Treatment															
Description Part	Chemical Oxidation (ISCO)	Yes	Medium	Low	Medium	Medium	Medium	Low	High	Effective	Limited	Effective	Limited	Limited	Yes	Yes
Particular Part	Electrokinetic Separation	Yes	High	Low	Medium	Medium	High	Medium	Medium	Limited	Effective	Limited	Limited	Effective	No	No
Sol Vagor Forcestion	Fracturing	Yes	Medium	Medium	Low	Medium	Medium	Medium	High	Limited		Limited	Limited	Not Effective	Possible	No
Solid Friedman Parish Harmon Parish Harm	Soil Flushing	Yes	Low	Low	Medium	Medium	Medium	Medium	High	Effective	Limited	Effective	Limited	Effective	No	No
Second Content Seco	Soil Vapor Extraction	Yes	Medium	Low	Medium	High	Low	Medium	High	Effective		Effective	Limited	Not Effective	Yes	Yes
Part	Solidification/Stabilization	Yes	Medium	Medium	Low-High	High	Low-High	Low	High	Limited		Limited	Limited	Effective	No	No
Second Presenter Issueming encounter I	In Situ Thermal Treatment															
Propries Property	Thermal Treatment	Yes	High	High	High	High	Medium	Low	High	Effective	Limited	Effective	Effective	Not Effective	Possible	No
Composing Yes Low Low Low Medium Low Medium High United Effective No	Ex Situ Biological Treatment (assuming exc	avation)														
Low Low-Medium Low Medium Medi	Biopiles	Yes	Low	Low	Low	High	Low	Medium-High	High	Effective	Limited	Effective	Limited	Limited	No	No
Sign Phase Blogical vs 14gh High High High Medium Medium Medium Medium High Limited Limited Limited Limited Limited Limited Effective Effective Vs No Chemical Extraction Vs High Low High Medium High Elmon Low High Limited Vs No Chemical Extraction Vs Medium High High Medium Low High Effective High Limited Limited Limited Limited Limited Limited Limited Vs No Chemical Medium Medium Medium Low High Low-Medium Medium Low High Limited Limited Limited Limited Limited Limited Limited Limited Vs No Chemical Medium Medium Low High Low-Medium Medium Low High Limited Li	Composting	Yes	Low	Low	Low	Medium	Low	Medium-High	High	Limited	Limited	Limited	Limited	Not Effective	No	No
Treatment (assuming excavation and profe treatment) Figh Figh Figh Figh Figh Medium Medium Figh United Uni		Yes	Low	Low-Medium	Low	High	Low	Medium-High	High	Limited	Limited	Limited	Effective	Not Effective	No	No
Chemical Extraction Ves Medium Medium High Low High Medium Low High Imited Limited Ves No Adoption (GAC)NINI/ Chéride Cervol Ves Medium Low High Low Medium Medium Limited Effective Limited Limited Ves No Soll Washing Ves Medium Low High Medium Low High Limited Ves No Soll Washing Ves Medium High High Medium Low High Limited Limited Limited Limited Limited Limited Limited Limited Limited Ves No Soll Washing Ves Medium High High Low High Limited Limited Limited Limited Limited Limited Limited Ves No Not Not Not Not Not Not Not Not Not	Treatment				High_	Medium	Medium	Medium	High	Limited	Limited	Limited	Effective	Limited	Yes	No
Chemical Extraction Yes High Low High Medium High Medium High Medium Low High Limited Consoling (GCL/DNy) Charles Low Medium High Medium Medium Medium High High Effective Not Fflective Effective Effective Limited L	Ex Situ Physical/Chemical Treatment groundwater extraction)	(assuming excava	tion and/or trea	atment and/or												
Addression (GAC)/Amyl Chloride Ves Low Medium High Modium High Low High Low High Medium Medium Limited Effective Limited Limit	Chemical Extraction	Yes	High	Low	High	Medium		Medium	High	Limited	Limited	Limited	Effective	Effective	Yes	No
Corried Yes Low Medium-High Medium High Low Medium-High High Effective Not Effective Effective Effective Limited Yes Yes Dehalogenation Yes Medium Low High Low High Medium Medium Limited Effective Limited Ves No Soldwishing Yes High Low High Low High Limited Ves No Soldwishing Yes Medium Medium High Low-High Low High Limited Ves No Soldwishing Yes Medium Medium High Low-High Low High Limited High Not Demonstrated Not	Chemical Reduction /Oxidation	Yes	Medium	Medium	High	High	Medium	Low	High	Limited	Limited	Limited	Limited	Effective	Yes	No
Dehalogenation Yes Medium Low High Low High Medium Medium Limited Effective Limited Limited Umited Ves No Solid Mashing Yes High Low High High Medium Low High Limited Limited Umited Effective Yes No No Not Not Not Not Not Not Not Not N		Yes	Low	Medium-High	Medium	High	Low-Medium	Medium-High	High	Effective	Not Effective	Effective	Effective	Limited	Yes	Yes
Soil Washing Yes High Low High High Medium Low High Limited Fffective Yes No Soildification/Stabilization Yes Medium Medium High High Low-High Low High Limited Fffective Limited Limited Limited Effective Yes No No Not Not Not Not Not Not Not Not N	Dehalogenation	Yes	Medium	Low	High	Low	High	Medium	Medium	Limited		Limited	Limited	Not Effective	Yes	No
Solidification/Stabilization Yes Medium Medium High High Low High Low High Limited Fffective Limited Limited Effective Yes No Part Perfective	Separation	Yes	Medium	Low	Medium	High	Medium	Low	High	Limited	Limited	Limited	Limited	Limited	Yes	No
Solidification/Stabilization Yes Medium Medium High High Low-High Low High Limited Effective Limited Limited Effective Yes No Not Not Not Not Not Not Not Not Not	Soil Washing	Yes	High	Low	High	High	Medium	Low	High	Limited		Limited	Limited	Limited	Yes	No
Hot Gas Decontamination No Low High High High High High Low Low High Not Demonstrated Effective Demonstrated Demon	Solidification/Stabilization	Yes	Medium	Medium	High	High	Low-High	Low	High	Limited		Limited	Limited	Effective	Yes	No
Hot Gas Decontamination No Low High High High High Low Low High Not Demonstrated Effective Demonstrated Demonstrated Ves No Incineration (off site) Yes Low N/A High Medium High Low High Low High Effective Limited Effective Effective Not Effective Yes No Pyrolysis Yes Medium High High High Low High Low Medium Limited Effective Limited Effective United Effective Not Effective Yes No No Medium Limited Effective Limited Effective United Effective Not Effective Yes No No Effective Yes No No Effective Yes No No Effective Yes No No Effective Not Effective Yes No No	Ex Situ Thermal Treatment (assuming exca	vation)														
Incineration (off site) Yes Low N/A High Medium High Low High Effective Limited Effective Effective Not Effective Yes No Pyrolysis Yes Medium High High Low High Low Medium Limited Effective Limited Effective United Effective Not Effective Yes No Medium Phigh Low High Effective Limited Effective United Effective Not Effective Yes No Containment Capping System Yes Low Medium Low High Low High Low Effective Limited Effective No	Het Can Beautaniantian	No	law	Lliah	High	High	Low	low	High	Not Demonstrated					Vac	No
Pyrolysis Yes Medium High High Low High Low Medium Limited Effective Limited Effective Limited Effective Not Effective Yes No Medium-High High Medium-High Low High Effective Limited Effective Limited Effective Limited Not Effective Yes No Containment Capping System Yes Low Medium Low High Low High Effective Effective Effective Effective Effective Effective Effective Effective Effective Not Effective Yes No Cap Enhancements/Alternatives Yes Low-Medium High Medium High Medium High Medium High Effective Effective Effective Effective Effective Effective No No No No No No No No No No																
Medium- Medium- High Medium High Low High Effective Limited Effective Limited Not Effective Yes No Containment Capping System Yes Low Medium Low High Low & Medium High Low & Medium High Low & Medium High Low & Medium Low High Low & Medium High Medium & Medium High Medium & Medium & Medium High Medium & Med	incheration (on site)	res	LOW	11/2	riigii	Wedialii	riigii	LOW	111611	Enective		Effective	Encourc	NOT EMECTIVE	763	110
Thermal Description Yes High High High Medium High Low High Effective Limited Effective Limited Not Effective Yes No Containment Low but long- term inspection Capping System Yes Low Medium Low High Low & maintenance High Effective Effective Effective Effective Effective Effective Effective Effective No No Other Treatment Low- Low- Low- Low- Defermance High Effective No No No No No No No No No No	Pyrolysis	Yes	Medium	High	High	Low	High	Low	Medium	Limited	Effective	Limited	Effective	Not Effective	Yes	No
Low but long- term inspection Capping System Yes Low Medium Low High Low & maintenance High Effective Effective Effective Effective Effective Effective Yes Yes Low but long- term inspection Low but long- term inspection term inspection Cap Enhancements/Alternatives Yes Low-Medium High Medium High Medium & maintenance High Effective Effective Effective Effective Effective No No Other Treatment	Thermal Description	Yes			High	Medium		Low	High	Effective	Limited	Effective	Limited	Not Effective	Yes	No
Low but long- term inspection Capping System Yes Low Medium Low High Low & maintenance High Effective Effective Effective Effective Effective Effective Yes Yes Low but long- term inspection Cap Enhancements/Alternatives Yes Low-Medium High Medium High Medium & maintenance High Effective Effective Effective Effective Effective Effective No No No Other Treatment Low-		,,,,,														
Medium- Low- term inspection Cap Enhancements/Alternatives Yes Low-Medium High Medium High Medium & maintenance High Effective Effective Effective Effective Effective Effective Down Other Treatment Low-		Yes	Low	Medium	Low	High	Łow	term inspection	High	Effective	Effective	Effective	Effective	Effective	Yes	Yes
Other Treatment Low-	Can Enhancements/Alternatives	Yes	Low-Medium			Hieh	Medium	term inspection	High	Effective	Effective	Effective	Effective	Effective	No	No
Low-		163	EON MEDIN	1.1.511	cararii			A								
	Excavation, Off-Site Disposal	Yes	Low	Low		High	Medium	Low	High	Effective	Effective	Effective	Effective	Effective	Yes	Yes

Table 6-2 Summary of Remedial Technology Screening – Groundwater

			Overall Cost and Performance							Treatmen				
	Established	Commission	0984	Control	Reliability/	6		A	une				Implementable	Retained for Alternation
n Situ Biological Treatment	Technology	Complexity	O&M	Capital	Maintainability	Cost	Time	Availability	VOCs_	CVOCs	SVOCs	Inorganics	at Site	Evaluation
13itu biologicai Treatment		Low-	Medium-				Medium-							
Enhanced Bioremediation	Yes	Medium	High	Medium	Medium	Low	High	High	Effective	Limited	Limited	Limited	Yes	No
Monitored Natural							Medium-			2	Limited	Ziiiiico	, 65	110
Attenuation/LTM	Yes	Low	High	Medium	Medium	Low	High	High	Effective	Limited	Limited	Limited	Yes	Yes
Phytoremediation	Yes	Low	Low	Low	Low	Low	High	Medium	Limited	Limited	Limited	Limited	No	No
Situ Physical/Chemical Treatment														
,				Low-			Low-					Not		
Air Sparging	Yes	Low	Low	Medium	Medium	Low	Medium	High	Effective	Effective	Limited	Effective	Yes	No
Bioslurping	Yes	Medium	Low	Low	Medium	Low	Medium	High	Effective	Limited	Limited	Limited	Yes	No
Chemical Oxidation (ISCO)	Yes	Low	High	Medium	Medium	Medium	Low	High	Effective	Effective	Limited	Limited	Yes	Yes
chemical oxidation (isso)		Low-	6	Mediam	Mediam	Micaiain	2011	111611	LITCUIVE	Lilective	Limited	Limited	163	163
Directional Wells (enhancement)	Yes	Medium	Medium	High	Medium	Medium	Medium	High	Limited	Limited	Limited	Limited	Yes	No
		Medium-				Medium-	Low-					Not		
Dual Phase Extraction	Yes	High	High	High	Medium	High	Medium	High	Effective	Effective	Effective	Effective	Yes	Yes
The second Transit and	W	re-t	10-6	ne. L	A.C. P	re-t	Low-					Not		
Thermal Treatment	Yes	High	High	High	Medium	High	Medium	High	Effective	Effective	Effective	Effective	Possible	No
Hydrofracturing Enhancements	Yes	Medium	Low	Low	High	Medium	Medium	High	Limited	Limited	Limited	Limited	Yes	No
In-Well Air Stripping	Yes	Medium	Medium	High	Medium	Medium	Medium	High	Effective	Limited	Limited	Not Effective	Yes	No
iii well all sempong	103	Wicalaili	mediam		Wicalam	Medium-	Medium-	,b.,	Encedive	Littica	Littica	Lifective	163	140
Passive/Reactive Treatment Walls	Yes	Low	Medium	High	Medium-High	High	High	Medium	Effective	Effective	Effective	Limited	No	No
Situ Biological Treatment														
	.,	Low-										Not		
Bioreactors	Yes	Medium	Medium	High	High	Low	Medium	High	Effective	Effective	Limited	Effective	Yes	No
Constructed Wetlands	Yes	Low- Medium	Medium	High	Medium-High	Medium	Medium	Medium	Limited	Limited	Limited	Effective	No	No
Situ Physical/Chemical Treatment (assuming g			Wicdiairi	111811	TVICUIUITI-I IIBIT	Wiediam	Wediam	Wiediaiii	Littited	Limited	Limited	cirective	110	INU
Adsorption (GAC)/Vinyl Chloride	. ouriameter exe		Medium-			Low-	Medium-							
Control	Yes	Low	High	Medium	High	Medium	High	High	Effective	Effective	Effective	Limited	Yes	Yes
							Low-							
Advanced Oxidation Processes	Yes	Medium	High	High	Medium	High	Medium	Medium	Effective	Effective	Effective	Limited	Yes	No
A la Chalanain a	V	A An alicens	Medium-	A A a dia	I timb	Mandia	A A = alta assa	re t		F((+ '	A1	Not		
Air Stripping Groundwater Pumping/Pump &	Yes	Medium Medium-	High	Medium Medium-	High	Medium Medium-	Medium Medium-	High	Effective	Effective	Not Effective	Effective	Yes	No
Treat	Yes	High	High	High	Medium	High	High	High	Effective	Effective	Limited	Effective	Yes	No
11001			6	Medium-	····caia···	Medium-		,	Not	Not	Littleca	Liiccuvc	103	NO
Ion Exchange	Yes	Medium	High	High	High	High	Medium	High	Effective	Effective	Not Effective	Effective	Yes	Possib
Description (Const.) standard (Charles				A A - altrase										
Precipitation/Coagulation/Flocculati	Yes	Love	Medium	Medium-	Llink	Medium	Madicina	U:-F	Not	Not	Not Effective	rec _{ented}	V.	
on Separation	Yes	Low Medium	High	High High	High High	Low	Medium Low	High High	Effective Effective	Effective Effective	Not Effective Effective	Effective Limited	Yes Yes	No No
Зерагасіон	163	Wediam	Low-	riigir	riigir	LOW	LOW	HIGH	Effective	Ellective	Effective	Not	res	No
Sprinkler Irrigation	Yes	Low	Medium	Low	Medium	Low	Medium	Medium	Effective	Effective	Limited	Effective	Yes	No
ntainment														
						Medium-	Medium-							
Physical Barriers	Yes	Low	Medium	High	High	High	High	Medium	Effective	Effective	Effective	Effective	No	No
Deep Well Injection	Yes	Low	Medium	Medium	Low	Medium	High	Medium	Limited	Limited_	Limited	Limited	Yes	No

Technologies are grouped by general response action and discussed in detail in the following sections. A summary of the soil screening process is provided in Table 6-1.

6.2.1 In Situ Biological Treatment

Implementation of in situ treatment, does not require the excavation of contaminated media. In situ technologies can minimize potential worker exposure to contaminants. In-situ technologies generally require a longer period of time to meet remedial objectives and can result in high operation and maintenance needs as compared to ex situ technologies.

6.2.1.1 Bioventing

Bioventing stimulates the natural in situ biodegradation of aerobically degradable compounds in soil by providing oxygen to existing soil microorganisms. Oxygen is delivered to contaminated unsaturated soils by forced air movement (either extraction or injection of air, or a combination of both). Bioventing uses relatively low air flow rates to provide only enough oxygen to sustain microbial activity.

Bioventing is not effective in treating inorganics and many chlorinated organics. In addition, bioventing can generate vapors that can build up in existing structures at the Site. Based on Site conditions and subsurface contamination, bioventing has been screened out and will not be evaluated further.

6.2.1.2 Enhanced Bioremediation

Enhanced bioremediation is a process in which indigenous or inoculated micro-organisms degrade (metabolize) organic contaminants found in soil and/or ground water, converting the contaminants to innocuous end products. Nutrients, oxygen, or other amendments may be used to enhance bioremediation and contaminant desorption from subsurface materials. Enhanced bioremediation of soil typically involves the percolation or injection of groundwater or uncontaminated water mixed with nutrients and/or saturated with dissolved oxygen. An

infiltration gallery or spray irrigation is typically used for shallow contaminated soils, and injection wells are used for deeper contaminated soils. A surface treatment system, such as air stripping or carbon adsorption, may be required to treat extracted groundwater prior to reinjection or disposal.

Bioremediation is most effective for remediating low-level residual organic contamination in conjunction with source removal and is generally lower in cost than other treatment technologies. However, bioremediation cannot degrade inorganic contaminants.

Distribution of water-based reagents may be effective in heterogeneous subsurface environments. However, the presence of preferential flow paths (as caused by fill material and buried debris) may severely decrease contact between injected fluids and contaminants throughout the treatment zones. Circulation of water-based reagents through the soil may increase contaminant mobility impacting the underlying groundwater. Based on subsurface conditions (presence of fill), Enhanced Bioremediation has been screened out and will not be evaluated further.

6.2.1.3 Phytoremediation

Phytoremediation is a process that uses plants to remove, transfer, stabilize, and destroy contaminants in soil and sediment. This technology is limited to shallow soils and is not readily implementable given the current active Site use. Phytoremediation has been screened out and will not be evaluated further.

6.2.2 In Situ Physical/Chemical Treatment

6.2.2.1 Chemical Oxidation

In-situ chemical oxidation (ISCO) is a process where powerful oxidizing chemicals are injected into the subsurface to chemically convert contaminants to less toxic compounds. In addition, contaminants may become more stable, less mobile, and/or inert. Chemical oxidant delivery

6-6

systems may include vertical or horizontal injection wells and sparge points, with forced advection to rapidly move the oxidant into the subsurface. Oxidizing agents that are commonly used to address contaminants include ozone, hydrogen peroxide, potassium permanganate, hypochlorites, chlorine, and chlorine dioxide.

In situ chemical oxidation is a viable remediation technology for mass reduction of organic contaminants in source areas. Chemical oxidation can have a relatively rapid treatment time, and can be implemented with readily available equipment. Limitations associated with chemical oxidation including: limited effectiveness in treating SVOCs and inorganics; requirements to handle and administer large quantities of hazardous oxidizing chemicals; and naturally occurring organic material in the formation can consume large quantities of oxidant. Chemical oxidation appears to be a promising technology for on-Site soil contamination, and has been retained for further analysis.

6.2.2.2 <u>Electrokinetic Separation</u>

The electrokinetic separation process consists of the application of a low-intensity direct current through the soil via ceramic electrodes installed in and around soil contamination areas. The induced current mobilizes charged contaminants toward the polarized electrodes to concentrate the contaminants for subsequent removal and ex-situ treatment / disposal.

Electrokinetic separation process is generally used to remove metals from low permeability soils (i.e. clay). Electrokinetics is most effective in clays because of the negative surface charge of clay particles. Due to the Site geology (i.e., presence of sands and fill in much of the overburden soils), this technology has been screened out and will not be evaluated further.

6.2.2.3 Fracturing

Fracturing is an enhancement technology designed to increase the efficiency of other in situ technologies in certain types of subsurface conditions (i.e., very low permeability soils / rock). Cracks are created in the media of interest by fracturing (pneumatically or mechanically) to

create new passageways or channels. Fracturing can thus increase the effectiveness of many in situ processes and enhance extraction efficiencies. Fracturing is not highly amenable to the Site, based on the geology and presence of fill material, and has screened out.

6.2.2.4 Soil Flushing

Soil flushing is a process where contaminants are extracted from the soil by passing uncontaminated water (or water containing an additive to enhance contaminant solubility) through in-place soils. Contaminants are leached into the water, which is then extracted and treated.

In general, heterogeneous soils, as are present on-Site, are difficult to treat via soil flushing. In addition, there is a potential for contaminant migration if contaminants are flushed beyond the capture zone. Further, ex-situ treatment costs for recovered fluids can add significantly to remedial costs associated with this process. Due to the concerns raised above, this technology was not retained for further analysis.

6.2.2.5 Soil Vapor Extraction

Soil vapor extraction (SVE) is an in situ unsaturated (vadose) zone soil remediation technology where a vacuum is applied to the subsurface soil to induce air flow through the soil medium and remove volatile (and some semivolatile) contaminants. Contaminants captured in the extracted soil vapor or typically treated above grade, via activated carbon or other process. It should be noted that limited SVE pilot testing conducted by ERM during the RI reported successful VOC removal. SVE's effectiveness at the Site may be enhanced by applying surficial capping over the SVE areas to prevent short-circuiting from drawing in ambient air to the subsurface. SVE is the presumed remedy for the organic contamination in the soil and is retained for further evaluation.

6.2.2.6 <u>Solidification/Stabilization (in-situ)</u>

Solidification/stabilization (S/S) reduces the mobility of hazardous substances and contaminants in the environment through both physical and chemical means. Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).

Auger/caisson and reagent/injector systems are techniques where S/S agents can be added to soils to trap or immobilize contaminants. These systems have limited effectiveness for SVOCs and limited or no effectiveness for VOCs.

In situ vitrification (ISV) is another in situ S/S process that uses an electric current to heat soil or other earthen materials to extremely high temperatures. Inorganic pollutants are immobilized within the resulting vitrified / crystalline mass. The vitrification product is a chemically stable, leach-resistant, glass and crystalline material similar to obsidian or basalt rock. The ISV process destroys and/or removes organic materials. Vapors and combustion products need to be captured and treated to remove particulates and other pollutants from the off gasses. In addition to the high energy consumption, ISV may result in a decrease in soil volume and the solidified material may hinder future Site use.

Based on the discussions above, S/S is not retained for further evaluation.

6.2.3 In Situ Thermal Treatment

6.2.3.1 Thermal Treatment

Steam/hot air injection or heating via electrical resistance, fiber optics, radio frequency, or other means can be utilized to increase the volatilization rate of VOCs and SVOCs and facilitate extraction. The process is otherwise similar to conventional SVE but requires heat resistant extraction wells.

Thermal treatment heats soil to enhance SVE in the followings ways: VOC and SVOC volatility are increased by heating; the soil permeability is increased by drying; water vapor converted to steam can facilitate stripping of volatile contaminants in the overburden; and heating may cause a decrease in contaminant viscosity which improves contaminant mobility.

Hot air or steam can be injected below the contaminated zone to heat the impacted soils and release contaminants from the soil matrix, where they are collected and transferred to the surface through SVE. Extracted vapor can then be treated by a variety of existing technologies (i.e., granular activated carbon).

Thermal treatment is not effective in treating inorganics. Subsurface utilities, fill materials, and debris may inhibit the implementation of this technology. These technologies are relatively higher in cost without offering greater implementability and effectiveness in relation to other alternatives and have therefore been screened out from further evaluation.

6.2.4 Ex Situ Biological Treatment

These ex-situ treatment technologies assume the excavation of impacted soils at the Site.

6.2.4.1 Biopiles

Biopiles include the controlled staging of excavated soils and mixing with soil amendments to enhance contaminant reduction. The biopiles are typically placed on a designated treatment area that includes a leachate collection system and a form of aeration to address VOCs and SVOCs. The treatment area will generally be covered or contained with an impermeable liner to minimize the risk of contaminants leaching into uncontaminated soil.

Biopiles have limited effectiveness in treating inorganics. Implementation of the biopile technology requires a portion of the Site to be dedicated (moderate to long-term timeframe) to the treatment and monitoring of excavated soils. Based on the commercial use of the Site and relatively limited area available, biopiles do not appear to be compatible for the Site. Therefore, biopile technology has been screen out and will not be evaluated further.

6.2.4.2 <u>Composting</u>

For the composting technology, contaminated soil is excavated and mixed with bulking agents and organic amendments such as wood chips, hay, manure, and vegetative (e.g., potato) wastes. Composting is a controlled biological process by which organic contaminants (e.g., VOCs, PAHs) are converted by microorganisms (under aerobic and anaerobic conditions) to innocuous, stabilized byproducts.

Factors that limit the applicability and effectiveness of composting include: off-gas control may be required for VOC and SVOC contamination; inorganics will not be degraded; a volumetric increase in material results because of the addition of amendment material; end products must be handled (spreading or disposed of); and substantial dedicated space may be required. Based on these limitations, composting has been screened out and will not be evaluated further.

6.2.4.3 Landfarming

With this technology, contaminated soil is excavated, applied into lined beds, and periodically turned over or tilled to aerate the waste. Landfarming is a full-scale bioremediation technology, which usually incorporates liners / drainage systems and other methods to control leaching of contaminants from the excavated soils.

Soil conditions in the beds are typically controlled and monitored to optimize the rate of contaminant degradation. Conditions requiring monitoring and control include:

- Moisture content (usually by irrigation or spraying).
- Aeration rate (by routinely tilling the soil within a predetermined frequency; the soil is mixed and aerated).
- pH (buffered to keep near neutral, by adding crushed limestone or agricultural lime).
- Other amendments (e.g., soil bulking agents, nutrients, etc.).

Contaminated media is usually treated in lifts that are up to 18 inches thick. When the desired level of treatment is achieved, the lift is removed and a new lift is constructed. It may be desirable to only remove the top of the remediated lift, and then construct the new lift by adding more contaminated media to the remaining material and mixing. This serves to inoculate the freshly added material with an actively degrading microbial culture, and can reduce treatment times.

Factors that may limit the applicability and effectiveness of the process include:

- A large amount of dedicated space is required.
- Conditions affecting biological degradation of contaminants (e.g., temperature, rain fall) are largely uncontrolled, which increases the length of time to complete remediation.
- Inorganic contaminants will not be biodegraded.
- Volatile contaminants, such as solvents and product-saturated soils may require pretreatment before landfarming.
- Dust control is an important consideration, especially during tilling and other material handling operations.
- Runoff collection facilities must be constructed and monitored.
- Topography, erosion, climate, soil stratigraphy, and permeability of the soil at the Site must be evaluated to determine the optimum design of facility.
- Waste constituents may be subject to "land-ban" regulation and thus may not be applied to soil for treatment by landfarming (e.g., some petroleum-saturated soils).

Based on these limitations, landfarming has been screened out and will not be evaluated further.

6.2.4.4 <u>Slurry Phase Biological Treatment</u>

An aqueous slurry is created by combining soil, sediment, or sludge with water and other additives. The excavated soil is first processed to physically separate debris, stones, and rubble. The soil is then mixed with water to form a slurry. The solids are maintained in suspension in a

reactor vessel and mixed with nutrients and oxygen. When biodegradation is complete, the soil slurry is dewatered.

Slurry phase biological treatment is not effective for treatment of metals and VOCs, requires screening soils prior to treatment, and is potential cost-intensive due to dewatering of fines after treatment. For these reasons, slurry phase biological treatment is not retained for further evaluation.

6.2.5 Ex Situ Physical/Chemical Treatment

These ex-situ treatment technologies assume the excavation of impacted soils at the Site.

6.2.5.1 <u>Chemical Extraction</u>

For the chemical extraction technology, contaminated soils are mixed in an extractor vessel, thereby dissolving the contaminants. The extracted solution is then placed in a separator unit, where the contaminants and extractant are separated for treatment / potential reuse as fill material. Chemical extraction does not destroy wastes but is a means of separating hazardous contaminants from soils, sludges, and sediments, thereby reducing the volume of the hazardous waste that must be treated.

Limitations of the technology include: traces of solvent may remain in the treated solids; the technology may not be effective on higher molecular weight organic and/or very hydrophilic substances; after acid extraction, any residual acid in the treated soil may require neutralization; and achieving stringent SCOs may prove uneconomical. Preliminary separation processes may also be required before chemical extraction to grade the soil into coarse and fine fractions. Based on these limitations, chemical extraction has been screened out and will not be evaluated further.

6.2.5.2 Chemical Reduction/Oxidation

Reduction/oxidation chemically converts soil contaminants to less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide.

This technology has limited effectiveness in treating organic contaminants and has a relative higher cost compared to other technologies without offering greater implementability or effectiveness. In addition, the technology requires handling and administering of large quantities of hazardous oxidizing chemicals. Therefore, this technology is not retained for further analysis.

6.2.5.3 <u>Dehalogenation</u>

In this technology, halogen contaminated soil (i.e., chlorinated VOCs) is excavated, screened, and processed with a crusher and pug mill, and mixed with reagents. The dehalogenation process is achieved by either the replacement of the halogen molecules or the decomposition and partial volatilization of the contaminants. The target contaminant groups for dehalogenation treatment are halogenated VOCs /SVOCs and pesticides. The technology may be viable for the Site; however, it may be less effective against selected halogenated VOCs and will generally be more expensive than other technologies. This technology is not retained for further evaluation.

6.2.5.4 <u>Separation</u>

Separation techniques concentrate contaminated solids through physical and chemical means.

The separation processes are used for removing/reducing contaminants in soils. Ex situ separation can be performed by many processes including gravity separation, sieving/physical separation, and magnetic separation. Physical separation often precedes chemical extraction treatment based on the assumption that most of the contamination is bound to finer soil particles (thus, separation will not readily address the fine fraction of impacted soil on its own). Due to heterogeneous soils at the site and increased logistical requirements (including continual on-site monitoring of the separation process), this technology has been screened out and will not be retained for further evaluation.

6.2.5.5 Soil Washing

Soil washing is a water-based process for scrubbing soils ex situ to remove contaminants. Contaminants sorbed onto fine soil particles are separated from bulk soil in an aqueous-based system on the basis of particle size. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organics and inorganics. The process removes contaminants from soils in one of the following two ways:

- By dissolving or suspending them in the wash solution (which can be sustained by chemical manipulation of pH for a period of time); or
- By concentrating them into a smaller volume of soil through particle size separation, gravity separation, and attrition scrubbing (similar to those techniques used in sand and gravel operations).

Complex waste mixtures (e.g., metals with organics) can make formulating the washing fluid difficult. Sequential washing, and applying various wash formulations and/or different soil-to-wash fluid ratios may be required for heterogeneous contaminant compositions (as exist at the Site). Additional treatment may be required to address the waste wash waters. The technology is generally less effective and is higher in cost relative to other technologies. This technology has been screened out and is thus not retained for further evaluation.

6.2.5.6 Solidification/Stabilization (ex-situ)

With ex-situ soil solidification / stabilization, soil contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization). Ex situ S/S, typically requires disposal of the resultant materials.

Nine distinct innovative processes or groups of processes have been identified for this ex-situ technology: (1) bituminization, (2) emulsified asphalt, (3) modified sulfur cement, (4) extrusion, (5) pozzolan/Portland cement, (6) radioactive waste solidification, (7) sludge stabilization, (8) soluble phosphates, and (9) vitrification/molten glass.

Factors that may limit the applicability and effectiveness of the process include: soil geology and contaminant conditions may affect the long-term immobilization of contaminants; processes may result in a significant increase in volume (up to double the original volume); and organics are generally not immobilized. As with in-situ S/S, this technology is not retained for further evaluation.

6.2.6 Ex-Situ Thermal Treatment

These ex-situ treatment technologies assume the excavation of impacted soils at the Site.

6.2.6.1 Hot Gas Decontamination

This process involves staging the impacted soil in a dedicated vessel and raising the temperature of the contaminated material for a specified period of time. The gas effluent from the material is treated in an afterburner system to destroy all volatilized contaminants. This is not a proven / highly demonstrated technology for VOCs, SVOCs, or metals. Therefore, this technology is not evaluated further.

6.2.6.2 <u>Incineration</u>

For this technology, excavated soil is transported off-site for incineration. High temperatures, 870 - 1,200 °C (1,600- 2,200 °F), are used to combust (in the presence of oxygen) organic constituents in the affected media. Often, auxiliary fuels are employed to initiate and sustain combustion. Off gases and combustion residuals generally require treatment.

Incineration is generally used for hazardous wastes, and logistics associated with coordinating with an incineration facility may be difficult for the Site soils. Therefore, this technology is not evaluated further.

6.2.6.3 Pyrolysis

With pyrolysis, chemical decomposition is induced in organic materials by heat in the absence of oxygen. Organic materials are transformed into gaseous components and a solid residue ("coke") containing fixed carbon and ash. Pyrolysis of organic materials produces combustible gases, including carbon monoxide, hydrogen, methane, and other hydrocarbons. The pyrolysis gases typically will require further treatment. Particulate removal equipment such as fabric filters or wet scrubbers are also required.

Pyrolysis is generally not effective for treating inorganics or VOCs. Therefore, pyrolysis is not retained for further evaluation.

6.2.6.4 <u>Thermal Desorption</u>

Thermal desorption is a physical separation process where excavated soils are heated to volatilize water/moisture and organic contaminants. A carrier gas or vacuum system transports volatilized water and organics to an off-gas treatment system. All thermal desorption systems require treatment of the off-gas to remove particulates and vapor phase contaminants. Particulates are removed by conventional equipment, such as wet scrubbers or fabric filters. Contaminants are removed through condensation followed by carbon adsorption, or they are destroyed in a secondary combustion chamber or a catalytic oxidizer.

Thermal desorption is not effective in removing inorganic contaminants. Due to the relative complexity of this treatment technology, thermal desorption is not retained for further evaluation.

6.2.6.5 Containment

The in-place containment of contaminated soils may be accomplished through capping or surface sealing. These containment technologies would mitigate stormwater infiltration to contaminated areas, thereby reducing a mechanism for contaminant migration from soil to groundwater or surface water. These technologies are effective at minimizing human exposures to impacted soils and other media.

6.2.6.6 <u>Capping</u>

Capping is one of the most common forma of remediation because it is generally less expensive and more easily implemented than other technologies, and it effectively manages human and ecological risks associated with a contaminated site. Land caps can be used to:

- Minimize direct contact with contaminated soils;
- Minimize vertical infiltration of water into subsurface wastes/contaminated zones that may result in migration of soil contaminants;
- Control vapor emissions from underlying contamination;
- Create a land surface that can support vegetation and/or be implemented into existing or future Site uses.

Capping does not lessen toxicity, mobility, or volume of hazardous wastes, but does mitigate migration. Capping systems are most effective where most of the underlying contaminated soil is above the water table. The technology requires long-term inspection and maintenance.

The design of capping systems is Site-specific and depends on the intended functions of the system / contemplated Site uses. Caps can be designed to be permeable (i.e., water from rain / snow melt is allowed to percolate through the cap and into the soil column) or impermeable (i.e., surface water runoff occurs, diverting water away and minimizing [or eliminating] the passage of waters through contaminated soil).

Impermeable or semi-permeable capping systems can range from a one-layer system of vegetated soil to a complex multi-layer system of soils and geosynthetics. Construction of a vegetated cap or a cap that does not approximate the existing Site topography will likely interfere with the current and anticipated future Site activities (commercial uses). Excavation / grading of existing surficial and shallow soils would be required to facilitate construction of a multilayer clay/soil and/or soil - geosynthetic capping system. Therefore, multilayer soil caps are not considered further.

Typically, the most effective single-layer caps are composed of concrete or bituminous asphalt. These materials are constructed to form a surface barrier between soil contamination and the above-grade environment. An asphalt or concrete cap could be used as a parking lot for the existing Site operations. Impermeable and low permeability caps are retained for further evaluation for the Site.

6.2.6.7 Cap Enhancements

The purpose of land cover enhancement is to reduce or eliminate contaminant migration (e.g., percolation). Water harvesting and vegetative cover are two means of cover enhancements. Water harvesting uses runoff enhancement systems to manage a site's water balance (often at large solid waste landfill facilities, but not typically at contaminated properties such as the subject Site). Vegetative cover reduces soil moisture via plant uptake and evapotranspiration. Cap enhancement technology is not practicable or readily implementable at a commercial use property and therefore is not retained for further analysis.

6.2.7 Other Treatment

6.2.7.1 Excavation

Implementation of the ex situ technologies require excavation of the contaminated soil prior to treatment. Soil excavation may be accomplished using conventional earthmoving equipment. Limitations that may affect the applicability and effectiveness of excavation at a site include: potential generation of fugitive emissions requiring monitoring and suppression; exposure of subsurface contaminants to workers; and depth and composition of the soil requiring excavation. Excavation can be implemented in a relatively short time frame and has no long-term operations and maintenance considerations. Excavation is retained for further evaluation.

6-19

NYSDEC

6.2.7.2 <u>Off-Site Disposal</u>

For off-site disposal, contaminated material is removed and transported to permitted off-site treatment and/or disposal facilities. The applicability and cost-effectiveness of off-site disposal may be limited by the distance from the subject Site to the nearest disposal facility. Also, transportation of impacted soil via truck through populated areas may affect community acceptability. However, reliability in the technology is high. Off-site disposal is retained as a feasible alternative.

6.2.7.3 Adsorption / Vapor-Phase VOC Control

Adsorption process consists of passing contaminated vapor (or liquids) through a sorbent media. Contaminants are adsorbed onto the media, reducing their concentration in the vapor or liquid phase. Adsorption mechanisms are generally categorized as either physical adsorption, chemisorption, or electrostatic adsorption. The most common adsorbent is granulated activated carbon (GAC).

Vapor-phase GAC adsorption is a process used for removing VOCs from vapor / air streams resulting from treatment such as SVE. When the concentrations of VOCs in the effluent exceed a certain level, the carbon can be regenerated in place; removed and regenerated at an off-site facility; or removed and disposed.

Adsorption is a viable technology if extraction of contaminated vapors is selected as a remedy for the site soils. Adsorption via GAC is retained for further analysis. Oxidation and alternate adsorption processes used in conjunction with GAC will be considered to address potential vinyl chloride in vapor / air streams resulting from on-site treatment (i.e., SVE). Alternate technologies (such as catalytic oxidation or organic clay / permanganate) are required in addition to GAC because vinyl chloride is not readily adsorbed onto activated carbon.

6.3 Identification and Screening of Technology for Groundwater

As discussed above, VOCs, SVOCs, and metals have been detected in the groundwater at the Site at concentrations greater than the NYS Class GA standards. The Site has been divided into several areas of concern to facilitate development and evaluation of remedial alternative for the impacted groundwater. A summary of the type of groundwater contamination at the Site is summarized in Table 3.1.

Technologies are grouped by general response action and discussed in detail in the following sections. A summary of the groundwater screening process is provided in Table 6.2.

6.3.1 In Situ Biological Treatment

6.3.1.1 Enhanced Bioremediation

Enhanced bioremediation is a process that attempts to accelerate the natural biodegradation process by introducing nutrients, electron acceptors, and/or competent contaminant-degrading microorganisms to the subsurface.

The rate of bioremediation can be enhanced by increasing the concentration of oxygen (aerobic condition) or adding a carbon substrate (anaerobic condition) to the groundwater. Oxygen enhancement can be achieved by either sparging air below the water table or circulating chemically bound oxygen (i.e., hydrogen peroxide, ORC [oxygen releasing compound]) throughout the contaminated groundwater zone. Oxygen enhancement with air sparging is typically used in conjunction with SVE or bioventing to enhance removal of the volatile component of the subsurface contamination. Under anaerobic conditions, a carbon source (nitrate) is circulated throughout the groundwater contamination zone to enhance bioremediation.

Factors that may limit the applicability and effectiveness of these processes at the Site include: time to remediate plume may take years; heterogeneous or low permeability subsurface environments can present difficulties in delivering reagent throughout entire contamination zone;

air injection may result in vapor generation that can accumulate in buildings; limited degradation of metals/inorganics; limited degradation of chlorinated VOCs, particularly vinyl chloride, under aerobic subsurface conditions; and a vapor collection and treatment system is likely to be required. Based on the rational above, enhanced bioremediation is not retained for further analysis.

6.3.1.2 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) is a process where natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials are allowed to reduce contaminant concentrations to acceptable levels. Regulatory approval of this option usually requires modeling and evaluation of contaminant degradation rates and pathways, and predicting contaminant concentration at potential downgradient receptor points. The primary objective of site modeling is to demonstrate that natural processes of contaminant degradation will reduce contaminant concentrations below regulatory standards or risk-based levels before potential exposure pathways are completed. In addition, long term monitoring must be conducted throughout the process to confirm that degradation is proceeding at rates consistent with meeting cleanup objectives.

If free product exists, it may have to be removed prior to implementing MNA. Under MNA, longer time frames are required to achieve remediation objectives, compared to active remediation. MNA is retained for further evaluation for the Site.

6.3.1.3 Phytoremediation

Phytoremediation is a set of processes that uses plants to remove, transfer, stabilize and destroy organic/inorganic contamination in groundwater. Phytoremediation processes are limited to shallow groundwater and are not implementable given the depth to groundwater and current/anticipated commercial activities at the Site. Therefore, phytoremediation technology is not considered further.

6.3.2 In Situ Physical/Chemical Treatment

6.3.2.1 Air Sparging

Air sparging is an in situ technology in which air is injected through a contaminated aquifer. Injected air traverses horizontally and vertically in channels through the soil column, creating a subsurface "air stripper" that removes contaminants by volatilization. The injected air helps to flush (bubble, or sparge) the contaminants upward into the unsaturated zone where a vapor extraction system is usually implemented (in conjunction with air sparging) to remove the generated vapor phase contamination. Low permeability aquifers may limit the effectiveness of air sparging. Inorganics are not effectively remediated via air sparging. Based on site-specific geology / hydrogeology, as well as its limited effectiveness with addressing inorganics, air sparging is not retained for further evaluation.

6.3.2.2 <u>Bioslurping</u>

Bioslurping combines the two remedial approaches of bioventing and vacuum-enhanced free-product recovery. Bioventing stimulates the aerobic bioremediation of hydrocarbon-contaminated groundwater. Vacuum-enhanced free-product recovery extracts LNAPLs from the capillary fringe and the water table without extracting large quantities of ground water.

Conditions that may limit the applicability and effectiveness of this technology include: bioslurping is less effective in tight (low-permeability) soils; aerobic biodegradation of chlorinated compounds may not be effective; and, collected vapor and/or groundwater generally requires treatment. Based on the Site specific geology/hydrogeology, bioslurping is not retained for further evaluation.

6.3.2.3 Chemical Oxidation

In-situ chemical oxidation (ISCO) chemically converts contaminants to less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, potassium permanganate, hypochlorites, chlorine, and chlorine

dioxide. Newer reagents (i.e., alkaline activated persulfate [AAP]) may also be considered. Matching the oxidant and *in situ* delivery system to the contaminants of concern and the Site conditions is the key to successful implementation and achieving performance goals.

In situ chemical oxidation is a viable remediation technology for mass reduction of organic contaminants in groundwater. Chemical oxidation can have a relatively rapid treatment time, and can be implemented with readily available equipment. Limitations associated with chemical oxidation include: limited effectiveness in treating SVOCs and inorganics; requirements to handle and administer large quantities of hazardous oxidizing chemicals; and naturally occurring organic material in the formation can consume large quantities of oxidant. Chemical oxidation appears to be a viable technology for on-site groundwater contamination, and has been retained for further analysis.

6.3.2.4 Directional Wells

Drilling techniques can be modified to position wells horizontally, or at an angle, to reach contaminants not accessible by direct vertical drilling. Directional drilling may be used to enhance other in-situ or in-well technologies such as groundwater pumping, bioventing, SVE, soil flushing, and in-well air stripping. Based on Site conditions, directional wells do not appear to be an applicable technology. This technology is screened from further evaluation.

6.3.2.5 Dual Phase Extraction

Dual-phase extraction (DPE), also known as multi-phase extraction or vacuum-enhanced extraction is a technology that utilizes a high vacuum system to remove various combinations of contaminated groundwater, separate-phase product (NAPL), and soil vapor from the subsurface. Extracted liquids and vapor are treated and collected for disposal or discharge (where permissible under applicable state regulations).

DPE systems are utilized in low permeability or heterogeneous formations. The vacuum extraction well includes a screened section in the zone crossing contaminated soils and groundwater, removing contaminants from above and below the water table. The system lowers

the water table around the well, exposing more of the impacted formation. Contaminants in the newly exposed vadose zone are then more amenable to vapor extraction. Once above ground, the extracted vapors or liquid-phase organics and ground water are separated and treated. DPE appears to be a viable technology for on-site groundwater contamination, and has been retained for further analysis.

6.3.2.6 Thermal Treatment

In this technology, steam is forced into an aquifer through injection wells to vaporize volatile and semivolatile contaminants. Vaporized components rise to the unsaturated zone where they are removed (i.e., by vacuum extraction) and the off-gases treated. Soil type, contaminant characteristics and concentrations, geology, and hydrogeology significantly impact process effectiveness. Based on the Site geology, thermal treatment is not retained for further evaluation.

6.3.2.7 <u>Hydrofracturing Enhancements</u>

This technology includes the injection of pressurized water through wells to form cracks in low permeability and over-consolidated soils. The cracks are filled with porous media that serve as substrates for bioremediation or to improve groundwater pumping/extraction efficiencies. Fracturing can also promote more uniform delivery of treatment fluids to the subsurface. However, with this technology the potential exists to create numerous pathways leading to the unwanted migration of contaminants (e.g., DNAPLs).

Hydrofracturing could be used to enhance other remedial technologies at the Site. Typical technologies linked with hydrofracturing include soil vapor extraction, in situ bioremediation, and pump-and-treat systems. Based on the available geological data, there is no indication that hydrofracturing would be required to improve the effectiveness of another remedial technology. Therefore, hydrofracturing is screened out and will not be evaluated further.

6.3.2.8 In-Well Air Stripping

With in-well air stripping technology, air is injected into a vertical well that has been screened at two depths. The lower screen is set in the groundwater saturated zone, and the upper screen is in the unsaturated zone. Pressurized air is injected into the well below the water table, aerating the water. The aerated water rises in the well and flows out of the system at the upper screen, inducing localized movement of groundwater into (and up) the well as contaminated groundwater is drawn into the system at the lower screen. VOCs vaporize within the well at the top of the water table, where the air bubbles out of the water. The contaminated vapors accumulating in the wells are collected via vapor extraction contained within the well. Vapor phase treatment typically occurs above grade. The partially treated groundwater is never brought to the surface; it is forced into the unsaturated zone, and the process is repeated as water follows a hydraulic circulation pattern or cell that allows continuous cycling of groundwater. As groundwater circulates through the treatment system *in situ*, and vapor is extracted, contaminant concentrations are gradually reduced.

For effective in-well treatment, the contaminants must be adequately soluble and mobile so they can be transported by the circulating ground water. In general, in-well air strippers are more effective at sites containing high concentrations of dissolved contaminants with high Henry's Law constants. In-well treatment should not be applied to areas containing NAPLs to prevent the possibility of smearing the contaminants. In-well air stripping is not effective for the removal of metals or in aquifers with low permeability. Based on the constraints listed above, in-well air stripping is not retained for further evaluation.

6.3.2.9 Passive/Reactive Treatment Walls

Treatment walls (or, treatment barriers) allow the passage of impacted groundwater while causing the degradation or removal of contaminants. A permeable reactive wall is installed across the flow path of a contaminant plume, allowing the water portion of the plume to passively move through the wall. The contaminants will either be degraded or retained in a concentrated form by the barrier material. The wall could provide permanent containment for relatively benign residues or provide a decreased volume of the more toxic contaminants for subsequent treatment.

Site specific geology and current / anticipated commercial activities would limit the implementation of this technology at the Site. In addition, deeper bedrock groundwater that is impacted (greater than 30 ft bgs) and the logistics involved with constructing a barrier along the gorge would drive the cost of this technology significantly. Therefore, passive/reactive treatment walls are screened out and will not be evaluated further.

6.3.3 Ex Situ Biological Treatment

These ex-situ treatment technologies assume the pumping of impacted groundwater at the Site.

6.3.3.1 <u>Bioreactors</u>

Contaminants in extracted groundwater are put into contact with microorganisms in attached or suspended growth biological reactors. Contaminated groundwater is circulated in suspended media, such as activated sludge, within an aeration basin. In attached systems, such as rotating biological contractors and trickling filters, microorganisms are established on an inert support matrix.

The dilute nature of the contamination (including metals, SVOCs) in on-site groundwater will not likely support an adequate microbial population density; therefore, bioreactors are screened out and will not be evaluated further.

6.3.3.2 Constructed Wetlands

The constructed wetlands-based treatment technology uses natural geochemical and biological processes inherent in an artificial wetland ecosystem to accumulate and fixate / remove metals and other contaminants from influent waters. The wetland technology can utilize filtration or degradation process. Typically, large areas need to be dedicated to establish adequate treatment wetlands. The wetland components also need to be monitored and maintained. Unwanted terrestrial vectors may also be attracted to the Site.

Due to the commercial use of the Site and space limitations, the constructed wetlands technology is screened out and will not be evaluated further.

6.3.4 Ex Situ Physical/Chemical Treatment

These ex-situ treatment technologies assume the pumping of impacted groundwater at the Site.

6.3.4.1 Adsorption

Adsorption process consists of passing contaminated groundwater through a sorbent media. Contaminants are adsorbed onto the media, reducing their concentration in the bulk liquid phase. Adsorption mechanisms are generally categorized as either physical adsorption, chemisorption, or electrostatic adsorption. The most common adsorbent is granulated activated carbon (GAC).

Liquid phase GAC adsorption is a process where ground water is pumped through a series of canisters or columns containing activated carbon to which dissolved organic contaminants adsorb. When the concentration of contaminants in the effluent from the bed exceeds a certain level, the carbon can be regenerated in place; removed and regenerated at an off-site facility; or removed and disposed. Vapor-phase GAC adsorption is a similar process used for removing VOCs from vapor / air streams resulting from treatment such as SVE.

Adsorption is a viable technology if extraction of contaminated groundwater/vapors is selected as a remedy for the site. Adsorption via GAC is retained for further analysis.

6.3.4.2 Vinyl Chloride Control

Oxidation and alternate adsorption processes used in conjunction with GAC will be considered to address potential vinyl chloride in liquid and vapor / air streams resulting from on-site treatment (i.e., SVE, dual-phase extraction). Alternate technologies (such as catalytic oxidation or organic clay / permanganate) are required in addition to GAC because vinyl chloride is not readily adsorbed onto activated carbon.

6.3.4.3 Advanced Oxidation Processes

Advanced oxidation processes including ultraviolet (UV) radiation, ozone, and/or hydrogen peroxide are used to destroy organic contaminants as impacted water is pumped into a treatment vessel. If ozone is used as the oxidizer, an ozone destruction unit(s) may be required to treat offgases from the treatment tank and where ozone gas may accumulate or escape. Advanced oxidation technology is associated with high energy requirements, and this process is generally higher in cost relative to other remedial technologies. Therefore, advanced oxidation process technology is not retained for further analysis.

6.3.4.4 <u>Air Stripping</u>

Air stripping involves the mass transfer of volatile contaminants from water to air. Volatile organics are separated from extracted groundwater by exposing the contaminated water to a flow of air. Air stripping configurations include packed towers, diffused aeration, tray aeration, and spray aeration.

Limitations to the applicability and effectiveness of the air stripping include: potential for inorganic or biological fouling, requiring pretreatment; ineffectiveness for the removal of metals and some SVOCs; relatively high energy demands; and off gases generally require collection and treatment. Due to the reasons listed above, air stripping is screened out and will not be evaluated further.

6.3.4.5 <u>Groundwater Pumping/Pump & Treat</u>

Groundwater pumping consists of pumping groundwater from an aquifer to remove dissolved phase contaminants and/or achieve hydraulic containment of contaminated groundwater to prevent migration. Processes typically evaluated or used in Pump & Treat systems include:

- *Ion Exchange*
- Precipitation/Coagulation/flocculation
- Separation
- Sprinkler Irrigation

Generally, treatment and monitoring of extracted groundwater is required. A multiple treatment train may be required for groundwater with multiple types of contaminants. A groundwater monitoring program is a component of any groundwater extraction system to verify its effectiveness.

Potentially long time periods are required for groundwater pumping to achieve remediation goals. Groundwater pumping may not be effective (or predictable) in aquifers with low hydraulic conductivities or in bedrock regimes as is found on the Site. Operation and maintenance considerations associated with treatment systems may be more extensive than other treatment technologies. For the reasons given, groundwater pumping is eliminated from the screening process.

6.3.5 Containment

6.3.5.1 Physical Barriers

Subsurface physical barriers generally consist of vertically excavated trenches filled with slurry. Physical barriers (or slurry walls) are used to slow groundwater flow and minimize migration of contaminated groundwater and/or provide a hydraulic barrier to enhance groundwater pumping systems. Slurry walls often are used where the waste mass is too large for treatment and where soluble and mobile constituents pose an imminent threat to a sensitive receptor.

Site specific geology and current / anticipated commercial activities would limit the implementation of this technology at the Site. In addition, deeper bedrock groundwater that is impacted (greater than 30 ft bgs) and the logistics involved with constructing a barrier along the gorge wall would drive the cost of this technology significantly. Thus, physical barrier technology is eliminated from further evaluation.

6.3.5.2 <u>Deep Well Injection</u>

Deep well injection is a liquid waste disposal technology that uses injection wells to place treated or untreated liquid waste into geologic formations that have no potential to allow migration of contaminants. Given the Site location and relatively high groundwater flow gradient to the Genesee River, this technology is not applicable for the Site, and is screened out from further evaluation.

6.4 Evaluation of Technologies and Selection of Representative Technologies

6.4.1 Retained Soil Technologies

Twenty seven soil remedial technologies were screened for potential applicability, effectiveness, and implementation at the Site. Technologies that successfully passed the screening process are as follows:

- Chemical Oxidation (ISCO);
- Soil Vapor Extraction (SVE);
- Capping; and
- Excavation / Off-site Disposal.

These technologies are incorporated in the remedial alternatives and further evaluated based on their applicability to Site conditions and effectiveness in meeting the RAOs.

6.4.2 Retained Groundwater Technologies

Twenty-four groundwater remedial technologies were screened for potential applicability, effectiveness, and implementation at the Site. Technologies that successfully passed the technology screening process are as follows:

- Monitored Natural Attenuation;
- Chemical Oxidation (ISCO); and
- Dual Phase Extraction.

These technologies are incorporated in the remedial alternatives and further evaluated based on their applicability to Site conditions and effectiveness in meting the RAOs. Adsorption via granular activated carbon (GAC) will also be described further, as it is a component of the above-listed technologies. Potential technologies to be utilized with GAC for vinyl chloride control (such as catalytic oxidation or organic clay/ permanganate units) will also be considered

7.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

7.1 Alternative Screening and Development

In accordance with NYSDEC's *Draft DER-10 Technical Guidance for Site Investigation and Remediation*, December 25, 2002 and DER-15: *Presumptive /Proven Remedial Technologies for New York State's Remedial Programs*, February 27, 2007, preliminary remedial alternatives for a site are developed by combining the remedial technologies that have successfully passed the screening stage into a range of alternatives.

NYSDEC's *Draft DER-10* requires a No-Action alternative and an alternative that would restore the Site to "pre-disposal conditions". Other alternatives are to be included based on:

- Current, intended, and reasonably anticipated future use of the Site;
- Removal of source areas of contamination; and
- Containment of contamination.

Identified alternatives for treating contaminated media at the Site are screened based on effectiveness, implementability and cost. The goal of the screening process is to reduce the number of alternatives that will be included for subsequent detailed evaluation by identifying those that are most compatible with the conditions of the Site and meet the RAOs. Remedial alternatives that appeared most feasible and appropriate will be retained for detailed evaluation.

7.1.1 Soil Alternative Development

SVOCs and metals were detected in soils at the Site at concentration greater than the commercial use SCOs. The SVOC and metal contamination has not been delineated. The pattern of contamination is widespread and does not appear to be associated with distinct release patterns. Likely, the SVOCs and metals are associated in part with historic fill hat exists at the Site. Based on the previous investigation results, historic fill is present across the entire Site at depths from 2 to 27 feet bgs. Based on the boring logs reviewed from previous investigations (NYSDEC, ERM), a clay layer underlies the historic fill over most of the Site and directly overlays bedrock.

Elevated VOCs were detected in the central portion of the Site base on soil sample analysis, elevated PID readings, and visual and olfactory observations. The VOCs appear to be associated with the former TCE storage tank and former operations of the Site located in former Building C, Building D, and the rail loading/unloading area (west of Building D). Free product was observed in soil from borings located beneath Building D, west of Building D, and the central area of the Site between former Building C and Building A (refer to Figure 3-1).

The soil remedial technologies retained for further analysis include capping, excavation and offsite disposal, SVE, and chemical oxidation. Remedial Alternatives were developed, based on the retained remedial technologies and Site-specific conditions, and are described in the following sections.

7.1.1.1 Alternative 1 - No Action

The "no action" option is included as a basis for comparison with active soil remediation technologies in accordance with Section 4.2 of DER-10. If no remedial action is taken, contaminants already present in the soil will remain in place or continue to impact the underlying groundwater. Contaminants, particularly chlorinated VOCs, may transform to form other compounds over time. In the absence of active soil remediation, any decreases in the contaminant mass will occur as a result of natural attenuation processes.

7.1.1.2 Alternative 2 – Capping

Alternative 2 consists of construction of a capping system over the entire Site to prevent and/or minimize direct contact with the contaminated soils at the Site. The extent of the capping system is based on the presence of metals and SVOCs at levels exceeding SCOs in most parts of the Site. Sampling conducted to date has not identified a surficial contaminant pattern; rather, the elevated levels are likely due to historic fill that was imported to and placed at the Site. A secondary benefit of the capping system is that it will limit percolation of surface water (i.e., stormwater) through subsurface contamination. This will effectively reduce or eliminate the migration of soil contamination in the subsurface.

Conceptually, a capping system would consist of an impermeable asphalt cover (i.e., 6-inches with 4-inch base course and 2-inch top course and underlain by gravel or dense graded aggregate (DGA)), or 12 inches of a low permeability barrier to subsurface contamination. The aerial extent of the cap would extend to the property line to the north, west and south and to the gorge to the east. The cap can be constructed in a relatively short time period (less than 1-year). However, periodic inspection of the cap (to make sure all elements are intact) and routine maintenance (if needed) will be required over the long-term. The cap would extent to the existing building footprints (the building floor will act as a cap). Normal operations (i.e. vehicle parking, equipment staging and storage) can continue over the capping system once it is installed.

Removal of approximately 1-foot of surface soil will be required to install the cap adjacent to existing structures (buildings, curb cuts) to minimize disruption to on-going Site operations. It is anticipated that this soil cut will be placed in other areas of the Site as part of re-grading to occur as part of the remedy. Re-grading of the sub grade is typical prior to the installation of the cap to facilitate stormwater runoff/management. For the purposes of the FS, it is assumed that there will be no significant off-site soil disposal required to install a capping system at the Site. It is possible that new stormwater collection facilities (catchbasins, conveyance piping) will need to be installed due to the low permeability nature of the ground surface resulting from this alternative.

Because soil contamination greater than the unrestricted SCOs will remain at the Site under this alternative, institutional controls (deed restriction, environmental easement, Site management plan) will be required. Deed restrictions are intended to prevent human contact with contaminated media through restrictions or limitations of Site uses. Deed restrictions limit or prohibit certain uses or development of the Site in the event of a property transfer and serve to notify prospective owners of the existence of remaining contamination at the Site.

7.1.1.3 <u>Alternative 3 – Cap and SVE</u>

Alternative 3 consists of a cap as described in Alternative 2, in conjunction with the installation of a soil vapor extraction (SVE) system to provide in-situ remediation of VOCs in soil. Based on limited pilot testing performed at the Site by ERM, the capping system may improve the effectiveness of the SVE system by minimizing short circuiting of air flow from the ground surface.

The SVE system would be sized to maintain a vacuum over areas of the Site where elevated VOCs and/or PID readings have been recorded. Conceptually, the system would consist of up to four (4) extraction wells and twenty (20) monitoring points. Subsurface piping would connect the wells to a centrally located blower/treatment system. Vacuum would be generated by a regenerative type blower, and collected vapor would by treated via GAC units. The collected vapor may also be passed through a second unit for treatment of vinyl chloride (e.g., via catalytic oxidation or organic clay/permanganate units) if needed. The blower/treatment system can be housed in a 10 by 10-foot shed.

The time for remediation of VOCs by SVE is estimated at 5 years based on a review of Site contaminant levels and geology. Replacement of the GAC will be required several times during this time frame (depending on actual mass removal rates achieved). An air permit will likely be required but is dependent on the mass of the contaminants in the effluent air stream.

Because soil contamination greater than the unrestricted SCOs will remain at the Site under this alternative, institutional controls (deed restriction, environmental easement, Site management plan) will be required. Deed restrictions are intended to prevent human contact with contaminated media through restrictions or limitations of Site uses. Deed restrictions limit or prohibit certain uses or development of the Site in the event of a property transfer and serve to notify prospective owners of the existence of remaining contamination at the Site.

7.1.1.4 <u>Alternative 4 – Cap and Chemical Oxidation</u>

Alternative 4 consists of a capping system as described in Alternative 2 in conjunction with chemical oxidation for the in-situ remediation of VOCs in soil. Chemical oxidation would consist of the injection of liquid reagent/chemical (i.e., peroxide (H2O2) or permanganate (KMnO4)) into the subsurface to rapidly degrade the organic contaminants. The actual chemical utilized would be based on bench-scale tests.

Conceptually, the injection of the selected reagent/chemical would be via the advancement of approximately 25 temporary well points spaced throughout the VOC impacted area (Figure 3-2). The time for remediation may be relatively short, on the order of weeks. Monitoring will occur subsequent to chemical oxidation events to confirm that VOC concentrations are being effectively reduced. Based on the monitoring, additional chemical oxidation events may be required.

Because soil contamination greater than the unrestricted SCOs will remain at the Site under this alternative, institutional controls (deed restriction, environmental easement, Site management plan) will be required. Deed restrictions are intended to prevent human contact with contaminated media through restrictions or limitations of Site uses. Deed restrictions limit or prohibit certain uses or development of the Site in the event of a property transfer and serve to notify prospective owners of the existence of remaining contamination at the Site.

7.1.1.5 Alternative 5 – Cap, SVE and Product Collection

Alternative 5 consists of a capping system as described in Alternative 2, a SVE system as described in Alternative 3, and a product collection system to address the free product observed in the soil at the Site.

The free product collection system would consist of approximately four recovery wells (8-12 inch diameter) located in the area of the Site where free product was observed in overburden soil (refer to Figure 3-2). Low flow pumps placed within the recovery wells would pump product that collects in the well to a container (55-gallon drum) for temporary storage prior to off-site disposal.

The time for remediation of the free product is relatively long and may extend beyond 5 years. A dedicated storage area for collected product will be required. The rate and volume of the product recovery is dependent of the type and amount of product present in the soil. The collection system may not be effective if the free product cannot flow through the soil matrix to the collection wells. The benefits of the collection of mobile free product include the reduction or elimination of the migration of free product to groundwater.

Because soil contamination greater than the unrestricted SCOs will remain at the Site under this alternative, institutional controls (deed restriction, environmental easement, Site management plan) will be required. Deed restrictions are intended to prevent human contact with contaminated media through restrictions or limitations of Site uses. Deed restrictions limit or prohibit certain uses or development of the Site in the event of a property transfer and serve to notify prospective owners of the existence of remaining contamination at the Site.

7.1.1.6 Alternative 6 – Cap, SVE and Product Excavation

Alternative 6 consists of a capping system as described in Alternative 2, a SVE system similar to that described in Alternative 3, and excavation of soil containing free product observed at the Site.

This alternative assumes excavations in AOC 3, AOC 4, AOC 6 and AOC 7 to remove the free product containing soil at the Site (total 2,900 cy assumed for excavation in this remedy; refer to Table 3-1).

The time to complete the remediation of the free product is relatively short (less than 1-year). Implementation of this alternative would involve disruption of the central portion of the Site for up to 6-months making it unavailable for current commercial uses.

Excavated soil would be appropriately characterized and transported to an approved off-site facility (landfill) for disposal. Removal of the soil containing free product will also remove a large portion of the soil impacted with VOCs. As a result, a smaller SVE system (with shorter remediation timeframe) may be required compared to the one described under Alternative 3 to treat the remaining VOC impacted soil.

Because soil contamination greater than the unrestricted SCOs will remain at the Site under this alternative, institutional controls (deed restriction, environmental easement, Site management plan) will be required. Deed restrictions are intended to prevent human contact with contaminated media through restrictions or limitations of Site uses. Deed restrictions limit or prohibit certain uses or development of the Site in the event of a property transfer and serve to notify prospective owners of the existence of remaining contamination at the Site.

7.1.1.7 Alternative 7 – Cap and Product and VOC Soil Excavation

Alternative 6 consists of excavating soil containing free product and/or VOC contamination greater than the commercial use SCO, and constructing a capping system on the remaining portions of Site as described in Alternative 2 (it is anticipated that a "non-engineered" cap can be left in place above the soil excavation areas under this scenario, see below).

This alternative assumes excavations in AOC 1, AOC 3, AOC 4, AOC 5, and AOC 7 to remove the VOC and free product containing soil at the Site (total 6,000 cy assumed for excavation in this remedy; refer to Table 3-1)

The time to complete the remediation of the VOC and free product impacted soil is relatively short (less than 1-year). Implementation of this alternative would involve disruption of the central portion of the site for up to 6-months making it unavailable for current commercial uses.

Excavated soil would be appropriately characterized and transported to an approved off-site facility (landfill) for disposal. VOCs and/or free product soil excavation will be backfilled with clean fill/soil. The clean soil will act as a cap for remaining SVOC or metal impacted soil. Therefore, an asphalt or gravel cap would not be required in areas with excavations greater than 2 feet deep and the overall cap footprint could be reduced.

Because soil contamination greater than the unrestricted SCOs will remain at the Site under this alternative, institutional controls (deed restriction, environmental easement, Site management plan) will be required. Deed restrictions are intended to prevent human contact with

contaminated media through restrictions or limitations of Site uses. Deed restrictions limit or prohibit certain uses or development of the Site in the event of a property transfer and serve to notify prospective owners of the existence of remaining contamination at the Site.

7.1.1.8 Alternative 8 – Unrestricted Site Use / Pre-Disposal Conditions

Alternative 8 was developed to provide a scenario to restore the site to "pre-disposal" conditions. For this scenario, excavation of the entire 3.4-acre site to bedrock was assumed, to remedy SCO exceedences found in soil along with historic fill material. Excavation to a depth of approximately 17 ft bgs and sheet piling around the south, west and north property line is assumed. As part of Alternative 8, demolition of on-site buildings and site restoration is also included.

7.1.2 Groundwater Alternative Development

Metals, VOCs, and SVOCs were detected in the on-site groundwater at concentrations greater than the NYSDEC Class GA groundwater standards. There was no continuous groundwater reported in the overburden at the Site. Groundwater flow in the bedrock has been characterized to be in a radial direction towards the gorge with a portion of the groundwater flowing towards the south.

The groundwater remedial technologies retained for further analysis include MNA / long-term monitoring, dual-phase extraction (DPE), and chemical oxidation. Remedial Alternatives were developed, based on the retained remedial technologies and Site-specific conditions, and are described in the following sections. Capping is described as part of three groundwater Alternatives, as installation of a capping system at the Site is expected to reduce migration of subsurface contamination into the groundwater medium at the Site.

7.1.2.1 Alternative 1 – No Action

The "no action" option is included as a basis for comparison with active soil remediation technologies in accordance with Section 4.2 of NYSDEC DER-10. If no remedial action is taken, contaminants already present in the groundwater will remain in place (or possible degrade via natural processes over time). Contaminants, particularly chlorinated VOCs, may transform to form other compounds over time. In the absence of active groundwater remediation, any decreases in the contaminant mass will occur as a result of natural attenuation processes. The "no action" alternative is retained for further evaluation.

7.1.2.2 <u>Alternative 2 – Long Term Monitoring</u>

Alternative 2 consists of the long term monitoring of the groundwater and does not include any active treatment. The groundwater will simply be monitored via wells to track the contaminant migration patterns and concentrations over time. Alternative 2 also includes institutional controls in the form of deed, development, and groundwater use restrictions. These institutional controls will prohibit land use and/or construction on the Site that would expose workers, or the surrounding public, to groundwater contaminants including restrictions on the use of groundwater as a potable or process water source without necessary water quality treatment as determined by NYSDEC.

Alternative 2 assumes that in addition to the existing 10 monitoring wells, an additional 5 groundwater monitoring wells will be installed. The monitoring program will consist of sampling the 15 wells on an annual basis for a period of 30 years. This monitoring program has been assumed in order to allow for cost comparisons among the other alternatives. The need for such a monitoring program may be re-evaluated and possibly discontinued at any time during the 30-yr period. If contaminant levels continue to exceed the remedial action objectives at the end of the 30-yr period, the monitoring program may be extended, or other remedial actions taken.

Because contamination greater than the unrestricted SCOs / groundwater standards will remain at the Site under this alternative, institutional controls (deed restriction, environmental easement, Site management plan) will be required. Deed restrictions are intended to prevent human contact

with contaminated media through restrictions or limitations of Site uses. Deed restrictions limit or prohibit certain uses or development of the Site in the event of a property transfer and serve to notify prospective owners of the existence of remaining contamination at the Site.

7.1.2.3 <u>Alternative 3 – Cap and Long Term Monitoring</u>

Alternative 3 consists of long term monitoring (LTM) as described in Alternative 2 in conjunction with a capping system as described in Soil Alternative 2. A presumed source of groundwater contamination consists of stormwater infiltrating through impacted soils, leaching contamination and recharging the groundwater. A cap will minimize stormwater infiltration into the subsurface, reducing contact with and leaching of contaminants from impacted soils.

Because contamination greater than the unrestricted SCOs / groundwater standards will remain at the Site under this alternative, institutional controls (deed restriction, environmental easement, Site management plan) will be required. Deed restrictions are intended to prevent human contact with contaminated media through restrictions or limitations of Site uses. Deed restrictions limit or prohibit certain uses or development of the Site in the event of a property transfer and serve to notify prospective owners of the existence of remaining contamination at the Site.

7.1.2.4 <u>Alternative 4 – Cap, Dual Phase Extraction, and LTM</u>

Alternative 4 consists of long term monitoring and a capping system as described in Alternative 3, in conjunction with dual phase extraction to address dissolved groundwater contamination and the NAPL detected in MW-1D.

The dual phase extraction system is assumed to consist (conceptually) of five extraction wells connected via underground piping to a treatment shed/building. An approximate 10 by 15 foot building would house the piping, treatment, mechanical equipments, and system controls. The system would include a liquid ring pump to provide a high vacuum to the extraction well points, a knock out tank to separate water/moisture and air flows; a screw pump to transfer water for above-grade treatment; and liquid phase and vapor phase GAC treatment units. Treated effluent

may be stored in an on-site tank for future disposal or discharged to the ground surface (if approved).

A dual phase extraction system may take up to 6-months to dewater the low permeable unit and 2 to 5 years to reduce the contaminant mass below the cleanup objectives. An air permit will likely be required for the vapor treatment system.

The dual phase extraction system can easily be configured to operate as a SVE system.

Because contamination greater than the unrestricted SCOs / groundwater standards will remain at the Site under this alternative, institutional controls (deed restriction, environmental easement, Site management plan) will be required. Deed restrictions are intended to prevent human contact with contaminated media through restrictions or limitations of Site uses. Deed restrictions limit or prohibit certain uses or development of the Site in the event of a property transfer and serve to notify prospective owners of the existence of remaining contamination at the Site.

7.1.2.5 <u>Alternative 5 – Cap, Chemical Oxidation, and LTM</u>

Alternative 5 consists of long term monitoring and a capping system as described in Alternative 3, in conjunction with chemical oxidation for the in-situ remediation of VOCs and the NAPL detected in MW-1D. Chemical oxidation would consist of the injection of a chemical /reagent (i.e., liquid peroxide (H2O2) or permanganate (KMnO4)) into the subsurface to degrade the organic contaminants.

The injection of the reagent would be via the advancement of approximately 10 temporary well points spaced around and down gradient of MW-1D. The time for remediation may be relatively short, on the order of weeks. Monitoring will occur subsequent to chemical oxidation events to confirm that VOC and NAPL concentrations are being effectively reduced. Based on the monitoring, additional chemical oxidation events may be required.

Because contamination greater than the unrestricted SCOs / groundwater standards will remain at the Site under this alternative, institutional controls (deed restriction, environmental easement, Site management plan) will be required. Deed restrictions are intended to prevent human contact with contaminated media through restrictions or limitations of Site uses. Deed restrictions limit or prohibit certain uses or development of the Site in the event of a property transfer and serve to notify prospective owners of the existence of remaining contamination at the Site.

7.1.3 Alternative Screening Process

7.1.3.1 <u>Criteria for Alternative Screening</u>

The Remedial Alternatives identified in the sections above are screened in this section based upon the anticipated future commercial land use, subsurface geologic and hydrogeologic conditions, contaminants present at the Site, the ability of the alternatives to meet the RAO's and the following criteria:

- Effectiveness Each alternative is screened for its effectiveness relative to other alternatives and the ability to achieve the RAOs at the Site.
- Implementability The alternatives are screened for the feasibility of implementing the remedial technology. Technical implementability will be evaluated in relation to existing Site conditions, including the subsurface geology/hydrology and the distribution of contaminants. Remedial alternatives that are difficult to construct and operate, result in potential adverse health and/or environmental impacts, or have reduced effectiveness due to existing conditions will be eliminated.
- Cost Remedial alternatives that are higher in relative cost compared with other alternatives without offering greater implementability and/or effectiveness will be eliminated.

7.1.3.2 Soil Alternative Screening

A summary of the comparative analysis of the identified soil alternatives based on the screening criteria is presented in Table 7-1.

•

Table 7-1
Relative Comparison for Screening of Soil Alternatives

Alternative No.	1	2	3	4	5	6	7	8	
Alternative No Action		Сар	Cap and SVE	Cap and Chemical Oxidation	Cap, SVE and Product Collection	Cap, SVE and Product Excavation	Cap and VOC and Product Excavation	Unrestricted Use/Pre- Disposal Conditions	
Effectiveness	Will not meet any of the RAOs for the site.	Provides direct contact protection from impacted soils. Eliminates surface contaminant migration and dust generation. Reduces, but may not eliminate, the source of groundwater contamination by minimizing groundwater infiltration. Will not eliminate the potential of free product migration.	 Provides direct contact protection from impacted soils. Eliminates surface contaminant migration and dust generation. Reduces, but may not eliminate, the source of groundwater contamination by minimizing groundwater infiltration. Mitigates the potential for inhalation of volatilized contaminants. Reduces the mass of VOCs in soil which may be acting as a source of groundwater contamination. Will not eliminate the potential of free product migration. 	 Provides direct contact protection from impacted soils. Eliminates surface contaminant migration and dust generation. Reduces, but may not eliminate, the source of groundwater contamination by minimizing groundwater infiltration. Reduces the mass of VOCs in soil which may be acting as a source of groundwater contamination. Reduces the potential of free product migration. 	 Provides direct contact protection from impacted soils. Eliminates surface contaminant migration and dust generation. Reduces, but may not eliminate, the source of groundwater contamination by minimizing groundwater infiltration. Mitigates the potential for inhalation of volatilized contaminants. Reduces the mass of VOCs and free product in soil which may be acting as a source of groundwater contamination. Reduces the potential of free product migration. 	 Provides direct contact protection from impacted soils. Eliminates surface contaminant migration and dust generation. Reduces, but may not eliminate, the source of groundwater contamination by minimizing groundwater infiltration. Mitigates the potential for inhalation of volatilized contaminants. Reduces the mass of VOCs in the soil which may be acting as a source of groundwater contamination. Eliminates the potential of free product migration. 	 Provides direct contact protection from impacted soils. Eliminates surface contaminant migration and dust generation. Reduces, but may not eliminate, the source of groundwater contamination by minimizing groundwater infiltration. Eliminates the potential for inhalation of volatilized contaminants. Removes the mass of VOCs in soil which may be acting as a source of groundwater contamination. Eliminates the potential of free product migration. 	Provides direct contact protection from impacted soils. • Eliminates surface contaminant migration and dust generation. • Eliminates a source of groundwater contamination by minimizing groundwater infiltration. • Mitigates the potential for inhalation of volatilized contaminants. • Eliminates the mass of VOCs in the soil which may be acting as a source of groundwater contamination. • Eliminates the potential of free product migration.	
Implementability	Will not meet applicable regulatory guidance or requirements.	Well established technology. Can be constructed with minimal disruption of current site operations.	Well established technologies. Can be constructed with minimal disruption of current site operations. Effectiveness of SVE system may be reduced in low permeability soil.	Soil is relatively heterogeneous and may reduce effectiveness of chemical oxidation. Low permeability soils (i.e., clay that exists over bedrock formation) will reduce dispersion of injected fluids, possibly decreasing contact between reagent and contaminants. Unsaturated soil will require additional volume of chemicals to assure contact with contaminants. High organic content of soils may require additional reagent.	Viscosity and conductivity of free product will affect recovery rates. Time frames for collection of product may be very long.	May cause temporary disruption to the current site operations.	May cause temporary disruption to the current site operations. Excavations may be restricted beneath existing structures.	Will cause disruption to the current site operations. • Buildings will need to be demolished. Extensive clean fill needed for site restoration (dust, traffic concerns). Specialized engineering needed for work along gorge face.	

Table 7-1 (continued) Relative Comparison for Screening of Soil Alternatives

Alternative No.	1	2	3	4	5	6	7	8
Alternative Name	No Action	Сар	Cap and SVE	Cap and Chemical Oxidation	Cap, SVE and Product Collection	Cap, SVE and Product Excavation	Cap and VOC and Product Excavation	Unrestricted Use/Pre- Disposal Conditions
Relative Remediation Time	Greater than 5 years	Less than 1 year	Less than 1 year for cap 3-5 years for SVE	Less than 1 year	 Less than 1 year for cap 3-5 years for SVE Greater than 5 years for product recovery 	 Less than 1 year for cap and excavation 2-4 years for SVE 	Less than 1 year * Assumes impermeable cap is not required over excavation areas.	Likely 1 year or more.
Relative Short Term Costs*	1	2	3	5	4	6	7	8
Relative Long Term Costs*	1	2	5	3	7	6	4	8

^{* -} Relative ranking where 1 is the most favorable (i.e., least amount of expense) and 8 is the least favorable (i.e., greatest amount of expense)

Former Raeco Products Site (#828107)

Based on the comparative analysis Alternative 2 (Capping) will be screened from further analysis for the following reasons:

 Based on the concentrations of VOCs detected in and the elevated PID reading recorded from the soil at the Site, there appears to be a significant potential for volatilization of contaminants. Although a Cap will reduce the migration of subsurface contamination in soil (and groundwater), it will not on its own eliminate or mitigate VOC or NAPL contaminants in the subsurface.

Based on the comparative analysis Alternative 4 (Cap and Chemical Oxidation) will be screened from further analysis for the following reasons:

- Site soils are relatively heterogeneous (presence of fill and debris has been noted) and injection of oxidation chemicals may not be uniform due to preferential flow paths.
- Chemical oxidation will have a reduced effectiveness on contaminants located in soils
 with relatively low permeability. A clay layer overlies the bedrock throughout much
 of the Site. Injection and uniform dispersion of oxidant may be difficult in the clay
 unit.
- Effective treatment of contaminants in unsaturated soils will require higher quantities of oxidizing chemicals.

Based on the comparative analysis Alternatives 5 (Cap, SVE and Product Recovery) will be screened from further analysis for the following reasons:

- Remediation time for product recovery will be relatively long (i.e. greater than 5 years).
- Collection rates may be ineffective based on the product viscosity and or conductivity conditions of the soil.

Soil Alternatives 1, 3, 6, 7 and 8 have been retained for further evaluation.

7.1.3.3 Groundwater Alternative Screening

A summary of the comparative analysis of identified groundwater alternatives based on the screening criteria is presented in Table 7-2.

Table 7-2
Relative Comparison for Screening of Groundwater Alternatives

Alternative No.	1	2	3	4	5
Alternative Name	No Action	Long Term Monitoring (LTM)	- Can and ITM		Cap, LTM and Chemical Oxidation
Effectiveness	Will not meet any of the RAOs for the site.	Will not reduce or limit migration of contaminants. Will not actively reduce the concentration of VOCs in soil or groundwater at the site. Will not actively reduce or remove NAPLs present in the groundwater.	 May reduce off-site migration of contaminants by minimizing infiltration of storm water throughout the site. Will not actively reduce the concentrations of VOCs in groundwater at the site. However, cap may minimize or slow the continuing source of groundwater contamination. A reduction of VOCs concentrations over time may result due to natural attenuation processes. Cap will reduce the potential exposure to or inhalation by the public of volatilized contaminants in the groundwater. Will not actively reduce or remove NAPLs present in the groundwater. 	 May reduce off-site migration of contaminants by minimizing infiltration of storm water throughout the site. DPE will provide localized hydraulic control of source area. Will reduce the concentrations of VOCs in groundwater at the site. Will reduce or prevent the potential exposure to or inhalation by the public of volatilized contaminants in the groundwater. Will recover and remove NAPLs present in the groundwater. 	 May reduce off-site migration of contaminants by minimizing infiltration of storm water throughout the site. Will reduce the concentrations of VOCs in groundwater at the site. However, presence of clay may limit the remedy's effectiveness. Will reduce the potential exposure to or inhalation by the public of volatilized contaminants in the groundwater. Will recover and remove NAPLs present in the groundwater.

Table 7-2 (continued)
Relative Comparison for Screening of Groundwater Alternatives

Alternative No.	1	2	3	4	5	
Alternative Name	No Action	Long Term Monitoring (LTM)	Cap and LTM	Cap, LTM and Dual Phase Extraction (DPE)	Cap, LTM and Chemical Oxidation	
Implementability	Will not meet applicable regulatory guidance or requirements.	 Well established technology. Can be implemented with minimal disruption of current site operations. 	 Well established technologies. Can be implemented with minimal disruption of current site operations. 	Low permeability bedrock and clay are well suited for DPE technology. DPE is often used in conjunction with SVE for VOC soil remediation.	Bedrock fracture flow paths may reduce effectiveness. Low permeability soils and bedrock will reduce dispersion of injected fluids, decreasing contact between reagent and contaminants.	
Relative Remediation Time	Greater than 5 years	• Greater than 10 years (30 years assumed)	 Less than 1 year for cap Greater than 10 years for LTM (30 years for LTM assumed) 	 Less than 1 year for cap Greater than 5 years for LTM 2-5 years for DPE 	 Less than 1 year for cap and chemical oxidation Greater than 5 years for LTM 	
Relative Short Term Costs*	1	2	3	4	5	
Relative Long Term Costs*	1	4	5	3 (assuming < 30 yrs needed for LTM)	2	

^{* -} Relative ranking where 1 is the most favorable (i.e., least amount of expense) and 5 is the least favorable (i.e., greatest amount of expense)

Based on the comparative analysis Alternative 2 (LTM) will be screened from further analysis for the following reasons:

- Will not reduce or limit migration of contaminants in groundwater.
- Will not actively reduce or remove NAPLs present in the groundwater.

Based on the comparative analysis Alternative 5 (Cap, LTM and Chemical Oxidation) will be screened from further analysis for the following reasons:

- Bedrock and clay soils have low permeability. Injection and dispersion of oxidizing compound will be difficult.
- Injection and dispersion may not be uniform due to fracture flow paths in bedrock.

Groundwater Alternatives 1, 3, and 4 have been retained for further evaluation.

7.2 Evaluation of Alternatives

7.2.1 Introduction

This Section presents the detailed evaluation of the remedial alternatives described in Section 8.1. The purpose of the evaluation is to identify the advantages and disadvantages of each alternative as well as key trade-offs among the alternatives. The evaluation was based on criteria established under NYSDEC's *Draft DER-10 Technical Guidance for Site Investigation and Remediation*. The evaluation criteria are as follows:

• Overall protection of human health and the environment: This criterion is an evaluation of the alternative's ability to protect public health and the environment, assessing how risks posed through each existing or potential pathway of exposure are eliminated, reduced or controlled through removal, treatment, engineering controls or institutional controls. The alternative's ability to achieve each of the RAOs is evaluated.

- Compliance with Standards, Criteria and Guidance (SCGs): This criterion evaluates the compliance of the alternative with all identified SCGs. All SCGs for the Site will be listed along with a discussion of whether or not the remedy will achieve compliance.
- Long term effectiveness and permanence: Each alternative is evaluated for its long-term effectiveness after implementation. If wastes or treated residuals remain on-site after the selected remedy has been implemented, the following items are evaluated:
 - o The magnitude of the remaining risks (i.e. will there be any significant threats, exposure pathways, or risks to the community and environment from the remaining wastes or treated residuals?);
 - o The adequacy of the engineering and institutional controls intended to limit the risk:
 - The reliability of these controls, and;
 - o The ability of the remedy to continue to meet RAOs in the future.
- Reduction of toxicity, mobility, or volume of contamination through treatment: The alternative's ability to reduce the toxicity, mobility or volume of Site contamination is evaluated. Preference should be given to remedies that permanently and significantly reduce the toxicity, mobility, or volume of the wastes at the Site.
- Short term impacts and effectiveness: The potential short-term adverse impacts and risks of the remedy upon the community, the workers, and the environment during the construction and/or implementation are evaluated. A discussion of how the identified potential adverse impacts to the community or workers at the Site will be controlled, and the effectiveness of the controls, should be presented. Provide a discussion of engineering controls that will be used to mitigate short term impacts (i.e., dust control measures). The length of time needed to achieve the remedial objectives is also estimated.
- Implementability: The technical and administrative feasibility of implementing each alternative is evaluated for this criterion. Technical feasibility includes the difficulties associated with the construction and the ability to monitor the effectiveness of the remedy. For administrative feasibility, the availability of the necessary personnel and material is evaluated along with potential difficulties in obtaining specific operating approvals, access for construction, etc.
- Cost: This criterion evaluates the estimated capital, operations, maintenance, and monitoring costs for each alternative. Costs are estimated and presented on a present worth basis.
- Community acceptance: The public's comments, concerns and overall perception of the remedy are evaluated in a format that responds to all questions that are raised (i.e. responsiveness summary).

7.2.2 Soil Alternative Evaluation

The five soil alternatives that were identified and pre-screened for evaluation include no action (Alternative 1); cap and SVE (Alternative 3); cap, SVE, and product excavation (Alternative 6); cap and VOC and product excavation (Alternative 7); and excavation / disposal to unrestricted use / pre-disposal conditions (Alternative 8). Carrying at least one alternative capable of achieving unrestricted use into the final evaluation of alternatives is required. An evaluation of each soil alternative against the criteria outlined above was conducted. A summary of the evaluation is provided in Table 7-3.

7.2.2.1 Protection of Human Health and the Environment

Alternative 1 will not meet the RAOs established for the Site. Alternative 8 will effectively restore the site to pre-disposal conditions (and achieve unrestricted use soil cleanup objectives). Give the anticipated future use of the Site, Alternatives 3, 6 and 7 in conjunction with institutional controls, meet the direct contact RAO. Alternative 3 (SVE), 6 (SVE) and 7 (VOC soil excavation) will also likely meet the RAO associated with inhalation of volatilized contamination. Alternative 6, 7, and 8 have a greater probability of meeting the RAO applicable to free product at the Site, due to the removal of product containing soil.

7.2.2.2 Compliance with Standards, Criteria, and Guidance

Alternative 1 will not meet the SCGs established for the Site. Give the anticipated future use of the Site and groundwater use in the area, Alternatives 3, 6, 7, and 8 in conjunction with institutional controls should not result in impacts to groundwater that would present a significant risk to public or private water supply users.

Table 7-3
Evaluation of Soil Alternatives

Alt. No.	Alternative Name No Action	Overall Protection of Human Health and the Environment • Will not meet any of the RAOs for the site.	Compliance with SCGs • Will not meet applicable regulatory guidance or requirements.	Long Term Effectiveness • Contaminants remain in the environment. • Magnitude of remaining risks will be unchanged.	Reduction of Toxicity, mobility or Volume Does not reduce toxicity, mobility or volume of contamination present in the site soils.	Short Term Effectiveness • Does not result in disruption of site operations or pose a short term threat to public health or the environment.	Implementability • No technical or administrative difficulties or constraints.	Capital: O&M: Present Worth:	\$0 \$0/yr \$0
3	Cap and SVE	Provides direct contact protection from impacted soils. Eliminates surface contaminant migration and dust generation. Mitigates the potential for inhalation of volatilized contaminants.	Applicable VOC soil standards may be achieved through SVE remediation. Containment and implementation of institutional controls will meet SCGs for historic fill at site.	SVE will permanently reduce VOC contaminants at the site. Inspection and periodic maintenance of the cap will be required to maintain long term effectiveness.	 Reduces the mass of VOCs in soil by transferring contaminants to the vapor phase and treating. Will not eliminate the potential of free product migration. Reduces, but may not eliminate, source of SVOC and/or metal groundwater contamination by minimizing groundwater infiltration. 	Can be constructed with minimal disruption of current site operations. Will generate noise and traffic during construction. Dust control measures will need to be implemented.	Effectiveness of SVE system may be reduced in low permeability soil.	Capital: O&M: Present Worth:	\$882,025 \$57,400/yr for Year 1-5 \$22,400/yr for Year 6-30 \$30,000/yr for Year 5 \$1,401,405 Est. PW BREAKDOWN of Remedy Elements: CAP: \$875,218 SVE: \$526,187

Table 7-3 (continued) Evaluation of Soil Alternatives

Alt.	Alternative Name	Overall Protection of Human Health and the Environment	Compliance with SCGs	Long Term Effectiveness	Reduction of Toxicity, mobility or Volume	Short Term Effectiveness	Implementability		Cost
6	Cap, SVE and Product Excavation	Provides direct contact protection from impacted soils. Eliminates surface contaminant migration and dust generation. Mitigates the potential for inhalation of volatilized contaminants.	Applicable VOC soil standards may be achieved through SVE remediation. Containment and implementation of institutional controls will meet SCGs for historic fill at site.	SVE will permanently reduce VOC contaminants at the site. Separate phase product will be permanently removed from the site. Inspection and periodic maintenance of the cap will be required to maintain long term effectiveness.	 Reduces the mass of VOCs in soil by transferring contaminants to the vapor phase and treating. Eliminates the potential of free product migration. Reduces, but may not eliminate, source of SVOC and/or metal groundwater contamination by minimizing groundwater infiltration. 	 May cause temporary disruption to the current site operations. Will generate noise and traffic during construction. Dust control measures will need to be implemented. 	Effectiveness of SVE system may be reduced in low permeability soil. Excavations may be restricted beneath existing structures.	Capital: O&M: Present Worth:	\$1,880,875 \$57,400/yr for Year 1-3 \$22,400/yr for Year 4-30 \$30,000/yr for Year 3 \$2,346,446 Est. PW BREAKDOWN of Remedy Elements: CAP: \$835,218 SVE: \$432,379 EXC:\$1,078,850

Table 7-3 (continued) Evaluation of Soil Alternatives

Alt. No.	Alternative Name Cap and VOC and Product Excavation	Overall Protection of Human Health and the Environment Provides direct contact protection from impacted soils. Eliminates surface contaminant migration and dust generation. Eliminates the potential for inhalation of volatilized contaminants.	Compliance with SCGs • Applicable VOC and free product soil cleanup objectives will be achieved through excavation. • Containment and implementation of institutional controls will meet SCGs for historic fill at site.	Long Term Effectiveness VOC and separate phase product will be permanently removed from the site. Inspection and periodic maintenance of the cap will be required to maintain long term effectiveness. Alternative offers the greatest	Reduction of Toxicity, mobility or Volume Permanently removes the mass of VOCs and free product in soil. Eliminates the potential of free product migration. Reduces, but may not eliminate, source of SVOC and/or metal groundwater contamination by minimizing groundwater infiltration.	Short Term Effectiveness • May cause temporary disruption to the current site operations. • Will generate noise and traffic during construction. • Dust control measures will need to be implemented.	Implementability • Excavations may be restricted beneath existing structures.	Capital: O&M: Present Worth:	\$2,517,346 \$22,400/yr \$2,861,688 Est. PW BREAKDOWN of Remedy Elements: CAP: \$830,238 EXC: \$2,031,450
		contaminants.	site.		infiltration.				

Former Raeco Products Site (#828107)

Table 7-3 (continued) Evaluation of Soil Alternatives

Alt.	Alternative Name	Overall Protection of Human Health and the Environment	Compliance with SCGs	Long Term Effectiveness	Reduction of Toxicity, mobility or Volume	Short Term Effectiveness	Implementability	Cost	Alt. No.
8	Unrestricted Site Use/ Pre-Disposal Conditions	Yes	Yes	Yes	Yes	Will cause significant disruption to the current site operations. Will generate noise and traffic during construction. Dust control measures will need to be implemented.	Specialized engineering needed for deep excavation, site restoration, and work along gorge. Demolition required.	Capital: O&M: Present Worth:	\$28,891,200 \$0/yr \$28,891,200

7.2.2.3 Long Term Effectiveness and Permanence

Alternative 1 will result in contaminants remaining in the environment and will have no long term effect on risks. Periodic inspection and maintenance of the cap (Alternatives 3, 6 and 7) will be required to ensure the reliability of the cap and its ability to continue to meet the RAOs. Alternative 7 and 8 will permanently remove NAPLs and VOC contaminated soil and therefore, have the relative greatest long term effectiveness.

7.2.2.4 Reduction of Toxicity, Mobility or Volume with Treatment

Alternative 1 will not reduce toxicity, mobility or volume of groundwater contamination. Alternative 3, 6 and 7, will reduce water infiltration, minimizing contaminants leaching from soils and migrating to groundwater. Alternative 3 and 6 reduce the mass of VOCs in soil by transferring contaminants to the vapor phase and treating ex-situ. Alternative 6 and 7 will permanently remove soil containing product from the Site. In addition, Alternative 7 will permanently remove VOC impacted soils from the Site.

7.2.2.5 Short Term Effectiveness

Alternative 1 and 3 can be implemented with minimal disruption to the Site operations. Alternative 6 and 7 will result in a temporary disruption to the current Site operations. Alternative 3, 6 and 7 will result in greater traffic and noise during construction. Alternative 6 and 7 have a relatively greater exposure risk to workers because contaminants are excavated and handled at the surface prior to off-site disposal.

7.2.2.6 Implementability

All of the alternatives are expected to be technically and administratively feasible. The effectiveness of SVE may be reduced in low permeable soil. Excavations beneath existing structures may require additional shoring and bracing to complete.

7.2.2.7 Cost

Cost evaluation of each alternative includes an estimation of construction/capital costs and operation and maintenance (O&M) costs. Attachment D includes conceptual cost analyses (and assumptions) for the soil alternatives being considered for the site. The costing was based on conceptual remedy assumptions and the information developed for this FS (e.g., AOC areas; site geology; contaminant levels). The costs are presented in present worth basis for comparison purposes. Table 7-3 provides a summary of the remedial costs developed for the soil alternatives. In Table 7-3 and in the analyses provided in Attachment D, the estimated costs of each of the main components of the remedies (e.g., Capping, SVE) are presented. Note that for costing purposes, it was assumed that an asphalt cap would be installed for the remedies that include installation of a capping system.

7.2.2.8 Community Acceptance

The evaluation of this criterion is required following public comment.

7.2.3 Groundwater Alternative Evaluation

The three groundwater alternatives that were identified and pre-screened for further evaluation include no action (Alternative 1); cap and LTM (Alternative 3); and cap, LTM and DPE (Alternative 4). An evaluation of each groundwater alternative against the criteria is outlined in Section 8.2.1. A summary of the evaluation is provided in Table 7-4.

7.2.3.1 Protection of Human Health and the Environment

Alternative 1 will not meet the RAOs established for the Site. Give the anticipated future use of the Site and groundwater use in the area, Alternatives 3 and 4 in conjunction with institutional controls, impacts to groundwater should not present a significant risk to public or private water supply users. Alternative 4 has a greater potential of meeting the Site RAOs due to the active collection and removal of NAPLs in the groundwater.

Table 7-4
Evaluation of Groundwater Alternatives

Alt. No.	Alternative Name No Action	Overall Protection of Human Health and the Environment • Will not meet any of the RAOs for the site.	Compliance with SCGs • Will not meet applicable regulatory guidance or requirements.	Long Term Effectiveness Contaminants remain in the environment. Magnitude of remaining risks will be unchanged.	Reduction of Toxicity, mobility or Volume • Does not reduce toxicity, mobility or volume of contamination present at the site.	Short Term Effectiveness • Does not result in disruption of site operations or pose a short term threat to public health or the environment.	• No technical or administrative difficulties or constraints.	Cost Capital: O&M: Present Worth:	\$0 \$0/yr \$0
3	Cap and LTM	May reduce off-site migration of contaminants by minimizing infiltration of storm water throughout the site. Cap will reduce the potential exposure to or inhalation by the public of volatilized contaminants in the groundwater.	A reduction in infiltration may result in a stabilized plume that does not migrate off-site. A reduction in organic concentrations may result due to natural attenuation processes, although it is not likely that groundwater SCGs will be achieved.	Inspection and periodic maintenance of the cap will be required to maintain long term effectiveness. Monitoring of contamination will result in some reduction of remaining risks.	Will not actively reduce the concentrations of VOCs in groundwater at the site. However, cap may minimize or slow the continuing source of groundwater contamination. A reduction of VOCs concentrations over time may result due to natural attenuation processes.	Can be implemented with minimal disruption of current site operations. Will generate noise and traffic during construction. Dust control measures will need to be implemented.	No technical or administrative difficulties or constraints.	Capital: O&M: Present Worth:	\$685,375 \$85,400/yr for Year 1-2 \$49,400/yr for Year 3-30 \$1,511,713 Est. PW BREAKDOWN of Remedy Elements: CAP: \$967,318 LTM: \$544,395

Table 7-4 (continued) Evaluation of Groundwater Alternatives

Alt.	Alternative Name	Overall Protection of Human Health and the Environment	Compliance with SCGs	Long Term Effectiveness	Reduction of Toxicity, mobility or Volume	Short Term Effectiveness	Implementability	Cost
3	Cap and LTM (Cont.)	Will not actively reduce or remove NAPLs present in the groundwater.			Reduces, but may not eliminate, source of SVOC and/or metal groundwater contamination by minimizing groundwater infiltration.			Cost

Table 7-4 (continued) Evaluation of Groundwater Alternatives

Alt.	Alternative Name	Overall Protection of Human Health and the Environment	Compliance with SCGs	Long Term Effectiveness	Reduction of Toxicity, mobility or Volume	Short Term Effectiveness	Implementability		Cost
4	Cap, Dual Phase Extraction (DPE), and LTM	May reduce off-site migration of contaminants by minimizing infiltration of storm water throughout the site. DPE will provide localized hydraulic control of source area. Will reduce or prevent the potential exposure to or inhalation by the public of volatilized contaminants in the groundwater.	A reduction in infiltration may result in a stabilized plume that does not migrate off-site. Active removal of NAPL will result in a reduction of organic concentrations potentially achieving the groundwater SCGs.	VOC and separate phase product will be permanently removed from the site. Inspection and periodic maintenance of the cap will be required to maintain long term effectiveness. Alternative offers the greatest potential for long term effectiveness by active remediation of groundwater contamination source.	Will reduce the concentrations of VOCs in groundwater at the site. Will recover and remove NAPLs present in the groundwater. Reduces, but may not eliminate, source of SVOC and/or metal groundwater contamination by minimizing groundwater infiltration.	Can be implemented with minimal disruption of current site operations. Will generate noise and traffic during construction. Dust control measures will need to be implemented.	Low permeability bedrock and clay are well suited for DPE technology. DPE is often used in conjunction with SVE for VOC soil remediation.	Capital: O&M: Present Worth:	\$944,425 \$141,400/yr for Year 1-2 \$105,400/yr for Year 3-4 \$49,400/yr for Year 5-30 \$45,000/yr for Year 4 \$2,006.357 Est. PW BREAKDOWN of Remedy Elements: CAP: \$866,068 DPE: \$593,495 LTM: \$546,795

7.2.3.2 Compliance with Standards, Criteria, and Guidance

Alternative 1 will not meet the applicable regulatory guidance. Alternative 3 may result in a stabilized contamination plume that potentially could meet SCGs at the property boundary. Alternative 4 has the relatively greatest potential of meeting the SCG due to NAPLs collection and resulting localized hydraulic control.

7.2.3.3 Long Term Effectiveness and Permanence

Alternative 1 will result in contaminants remaining in the environment and will have no long term effect on risks. Periodic inspection and maintenance of the cap (Alternative 3 and 4) will be required to ensure the reliability of the cap and its ability to continue to meet the RAOs. Alternative 4 will permanently remove NAPLs and VOC contaminated groundwater from the aquifer and therefore has the relative greatest long term effectiveness.

7.2.3.4 Reduction of Toxicity, Mobility or Volume with Treatment

Alternative 1 will not reduce toxicity, mobility or volume of groundwater contamination. Alternative 3 and 4, may reduce the source of groundwater contamination by minimizing water infiltration through contaminated soils prior to recharging the groundwater. Alternative 4 will actively remove NAPLs and contaminated groundwater from the subsurface for treatment and therefore, achieves the greatest relative reduction of toxicity, mobility and volume of groundwater contamination.

7.2.3.5 Short Term Effectiveness

All three alternatives can be implemented with minimal disruption to the Site operations. Alternative 3 and 4 will result in greater traffic and noise during construction. Alternative 4 has a relative greater risk to workers because contaminants are brought to the surface for ex-situ treatment.

7.2.3.6 <u>Implementability</u>

All of the alternatives are expected to be technically and administratively feasible.

7.2.3.7 <u>Cost</u>

Cost evaluation of each alternative includes an estimation of construction/capital costs and operation and maintenance (O&M) costs. Attachment D includes conceptual cost analyses (and assumptions) for the groundwater alternatives being considered for the site. The costing was based on conceptual remedy assumptions and the information developed for this FS (e.g., AOC areas; site geology; contaminant levels). The costs are presented in present worth basis for comparison purposes. Table 7-4 provides a summary of the remedial costs developed for the groundwater alternatives. In Table 7-4 and in the analyses provided in Attachment D, the estimated costs of each of the main components of the remedies (e.g., Capping, DPE) are presented. Note that for costing purposes, it was assumed that an asphalt cap would be installed for the remedies that include installation of a capping system.

7.2.3.8 Community Acceptance

The evaluation of this criterion is required following public comment.

This page intentionally left blank.

8.0 REFERENCES

6 NYCRR Part 375, Environmental Remediation Programs, December 14, 2006.

40 CFR 300.430-National Oil and Hazardous Substances Pollution Contingency Plan

City of Rochester, New York, Online Geographic Information System (GIS), http://www.cityofrocheser.gov/GIS

Environmental Resources Management, .<u>Remedial Investigation Report</u>, February 13, 2007.

NYSDEC, <u>DER-15</u>: <u>Presumptive /Proven Remedial Technologies for New York State's Remedial Programs</u>, February 27, 2007.

NYSDEC, Division of Water Technical and Operational Guidance Series (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations, June 1998. NYSDEC, <u>Draft DER-10 Technical Guidance for Site Investigation and Remediation</u>, December 25, 2002.

NYSDEC <u>Draft DER-10 Technical Guidance For Site Investigation and Remediation</u>, December 2002.

NYSDEC, <u>Preliminary Site Investigation Report, Former Raeco Products Site #828107, City of Rochester</u>, Monroe County, April 2001.

NYSDEC, <u>Selection of Remedial Actions at Inactive Hazardous Waste Sites (TAGM-4030)</u>, May 15, 1990.

NYSDOH, <u>Guidance for Evaluating Soil Vapor Intrusion in the State of New York</u>, October 2006.

USEPA, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, October 1988.

USEPA, Technology Innovation Program, Contaminated Site Clean-up Information, http://cluin.org, February 27, 2008.

This page intentionally left blank.

Appendix A

April 29, 2009 Site Photographs



Corner of Cliff St. and Spencer St., Looking East/Northeast at Site.



Corner of Ambrose St. and Cliff St – Looking South.



Looking East at Site from Cliff Street, MW-4D and MW-4DD in Background.



Looking South at Site Entrance Gate.



Building A – Looking southeast.



North Side of Building B, Looking Over Genesee River.



Looking North at Building D.



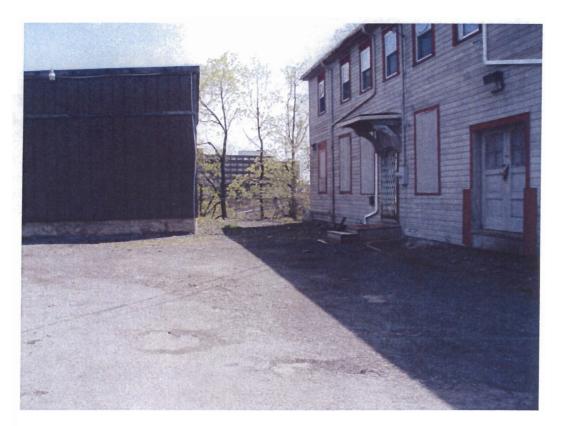
West Side of Building D. Note Surface Staining.



Looking North at Building F.



Looking at Genesee River from Building A Area.



Looking East at North Side of Building A and South Side of Building B.



Looking North/Northeast at Former TCE Tank Location.



Looking North/Northwest at South Side of Building A and Existing Staging Area.



Looking Northwest at TP-3, TP-7 and CSX Right-of-Way From South of Building D.



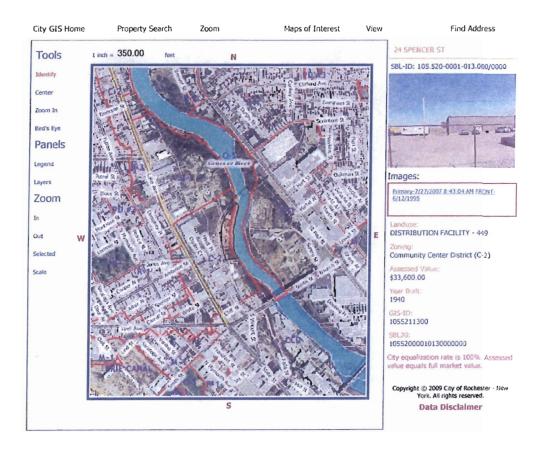
 ${\bf Looking\ Southwest\ Toward\ Southwest\ Corner\ of\ Site\ and\ Cliff\ Street}.$



Existing Heavy Equipment and Surface Stains.

Appendix B

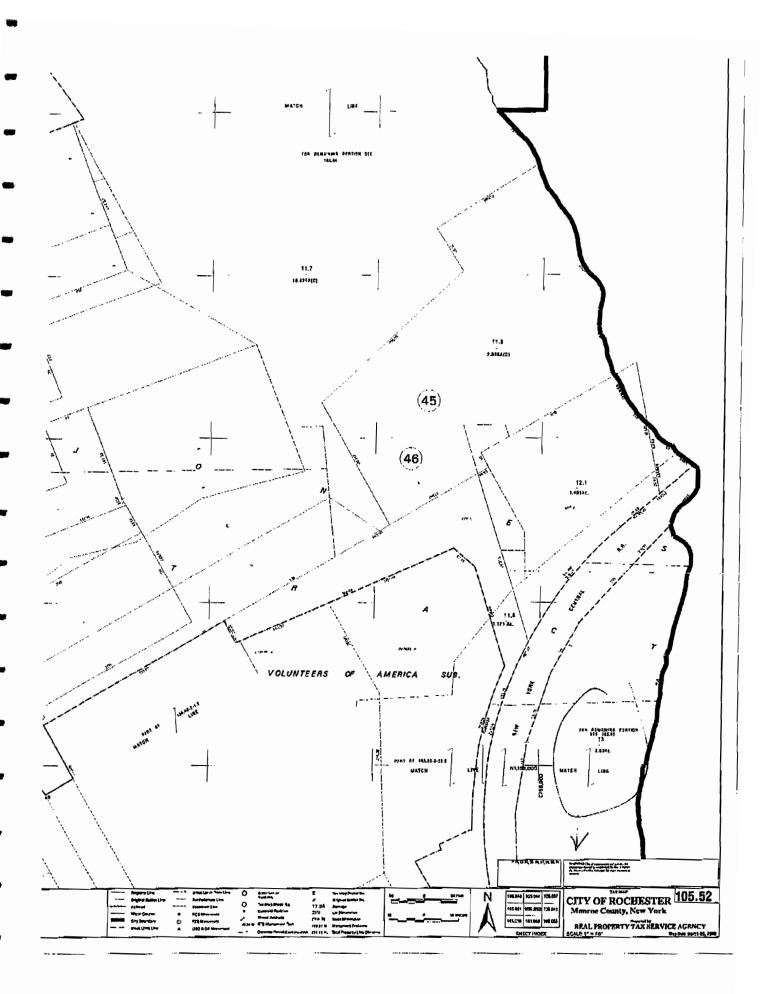
City of Rochester Zoning Information

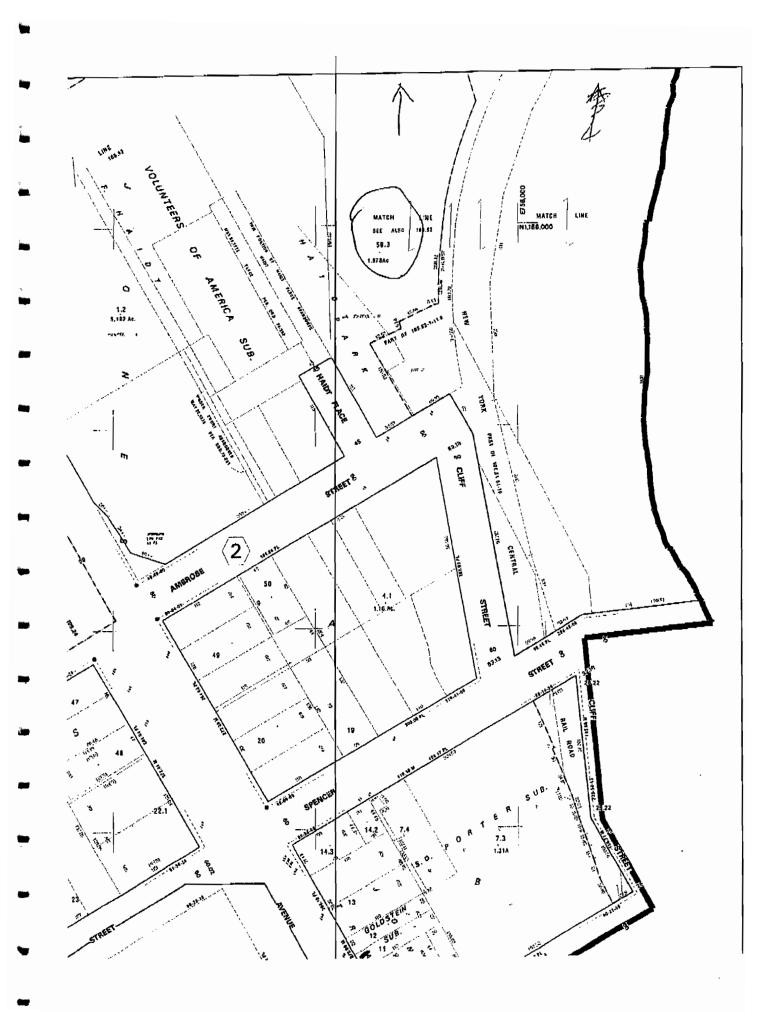




Copyright © 2009 City of Rochester - New York, All rights reserved.

Data Disclaimer





Appendix C

Site Sewer Details

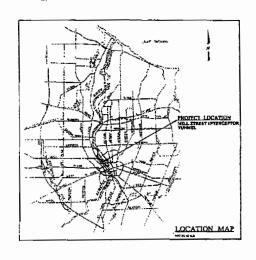
ROCHESTER PURE WATERS DISTRICT MONROE COUNTY, NEW YORK

MILL STREET INTERCEPTOR TUNNEL REHABILITATION

PROJECT NO. 51439

		DRAWINGS
THER MI.	BRANTHO NO.	TIL.
1	COVER	TITLE AND GENERAL LOCATION
2	! 1-1	GENERAL NOTES. ABBREVIATIONS, LEGEND AND ESTIMATE OF QUANTITIES
3	WA-1	Work areas and traffic maintenance
4	MD-1	MISCELLANEOUS DETAILS
5	PJL-1	PLAN AND PROFILE
6	PL-2	PLAN AND PROFILE
7*	SM-SW-15-4*	OVERFLOW DROP LOCATION 15
\$*	SM-SW-27-7 (R)*	OVERFLOW DROP LOCATION 27 (REVISED)

Lyzavets (c.9.3)?



ROBERT L. KING Funct L. Sho'ss
CHAIR BARRING

JOHN E. GRAHAM P.E.
Director, Department of Environmental Services

DOHN N. DAVIS, P.E.
Director, Communication of Environmental Services

Estat/32

Interference Communication of Environmental Services

STV/SEELYE STEVENSON VALUE & KNECHT
ST. PAUL HAS
BY THE PAUL HTS
BY CHARLES TH

SHAWN R BRAY, P.E.

RICHARD J. RICHTER, P.E.

AS BUILT





LIEN NO.	CENCRAFTICH	UNIT	OCCUPANTY.	Division Time
701	ROCK DOWELS	540	1,650	440
70.3	ROCK BOWELS WITH STEEL STRAF	BET		40
703	S HON STEEL KISEN NOWYONDED SHOTCHETE	\$ <i>J</i> .	. 2500	2500
794	SPOUTERS BETWEEN BRIDER CHEEK	LE	₩ E.	100%
PAS	BRICK UMBIT RÉPAIR AT FACTORY STRÉÉT REGILATION	La.	HEC.	11104
108	MENNY BRICH FRIENDSCREEN SLYSCH ITS SENS WHO PIS SLYFF	LX	MEC.	1625
1191	TEMPORARY CHASH LINK FENCING	U.		525.7
1235	CLEARING, SCALING AND REDGEAL OF TOWNER DISCUSS	You	490	16335
1531	MANNEY AND PROTECTION OF TRUFFC	LS.	MCC	100%
1991	PLOW DIVERSION AT PROPET THESE MEGILATOR	us	MEC	100%
1201	CO-STATANT'S PRID OFFICE	wo.		,

	1	<u> </u>
ADD/DEDUCT ITEMS		
	.—	1
TTIL DESCRIPTION	Urer	QUENTITY
RISA ROCK DONYELS	ZACH	
2024 FOCK DOWELS WITH STEEL STREET	357	
TOCK CRIMENT POR GROWTING	1 845	440

ADD ALTERNATE ND. 1 окаслеттон

GENERAL NOTES:

- t. HE THAN AMEND OF SCHOOL OF "A MARKET AN OWNERS TO THE HOP AND FOR THE THE COTTACTORS CONTROL OF MALE PARKET OF THE THE OWNERS OF THE PARKET OF THE OWNERS OF THE PARKET OF THE OWNERS OF THE PARKET OF THE OWNERS OWNERS OF THE OWNERS OWNERS OF THE OWNERS

- 4. PRINCIPLE DALL IN COMPLET IN MARK MICH. "LAST CARRESTED WAS CIRCLE IN THE HEIGHT OF LIGHT MY CONTINUE OF THE PROPERTY.

- The Target Stationary Comp & . A wind and Challed and adding the and the end in

•			,
4	ADDENDUM NO. 1	in (H	9/92
			-
_			
_			
_			
_			
_			
		-	_



MONROE COUNTY, NEW YORK

ROBERT L. KING

Change Excesive

WIT/SERLER STEVENSON VALUE & MWECHT



MILL STREET INTERCEPTOR TUNNEL REHABILITATION

" GENERAL NOTES, ABBREVIATIONS, LEGEND, AND ESTIMATE OF QUANTIES

T.E.A. I — |

orresta or B. J. R. SHEET 2 OF 8

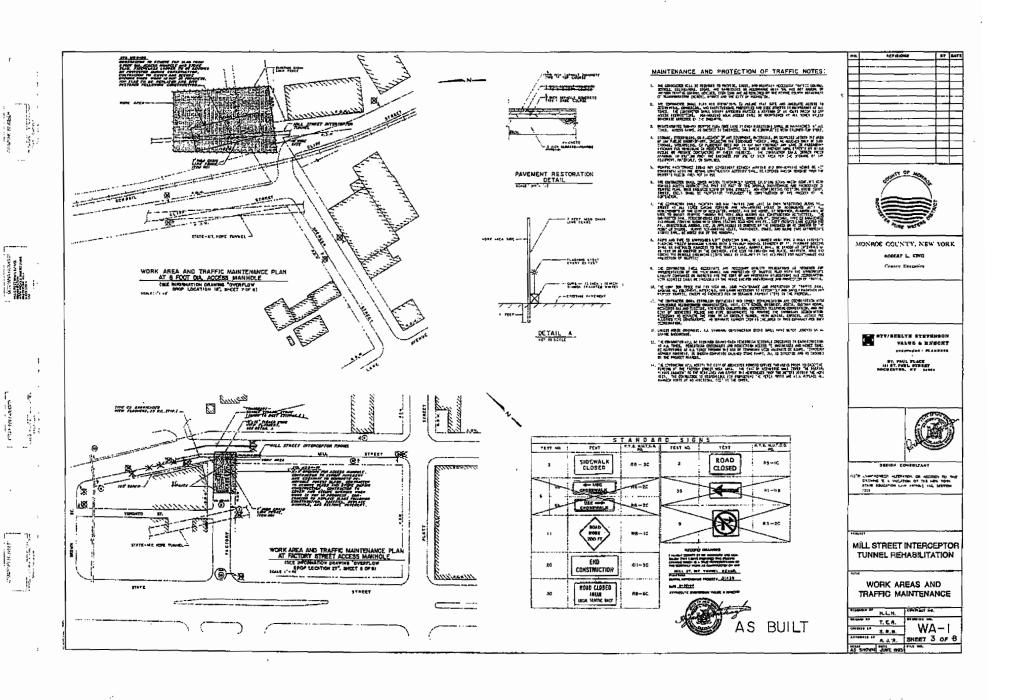
Krass NONE SCHE 1933 I'll 48. T.E A.

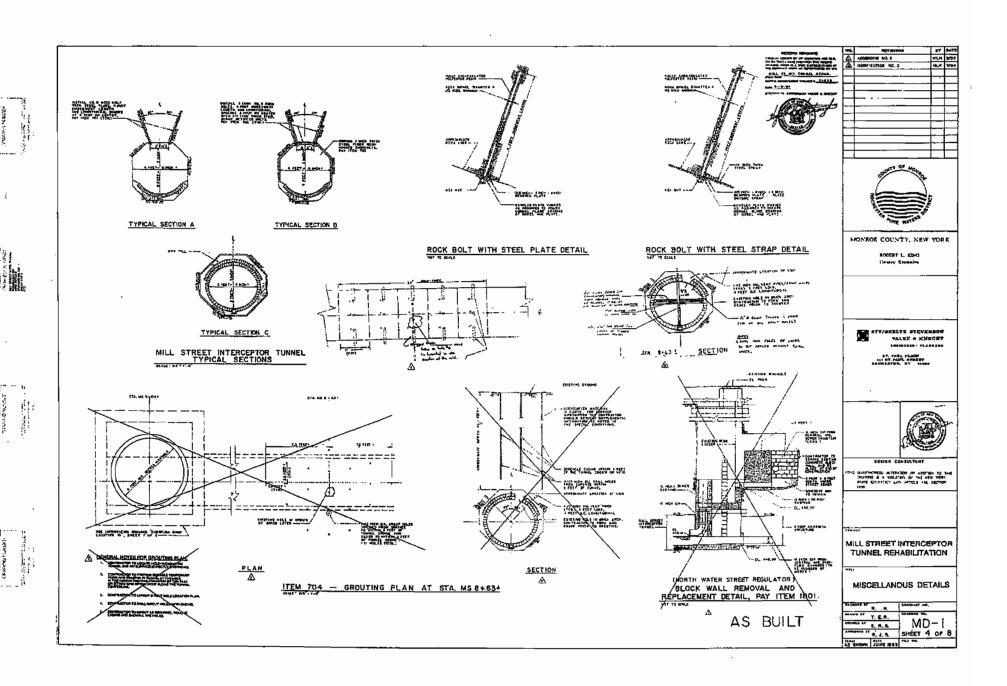
P- H-74

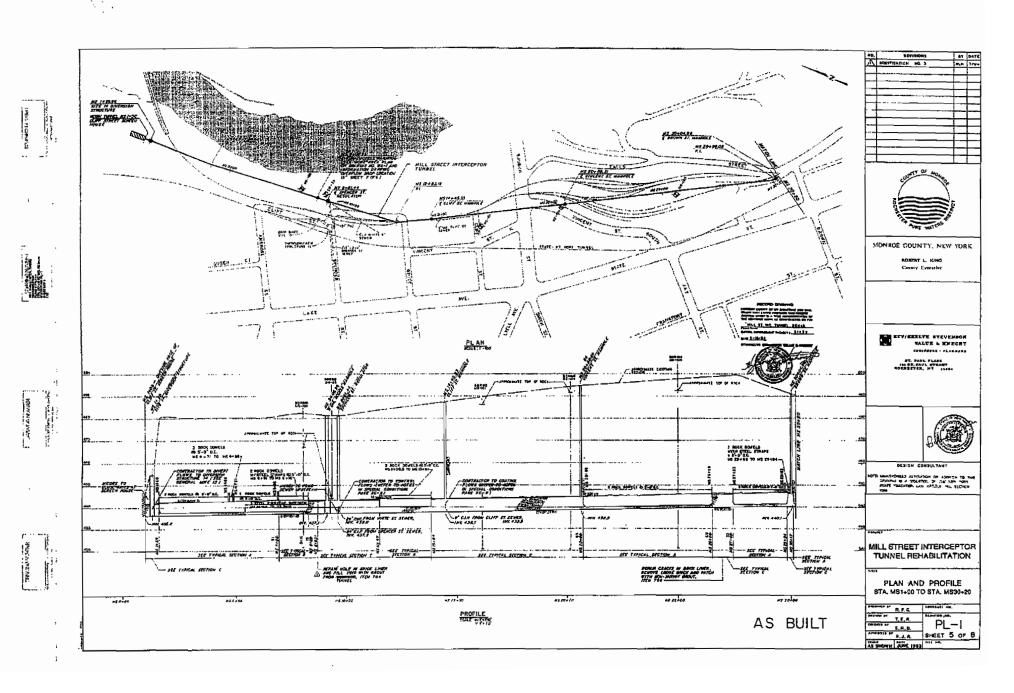
AS BUILT

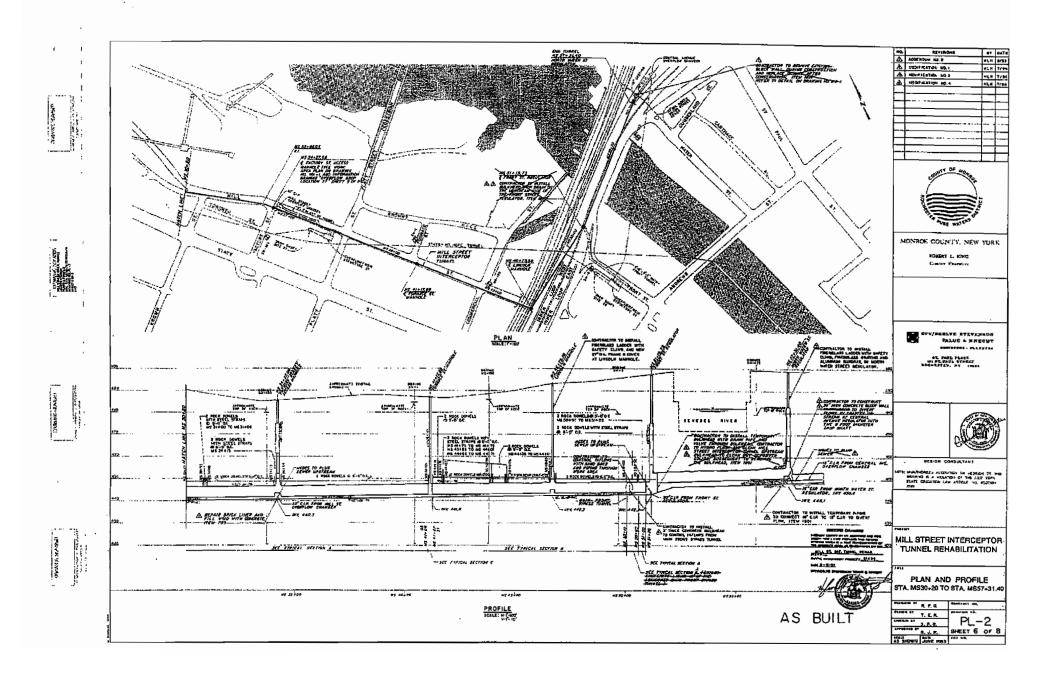
ALECT REPORTED

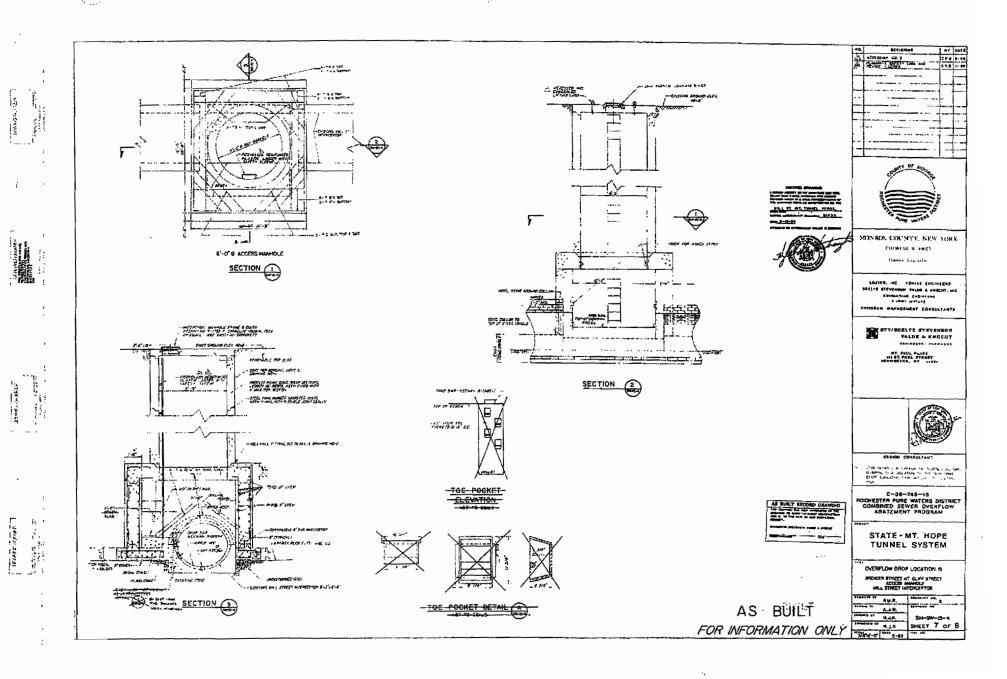
THE WAY DENNES

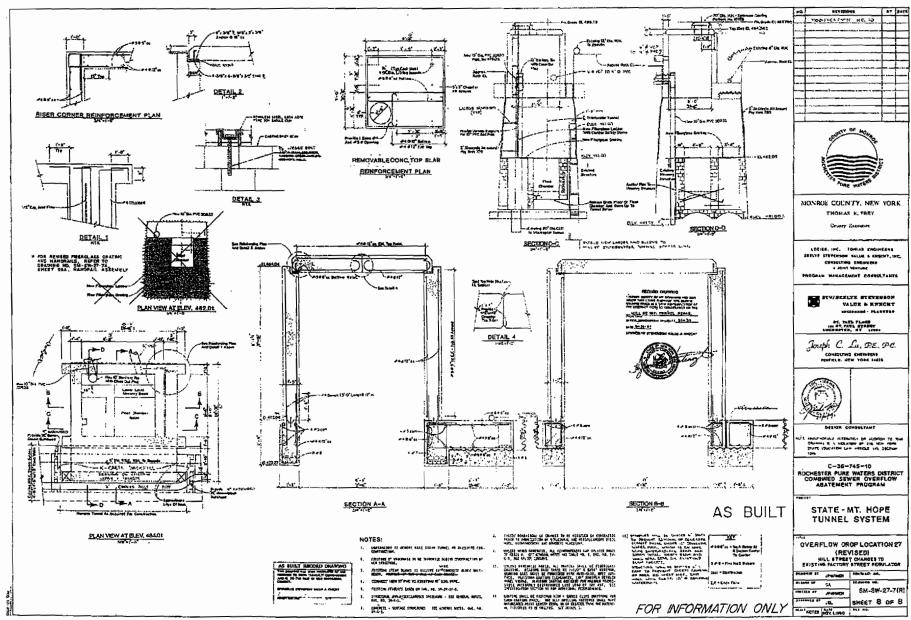




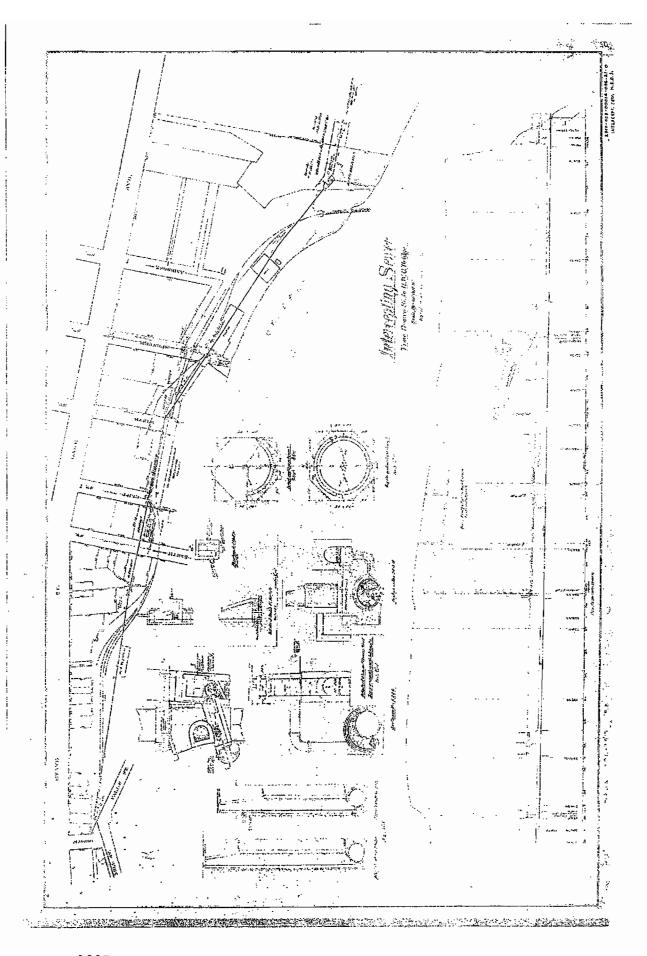








., .,



Appendix D

Conceptual Feasibility Study Cost Analysis

TABLE 1 COST ESTIMATE - SOIL REMEDIATION ALTERNATIVE 3: CAPPING AND SVE FEASIBILITY STUDY (FORMER RAECO PRODUCTS)

	ITEM	QUANTITY	UNIT COST(\$)	UNIT	COST(2009 \$)
	CAPITAL COST				
A	Direct Capital Cost]
1	Site Preparation				
l	a. Contractor mobilization/demobilization	1	10,000	LS	10,000
l	b. Utility clearance	1	4,000	LS	4,000
	c. Construction of staging area/ truck wash	1	3,000	LS	3,000
	d. Site access restrictions	1	5,000	LS	5,000
	e. Survey	30	1,200	Day	36,000
2	Capping				
ĺ	a. Re-grading of the sub grade/Landscaping	4200	2	SY	8,400
	b. Removal of 1' of surface soil near buildings and curb cuts	1000	30	CY	30,000
	c. Residual debris/material disposal	1	5,000	LS	5,000
	d. Asphalt fill (4-inches base and 2-inches top soil)	2400	40	CY	96,000
ļ	e. Gravel/DGA (6-inches)	2400	36	CY	87,516
	f. Erosion control measures/Storm water management	2000	7	LF	14,000
	g. Site restoration		5,000	LS	5,000
	h. Storm water infrastructure design and implementation	1 1	20,000	LS	20,000
3	SVE	1			
1	a. Pilot test for SVE system	1	30,000	LS	30,000
	b. Air permit for effluent release	1 1	5,000	LS	5,000
	c. Drilling and installation of vapor extraction wells	80	125	FT	10,000
	d. Drilling and installation monitoring points	20	500	EA	10,000
	e. Subsurface piping, excavation and installation	600	35	LF	21,000
	f. Asphalt removal, disposal and restoration	600	21	LF	12,600
	g. Central treatment unit and building (10'×10') set up	1 1	10,000	LS	10,000
	h. Blower and SVE system equipment set up	1 1	30,000	LS EA	30,000
	i. Vapor system treatment installation j. Utility Setup	1	7,500 5,000	LS	7,500 5,000
	j. Utility Setup k. System Start-up	i	5,000	LS	5,000
	K. System Start up	'	2,000		2,000
4	Health & Safety/Inspection Items	} }		1	
	a. Health & Safety (Field crew and supplies, HASP,	1 , 1	15,000	1.0	15 000
	prep H&S documents and implement plan) b. Air monitoring/ Dust control (Perimeter monitoring, CAMP)	1 1	15,000 12,000	LS LS	15,000 12,000
	c. PPE and other H&S equipment rental	1	5,000	LS	5,000
5	Institutional Controls (Land use controls/deed restrictions, site mgmt plan)	1	50,000	LS	50,000
6	Construction management	3	12,000	Month	36,000
	Total Direct Costs	-		-	588,016
					200,010
В	Indirect Cost				
1	Engineering and Design@15%				88,202
2	Legal and Administrative@10%			1	58,802
3	Contingency @25%			ł	147,004
	Total Indirect Costs				294,008
	TOTAL CAPITAL COST				882,025

TABLE 1 COST ESTIMATE - SOIL REMEDIATION ALTERNATIVE 3: CAPPING AND SVE FEASIBILITY STUDY (FORMER RAECO PRODUCTS)

	ITEM	QUANTITY	UNIT COST(\$)	UNIT	COST(2009 \$)
	ANNUAL O&M COST				
A	Capping				
1	Site inspections/ Reporting (Semi-annually)	2	1,200	EA	2,400
2	Annual maintenance/ repair	1	20,000	LS	20,000
В	SVE system (5 yr duration assumed)				
1	Electricity (blower, lighting and controls)	30000	0.15	KWH	4,500
2	Maintenance contract	1	20,000	LS	20,000
3	Condensate disposal (Nonhazardous)	500	3	GAL	1,500
4	Vapor treatment O&M (GAC + Vinyl Chloride Control)	1	4,000	LS	4,000
5	Monitoring/ Reporting	1	5,000	LS	5,000
	ADDITIONAL COSTS FOR YEAR 5)			
6	System decommissioning/ well abandonment	1	10,000	LS	10,000
7	Confirmatory sampling/ evaluation/ reporting	1	20,000	LS	20,000
	ANNUAL COST FOR YEAR 1-5		-		57,400
	ANNUAL COST FOR YEAR 6-30				22,400
	ADDITIONAL COSTS FOR YEAR 5				30,000
	PRESENT WORTH OF COSTS				
A	O&M Cost (30 years duration, 5% discount rate)				519,380
В	Total Capital Costs				882,025
	TOTAL PRESENT WORTH				1,401,405

TOTAL APPROXIMATE PRESENT WORTH FOR CAPPING TOTAL APPROXIMATE PRESENT WORTH FOR SVE

875,218 526,187

- 1. No underground utility survey was performed
- 2. The existing fence on site will be used and a gate will be built for site restriction
- 3. Three feet trench for the removal of one foot surface soil near buildings and curb cuts
- 4. It is assumed that there will be no significant soil disposal required to install an asphalt cap at the site.
- 5. Total present worths for capping and SVE are approximate.

Capping and Soil Vapor Extraction

- a. Capping
- b. Soil Vapor Extraction (SVE)

Capping:

Capping Area : 14,000 sq. yd Re-grading : 30% of total area

Pilot Testing:

Consider 4 locations for the pilot test

Each location : 2 step tests and 1 long duration test

Each location : 1 or 2 days effects Total duration including mob/demob. : 2 weeks

> - Equipment rental: \$5000 / week : \$10,000 - Field labor and technical support : \$15,000

- Vehicle rentals, personal protection

- Equipment and mics. expenses : \$5000 Total costs : \$30,000

Extraction Wells:

Quantity of Wells : 4

Depth of Wells : 20 ft (boring log)

Diameter of Wells : 4 in

Monitoring Points:

Quantity of Wells : 20
Depth of Wells : 10 ft
Diameter of Wells : 1in

Piping:

Total Length of Pipeline: 600 ft Diameter of Pipeline : 4in

Equipment shed : \$100 per sq. ft

Construction Management:

Superintendent @50%: 1 (\$8,000/month)

Support Technician: 1 (\$4,000/month)

Total including other office support, say \$15,000/month.

Duration of work : 3 months

TABLE 2 COST ESTIMATE - SOIL REMEDIATION ALTERNATIVE 6: CAPPING, SVE AND PRODUCT SOIL EXCAVATION FEASIBILITY STUDY (FORMER RAECO PRODUCTS)

	ITEM	QUANTITY	UNIT COST(\$)	UNIT	COST(2009 \$)
	CAPITAL COST				
A	Direct Capital Cost				
1	Site Preparation				
	a. Contractor mobilization/demobilization	1	10,000	LS	10,000
	b. Utility clearance	1	4,000	LS	4,000
	 c. Construction of staging and load out area/ truck wash 	1	7,000	LS	7,000
	d. Site access restrictions	1	5,000	LS	5,000
	e. Surveying	30	1,200	Day	36,000
2	Capping				
	a. Re-grading of the sub grade/Landscaping	4200	2	SY	8,400
	 Removal of 1' of surface soil near buildings and curb cuts 	1000	30	CY	30,000
	c. Residual debris/material disposal	1	5,000	LS	5,000
	d. Asphalt fill (4-inches base and 2-inches top soil)	2400	40	CY	96,000
	e. Gravel/DGA (6-inches)	2400	36	CY	87,516
	f. Erosion control measures/Storm water management	2000	7	LF	14,000
	g. Site restoration	1	5,000	LS LS	5,000
	h. Storm water infrastructure design and implementation	1	20,000	Lo	20,000
3	SVE				
	a. Pilot test for SVE system	1	30,000	LS	30,000
	b. Air permit for effluent release	1	5,000	LS	5,000
	c. Drilling and installation of vapor extraction wells	80	125	FT	10,000
	d. Drilling and installation monitoring points	20	500 35	EA LF	10,000 21,000
	e. Subsurface piping, excavation and installation	600 600	21	LF	12,600
	f. Asphalt removal, disposal and restoration	1	10,000	LS	10,000
	g. Central treatment unit and building (10'×10') set up	1 1	30,000	LS	30,000
	h. Blower and SVE system equipment set up i. Vapor system treatment installation	1 1	7,500	EA	7,500
	i. Vapor system treatment installation j. Utility Setup	î	5,000	LS	5,000
	k. System Startup	1	5,000	LS	5,000
4	Product Soil Excavation				
4	a. Delineation	1	10,000	LS	10,000
	b. Excavation	2900	35	CY	101,500
	c. Confirmatory Waste Sampling	6	1,400	EA	8,400
	d. Transportation and disposal of contaminated soil (hazardous)	450	250	Ton	112,500
	e. Transportation and disposal of contaminated soil (non-hazardous)	3900	80	Ton	312,000
	f. Backfill and compaction (purchase transport compact backfill material)	2900	15	CY	43,500
	(purchase, transport, compact backfill material) g. Securing excavation areas	1	5,000	LS	5,000
	g. Securing excavation areas h. Construction water handling and disposal	î	50,000	LS	50,000
	i. Site restoration	i	5,000	LS	5,000
	j. Water management (frac tanks, vac truck)	1	10,000	LS	10,000
_	Harlib & Cafety/Ingrestion Items				
5	Health & Safety/Inspection Items a. Health & Safety (Field crew and supplies, HASP,				
	prep H&S documents and implement plan)	1	15,000	LS	15,000
	b. Air monitoring/ Dust control (Perimeter monitoring, CAMP)	1	12,000	LS	12,000
	c. PPE and other H&S equipment rental	1	5,000	LS	5,000
6	Institutional Controls (Land use controls/deed restrictions, site mgmt plan)	1	30,000	LS	30,000
6	Institutional Controls (Land use controls/deed restrictions, site mgmt plan)	1	30,000	LS	

TABLE 2 COST ESTIMATE - SOIL REMEDIATION ALTERNATIVE 6: CAPPING, SVE AND PRODUCT SOIL EXCAVATION FEASIBILITY STUDY (FORMER RAECO PRODUCTS)

	ITEM	QUANTITY	UNIT COST(\$)	UNIT	COST(2009 \$)
7	Construction management	5	12,000	Month	60,000
	Total Direct Costs		_		1,253,916
В	Indirect Cost				
1	Engineering and Design@15%				188,087
2	Legal and Administrative@10%				125,392
3	Contingency @25%				313,479
	Total Indirect Costs		<u> </u>		626,958
	TOTAL CAPITAL COST				1,880,875
	ANNUAL O&M COST				
A	Capping				
1	Site inspections/ Reporting (Semi-annually)	2	1,200	EA	2,400
2	Annual maintenance/ repair	1	20,000	LS	20,000
В	SVE system (3 yr duration assumed)				
1	Electricity (blower, lighting and controls)	30000	0.15	KWH	4,500
2	Maintenance contract	1	20,000	LS	20,000
3	Condensate disposal (Nonhazardous)	500	3	GAL	1,500
4	Vapor treatment O&M (GAC + Vinyl Chloride Control)	1	4,000	LS	4,000
5	Monitoring/ Reporting	1	5,000	LS	5,000
	ADDITIONAL COSTS FOR YEAR 3				
6	System decommissioning/ well abandonment	1	10,000	LS	10,000
7	Confirmatory sampling/ evaluation/ reporting	1	20,000	LS	20,000
	ANNUAL COST FOR YEAR 1-3				57,400
	ANNUAL COST FOR YEAR 4-30				22,400
	ADDITIONAL COSTS FOR YEAR 3				30,000
	PRESENT WORTH OF COSTS				
A	O&M Cost (30 years duration, 5% discount rate)				465,572
B	Total Capital Costs				1,880,875
	TOTAL PRESENT WORTH		-		2,346,446

TOTAL APPROXIMATE PRESENT WORTH FOR CAPPING
TOTAL APPROXIMATE PRESENT WORTH FOR SVE
TOTAL APPROXIMATE PRESENT WORTH FOR PRODUCT EXCAVATION

835,218 432,379

1,078,850

- 1. No underground utility survey was performed
- 2. The existing fence on site will be used and a gate will be built for site restriction
- 3. Three feet trench for the removal of one foot surface soil near buildings and curb cuts
- 4. It is assumed that there will be no significant soil disposal required to install an asphalt cap at the site.
- 5. Total present worths for capping, SVE and product excation are approximate.

Capping, Soil Vapor Extraction and Product Soil Excavation

- a. Capping
- b. Soil Vapor Extraction (SVE)
- c. Soil Excavation

Capping:

Capping Area

14,000 sq. yd

Re-grading

30% of total area

Pilot Testing:

Consider 4 locations for the pilot test

Each location

2 step tests and 1 long duration test

Each location

1 or 2 days effects

Total duration including mob/demob.: 2 weeks

- Equipment rental: \$5000 / week

\$10,000

- Field labor and technical support

\$15,000

- Vehicle rentals, personal protection

- Equipment and mics. expenses

\$5000

Total costs

\$30,000

Extraction Wells:

Quantity of Wells

4

Depth of Wells

20 ft (boring log)

Diameter of Wells

4 in

Monitoring Points:

Quantity of Wells

20

Depth of Wells

10 ft

Diameter of Wells

1 in

Piping:

Total Length of Pipeline:

600 ft

Diameter of Pipeline

4in

Equipment shed

\$100 per sq. ft

Soil Excavation:

Delineation

:

The excavation area and volume is already defined. A lump sum

\$10,000 is budgeted for possible delineation on site.

Excavation volume

2900 cu. Yd

Hazardous waste

Say 10% of the total volume

Construction Management:

Superintendent @50% : 1 (\$8,000/month) Support Technician : 1 (\$4,000/month)

Total including other office support, say \$15,000/ month.

Duration of work : 5 months

TABLE 3 COST ESTIMATE - SOIL REMEDIATION ALTERNATIVE 7: CAPPING AND PRODUCT/VOC SOIL EXCAVATION FEASIBILITY STUDY (FORMER RAECO PRODUCTS)

	ITEM	QUANTITY	UNIT COST(\$)	UNIT	COST(2009 \$)
	CAPITAL COST				
A	Direct Capital Cost				
1	Site Preparation				
	a. Contractor mobilization/demobilization	1	10,000	LS	10,000
	b. Utility clearance	1	4,000	LS	4,000
	 c. Construction of staging and load out area/ truck wash 	1	9,000	LS	9,000
	d. Site access restrictions	30	5,000 1,200	LS Day	5,000 36,000
	e. Surveying	30	1,200	Дау	30,000
2	Capping				
]	a. Re-grading of the sub grade/Landscaping	3400	2	SY	6,800
	b. Removal of 1' of surface soil near buildings and curb cuts	1000	30	CY LS	30,000 5,000
	c. Residual debris/material disposal	2000	5,000 40	CY	80,000
	 d. Asphalt fill (4-inches base and 2-inches top soil) e. Gravel/DGA (6-inches) 	2000	36	CY	72,930
	e. Gravel/DGA (6-inches) f. Erosion control measures/Storm water management	1600	7	LF	11,200
	g. Site restoration	1	5,000	LS	5,000
	h. Storm water infrastructure design and implementation	1	20,000	LS	20,000
3	Product/ VOC Soil Excavation				
	a. Delineation	1	30,000	LS	30,000
	b. Excavation	6000	35	CY	210,000
	c. Confirmatory Waste Sampling	2	1,400	EA	2,800
	d. Transportation and disposal of contaminated soil (hazardous)	900	250	Ton	225,000
	e. Transportation and disposal of contaminated soil (non-hazardous)	8100	80	Ton	648,000
	f. Backfill and compaction	5200	10	GV.	52,000
	(purchase, transport, compact backfill material)	5300	10 5,000	CY LS	53,000 5,000
1	g. Securing excavation areas	25	900	EA	22,500
	h. Post excavation soil sampling (VOC only)	1	50,000	LS	50,000
	 i. Construction water handling and disposal i. Site restoration 	1	5,000	LS	5,000
	j. Site restorationk. Water management (frac tanks, vac truck)	1	10,000	LS	10,000
	Health & Safety/Inspection Items				
4	a. Health & Safety (Field crew and supplies, HASP,			ļ	
	prep H&S documents and implement plan)	1	15,000	LS	15,000
	b. Air monitoring/ Dust control (Perimeter monitoring, CAMP)	1	12,000	LS	12,000
	c. PPE and other H&S equipment rental	1	5,000	LS	5,000
5	Institutional Controls (Land use controls/deed restrictions, site mgmt plan)	1	30,000	LS	30,000
6	Construction management	5	12,000	Month	60,000
	Total Direct Costs				1,678,230
1 . 1	Indirect Cost				251,735
1 2	Engineering and Design@15% Legal and Administrative@10%				167,823
	Contingency @25%				419,558
	Total Indirect Costs				839,115
\vdash	TOTAL CAPITAL COST				2,517,346

TABLE 3

COST ESTIMATE - SOIL REMEDIATION ALTERNATIVE 7: CAPPING AND PRODUCT/VOC SOIL EXCAVATION FEASIBILITY STUDY (FORMER RAECO PRODUCTS)

	ITEM	QUANTITY	UNIT COST(\$)	UNIT	COST(2009 \$)
	ANNUAL O&M COST				
A	Capping				
1	Site inspections/ Reporting (Semi-annually)	2	1,200	EA	2,400
2	Annual maintenance/ repair	1	20,000	LS	20,000
	TOTAL ANNUAL O&M COST				22,400
A B	PRESENT WORTH OF COSTS O&M Cost (30 years duration, 5% discount rate) Total Capital Costs				344,343 2,517,346
	TOTAL PRESENT WORTH				2,861,688

TOTAL APPROXIMATE PRESENT WORTH FOR CAPPING TOTAL APPROXIMATE PRESENT WORTH FOR PRODUCT/VOC EXCAVATION

830,238 2,031,450

- 1. No underground utility survey was performed
- 2. The existing fence on site will be used and a gate will be built for site restriction
- 3. Three feet trench for the removal of one foot surface soil near buildings and curb cuts
- 4. It is assumed that there will be no significant soil disposal required to install an asphalt cap at the site.
- 5. Total present worths for capping and product/voc excation are approximate.

Capping, Product and VOC Soil Excavation

Capping

b. Soil Excavation

Capping:

12,000 sq. yd Capping Area Re-grading

30% of total area

Soil Excavation:

Delineation The excavation area and volume is already defined. A lump sum

\$30,000 is budgeted for possible delineation on site.

Excavation volume 6000 cu. Yd

Hazardous waste Say 10% of the total volume

Construction Management:

Superintendent @50%: 1 (\$8,000/month) Support Technician 1 (\$4,000/month)

Total including other office support, say \$15,000/ month.

Duration of work 5 months

TABLE 4 COST ESTIMATE - SOIL REMEDIATION ALTERNATIVE 8: UNRESTRICTED SITE USE / PRE-DISPOSAL CONDITIONS FEASIBILITY STUDY (FORMER RAECO PRODUCTS)

	ITEM	QUANTITY	UNIT COST(\$)	UNIT	COST(2009 \$)
	CAPITAL COST				
A	Direct Capital Cost				
1	Site Preparation			ĺ	
	a. Contractor mobilization/demobilization	1	10,000	LS	10,000
	b. Utility clearance	1	4,000	LS	4,000
	c. Construction of staging and load out area/ truck wash	1	9,000	LS	9,000
	d. Site access restrictions	1	5,000	LS	5,000
	e. Surveying	30	1,200	Day	36,000
2	Soil Excavation				
	Soil staging areas	1	10,000	LS	10,000
	b. Excavation	94000	35	CY	3,290,000
	c. Confirmatory Waste Sampling	2	1,400	EA	2,800
	d. Transportation and disposal of contaminated soil (hazardous)	14100	250	Ton	3,525,000
	e. Transportation and disposal of contaminated soil (non-hazardous)	127000	80	Ton	10,160,000
	f. Backfill and compaction	l i			
	(purchase, transport, compact backfill material)	94000	10	CY	940,000
	g. Securing excavation areas	1	15,000	LS	15,000
	h. Sheeting around 3 sides of site perimeter	24000	13	SF	312,000
	 Construction water handling and disposal 	1	500,000	LS	500,000
	j. Site restoration	1	50,000	LS	50,000
	k. Water management (frac tanks, vac truck)	1	100,000	LS	100,000
	l. Building demolition (4 buildings)	1	200,000	LS	200,000
4	Health & Safety/Inspection Items				
	 a. Health & Safety (Field crew and supplies, HASP, 				
	prep H&S documents and implement plan)	1	15,000	LS	15,000
	b. Air monitoring/ Dust control (Perimeter monitoring, CAMP)	1	12,000	LS	12,000
	c. PPE and other H&S equipment rental	1	5,000	LS	5,000
5	Construction management	5	12,000	Month	60,000
	Total Direct Costs				19,260,800
В	Indirect Cost				
1	Engineering and Design@15%				2,889,120
2	Legal and Administrative@10%				1,926,080
	Contingency @25%				4,815,200
	Total Indirect Costs				9,630,400
	TOTAL CAPITAL COST				28,891,200

TABLE 4

COST ESTIMATE - SOIL REMEDIATION ALTERNATIVE 8: UNRESTRICTED SITE USE / PRE-DISPOSAL CONDITIONS FEASIBILITY STUDY (FORMER RAECO PRODUCTS)

	ITEM	QUANTITY	UNIT COST(\$)	UNIT	COST(2009 \$)
	ANNUAL O&M COST				
	TOTAL ANNUAL O&M COST				0
A	PRESENT WORTH OF COSTS Total Capital Costs				28,891,200
	TOTAL PRESENT WORTH				28,891,200

- 1. No underground utility survey was performed
- 2. The existing fence on site will be used and a gate will be built for site restriction
- 3. Three feet trench for the removal of one foot surface soil near buildings and curb cuts
- 4. It is assumed that there will be no significant soil disposal required to install an asphalt cap at the site.

Unrestricted Site Use / Pre-Disposal Conditions

a. Soil Excavation

Soil Excavation:

Delineation : The excavation area and volume is already defined. A lump sum

\$30,000 is budgeted for possible delineation on site.

Excavation volume :

94000 cu. Yd

Hazardous waste

Say 10% of the total volume

Construction Management:

Superintendent @50% : Support Technician :

1 (\$8,000/month)

1 (\$4,000/month)

Duration of work

5 months

Total including other office support, say \$15,000/ month.

TABLE 5 COST ESTIMATE - GROUNDWATER REMEDIATION ALTERNATIVE 3: CAPPING AND LTM FEASIBILITY STUDY (FORMER RAECO PRODUCTS)

	ITEM	QUANTITY	UNIT COST(\$)	UNIT	COST(2009 \$)
	CAPITAL COST				
	CAFITAL COST		1		
A	Direct Capital Cost				
	Site Preparation				
	a. Contractor mobilization/demobilization	1	10,000	LS	10,000
	b. Utility clearance	1	4,000	LS	4,000
	c. Construction of staging area/ truck wash	1	3,000	LS	3,000
ł	d. Site access restrictions	1	5,000	LS	5,000
	e. Surveying	30	1,200	Day	36,000
2	Capping				
	a. Re-grading of the sub grade/Landscaping	4200	2	SY	8,400
	 Removal of 1' of surface soil near buildings and curb cuts 	1000	30	CY	30,000
ĺ	c. Residual debris/material disposal	1	5,000	LS	5,000
	d. Asphalt fill (4-inches base and 2-inches top soil)	2400	40	CY	96,000
	e. Gravel/DGA (6-inches)	2400	36	CY	87,516
	f. Erosion control measures/Storm water management	2000	7	LF	14,000
	g. Site restoration	1	5,000	LS	5,000
	h. Storm water infrastructure design and implementation	1	20,000	LS	20,000
3	LTM			ĺ	
	a. Install groundwater monitoring wells (5 wells, 40ft depth)	200	125	LF	25,000
4	Health & Safety/Inspection Items				
	 Health & Safety (Field crew and supplies, HASP, 				
	prep H&S documents and implement plan)	1	15,000	LS	15,000
	b. Air monitoring/ Dust control (Perimeter monitoring, CAMP)	1	12,000	LS	12,000
	c. PPE and other H&S equipment rental	1	5,000	LS	5,000
5	Institutional Controls (Land use controls/deed restrictions, site mgmt plan)	1	40,000	LS	40,000
6	Construction management	3	12,000	Month	36,000
	Total Direct Costs				456,916
	La Marca Cont				
	Indirect Cost				(0.527
1 2	Engineering and Design@15% Legal and Administrative@10%				68,537 45,692
	Contingency @25%				
3	Contingency (#2370				114,229
	Total Indirect Costs				228,458
	TOTAL CAPITAL COST				685,375

TABLE 5 COST ESTIMATE - GROUNDWATER REMEDIATION ALTERNATIVE 3: CAPPING AND LTM FEASIBILITY STUDY (FORMER RAECO PRODUCTS)

	ITEM	QUANTITY	UNIT COST(\$)	UNIT	COST(2009 \$)
	ANNUAL O&M COST				
A	Capping				
1	Site inspections/ Reporting (Semi-annually)	2	1,200	EA	2,400
2	Annual maintenance/ repair	1	20,000	LS	20,000
В	LTM				
1	Groundwater sampling and lab test for VOC and metals (Quarterly for 2 years)	60	800	EA	48,000
2	Annual testing of VOC and metals for years 3 through 30	15	800	EA	12,000
3	Sample collection and monitoring well maintenance	1	5,000	LS	5,000
4	Reporting/ Database management	1	10,000	LS	10,000
	ANNUAL COST FOR YEAR 1-2				85,400
	ANNUAL COST FOR YEAR 3-30				49,400
	PRESENT WORTH OF COSTS				
A	O&M Cost (30 years duration, 5% discount rate)				826,338
В	Total Capital Costs				685,375
	TOTAL PRESENT WORTH				1,511,713

TOTAL APPROXIMATE PRESENT WORTH FOR CAPPING TOTAL APPROXIMATE PRESENT WORTH FOR LTM

967,318 544,395

- 1. No underground utility survey was performed
- 2. The existing fence on site will be used and a gate will be built for site restriction
- 3. Three feet trench for the removal of one foot surface soil near buildings and curb cuts
- 4. It is assumed that there will be no significant soil disposal required to install an asphalt cap at the site.
- 5. QC includes 1 Trip Blank/day(VOC only), 1 Field Blank, 1 Field Duplicate, 1 Matrix Spike, 1 Matrix Spike Duplicate
- 6. Ten monitoring wells exist
- 7. Total present worths for capping and LTM are approximate.

Details of Groundwater Remediation Alternative 3

Capping and Long Term Monitoring (LTM)

- a. Capping
- b. LTM

Capping:

Capping Area : 14,000 sq. yd Re-grading : 30% of total area

Groundwater Monitoring Wells:

Quantity of Wells : 5
Depth of Wells : 40 ft
Diameter of Wells : 4 in

Long Term Monitoring Program:

Quantity of Wells : 15

Frequency : Quarterly for year 1-2

Annually for year 3-30

QA/QC requirement : 1 Trip Blank,

Field Blank
 Field Duplicate
 Matrix Spike

1 Matrix Spike Duplicate

Construction Management:

Superintendent @50%: 1 (\$8,000/month)

Support Technician: 1 (\$4,000/month)

Total including other office support, say \$15,000/month.

Duration of work : 3 months

TABLE 6
COST ESTIMATE - GROUNDWATER REMEDIATION
ALTERNATIVE 4: CAPPING, DUAL PHASE EXTRACTION AND LTM
FEASIBILITY STUDY (FORMER RAECO PRODUCTS)

	ITEM	QUANTITY	UNIT COST(\$)	UNIT	COST(2009 \$)
	CAPITAL COST				
A	Direct Capital Cost				
1	Site Preparation				
	a. Contractor mobilization/demobilization	1	10,000	LS	10,000
	b. Utility clearance	1	4,000	LS	4,000
	c. Construction of staging area/ truck wash	1	5,000	LS	5,00
	d. Site access restrictions	1	5,000	LS	5,00
	e. Surveying	30	1,200	Day	36,000
2	Capping				
	a. Re-grading of the sub grade/Landscaping	4200	2	SY	8,400
	b. Removal of 1' of surface soil near buildings and curb cuts	1000	30	CY	30,000
	c. Residual debris/material disposal	1	5,000	LS	5,000
	d. Asphalt fill (4-inches base and 2-inches top soil)	2400	40	CY	96,000
	e. Gravel/DGA (6-inches)	2400	36	CY	87,510
	f. Erosion control measures/Storm water management	2000	7	LF	14,000
	g. Site restoration	1	5,000	LS	5,000
	h. Storm water infrastructure design and implementation	1	20,000	LS	20,000
3	LTM				
	a. Install groundwater monitoring wells (5 wells, 40ft depth)	200	125	LF	25,000
4	Dual Phase Extraction				
	a. Pilot test for DPE system	1 1	30,000	LS	30,000
	c. Air permit for effluent release	1	5,000	LS	5,000
	d. Extraction (5 wells) and injection well installation	200	125	FT	25,000
	e. Treatment building (10x15')	1 1	15,000	LS	15,000
	f. Asphalt Removal, disposal and restoration	700	21	LF	14,700
	g. Subsurface piping installation	700	35	LF	24,500
	h. Liquid phase GAC and vapor phase treatment unit set up	1	7,500	EA	7,500
	 i. Blower and DPE system equipment set up j. System Start-up 	1 1	30,000 5,000	LS LS	30,000 5,000
5	Health & Safety/Inspection Items				
	a. Health & Safety (Field crew and supplies, HASP,				
	prep H&S documents and implement plan)	1	15,000	LS	15,000
	b. Air monitoring/ Dust control (Perimeter monitoring, CAMP)	1	12,000	LS	12,000
	c. PPE and other H&S equipment rental	1	5,000	LS	5,000
6	Institutional Controls (Land use controls/deed restrictions, site mgmt plan)	1	30,000	LS	30,000
7	Construction management	5	12,000	Month	60,000
\dashv	Total Direct Costs				629,616

TABLE 6

COST ESTIMATE - GROUNDWATER REMEDIATION ALTERNATIVE 4: CAPPING, DUAL PHASE EXTRACTION AND LTM FEASIBILITY STUDY (FORMER RAECO PRODUCTS)

	ITEM	QUANTITY	UNIT COST(\$)	UNIT	COST(2009 \$)
B	Indirect Cost				
1	Engineering and Design@15%				94,442
2	Legal and Administrative@10%				62,962
3	Contingency @25%				157,404
	Containgency ©2370				137,404
	Total Indirect Costs				314,808
	TOTAL CAPITAL COST				944,425
	ANNUAL O&M COST				
A	Capping				
1	Site inspections/ Reporting (Semi-annually)	2	1,200	EA	2,400
2	Annual maintenance/ repair	1	20,000	LS	20,000
ъ	LTM				
B	Groundwater sampling and lab test for VOC and metals (Quarterly for 2 years)	60	800	17: A	40,000
2	Annual testing of VOC and metals for years 3 through 30	15	800	EA EA	48,000
3	Sample collection and monitoring well maintenance	15	5,000	LS	12,000
_	Reporting/ Database management	1	10,000	LS	5,000 10,000
4	Reporting/ Database management	1	10,000	rs	10,000
C	Dual Phase Extraction (4 yr duration assumed)				
1	Electricity (blower, lighting and controls)	50000	0.15	KWH	7,500
2	Maintenance contract	1	25,000	LS	25,000
3	Condensate disposal (Nonhazardous)	1500	3	GAL	4,500
4	Vapor treatment O&M (GAC + Vinyl Chloride Control)	1	4,000	LS	4,000
	Sampling (effluent, disposal etc.)	1	10,000	LS	10,000
6	Reporting	1	5,000	LS	5,000
	ADDITIONAL COSTS FOR YEAR 4				
7	System decommissioning/ well abandonment	1	15,000	LS	15,000
	Confirmatory sampling/ evaluation/ reporting	1	30,000	LS	30,000
	ANNUAL COST FOR WEAD 1.2				444 400
	ANNUAL COST FOR YEAR 1-2				141,400
	ANNUAL COST FOR YEAR 3-4				105,400
	ANNUAL COST FOR YEAR 5-30 ADDITIONAL COSTS FOR YEAR 4				49,400
	ADDITIONAL COSTS FOR TEAR 4				45,000
	PRESENT WORTH OF COSTS				
A	O&M Cost (30 years duration, 5% discount rate)				1,061,933
	Total Capital Costs				944,425
	TOTAL PRESENT WORTH				2,006,357
	TOTAL TURBERT WORTH				/ 55,000,35

TOTAL APPROXIMATE PRESENT WORTH FOR CAPPING TOTAL APPROXIMATE PRESENT WORTH FOR DPE TOTAL APPROXIMATE PRESENT WORTH FOR LTM

866,068 593,495 546,795

- 1. No underground utility survey was performed
- 2. The existing fence on site will be used and a gate will be built for site restriction
- 3. Three feet trench for the removal of one foot surface soil near buildings and curb cuts
- 4. It is assumed that there will be no significant soil disposal required to install an asphalt cap at the site.
- 5. QC includes 1 Trip Blank/day(VOC only), 1 Field Blank, 1 Field Duplicate, 1 Matrix Spike , 1 Matrix Spike Duplicate
- 6. Ten monitoring wells exist
- 7. Total present worths for capping, DPE and LTM are approximate.

Details of Groundwater Remediation Alternative 4

Capping, LTM and Dual Phase Extraction (DPE)

- a. Capping
- b. LTM
- c. DPE

Capping:

Capping Area : 14,000 sq. yd Re-grading : 30% of total area

Groundwater Monitoring Wells:

Quantity of Wells : 5
Depth of Wells : 40 ft
Diameter of Wells : 4 in

Long Term Monitoring Program:

Quantity of Wells : 15

Frequency: Quarterly for year 1-2

Annually for year 3-30

QA/QC requirement : 1 Trip Blank,

Field Blank
 Field Duplicate
 Matrix Spike

1 Matrix Spike Duplicate

Pilot Testing:

Consider 4 locations for the pilot test

Each location : 2 step tests and 1 long duration test

Each location : 1 or 2 days effects Total duration including mob/demob. : 2 weeks

> - Equipment rental: \$5000 / week : \$10,000 - Field labor and technical support : \$15,000

- Vehicle rentals, personal protection

- Equipment and mics. expenses : \$5000 Total costs : \$30,000

Extraction Wells:

Quantity of Wells : 5
Depth of Wells : 40 ft
Diameter of Wells : 4 in

Piping:

Total Length of Pipeline:

700 ft

Diameter of Pipeline

4in

Equipment shed

\$100 per sq. ft

Construction Management:

Superintendent @50%:

1 (\$8,000/month)

Support Technician

1 (\$4,000/month)

Total including other office support, say \$15,000/ month.

Duration of work

5 months