New York State Department of Environmental Conservation

MEMORANDUM

To: Daniel Steenberge, RHWRE, Region 5 - Ray Brook
From: Marsden Chen, Bureau of Eastern Remedial Action
Subject: Malta Rocket Fuel Area Site ID No. 546022

Date: October 10, 1995

Attached is a copy of the final feasibility study for the Malta Rocket Fuel Area site for your files.

If you have any questions, please contact Victor Cardona, of my staff, at (518) 457-3976.

Attachment

Marsden Chen

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FEASIBILITY STUDY
Malta Rocket Fuel Area Site Saratoga County, New York

Prepared for:

Malta Participating Parties
Albany, New York

October, 1995

RECEIVED
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BUREAU OF EASTERN REMEDIAL ACTION
DIVISION OF HAZARDOUS WASTE REMEDIATION

Quality through teamwork

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Table 1-11
Areas and Media Evaluation
Malta Rocket Fuel Area Site

Media*	Locations with Exceedances of MRFA Comparative Criteria (from RI)	Evidence of Impact to Ground-water	Requires Remedial Alternative Evaluation	Rationale
Surface Water	Muggett's Pond (Inorganics)	No	No	The RA found that surface water in Muggett's Pond results in no unacceptable risk to human health. Although measured levels of several metals exceeded chronic surface water benchmarks, these exceedances are not expected to be ecologically significant because they were based on unfiltered samples. Dissolved metals (filtered samples) would represent the bioavailable, and therefore potentially toxic, fraction. Total (unfiltered) metal levels are likely to significantly overestimate potential risks.
	Ravine 1b (Inorganics)	No	No	The RA found that surface water in Ravine 1b results in no unacceptable risk to human health. The RA indicates that the levels of several metals exceeded chronic surface water benchmarks based on unfiltered samples. It is believed that upwelling groundwater feeds the stream. Based on a comparison of filtered and unfiltered groundwater data, metals concentrations in filtered stream samples would be significantly reduced, resulting in insignificant ecological risks.
Sediment	Building 3 - Quench Pit (Inorganics, PCBs) Building 25 - Quench Pit (Inorganics, PCBs, Methoxychlor)	No	No	The RI indicates that constituents in the quench pit sediments do not contribute to the observed distribution of constituents in groundwater. The quench pits are concrete-lined structures, and the sediments consist of organic detritus that is not likely to provide habitat for sediment dwelling organisms.
	Muggett's Pond (Inorganics, SVOCs, PCBs, Pesticides)	No	No	The RA indicates these constituents in sediment do not pose a risk to human health**. Exceedances of sediment benchmarks occurred for mercury and PCBs, suggesting that some adverse effects are possible to aquatic receptors. The RA concludes that risks to aquatic receptors that may inhabit Muggett's Pond are minimal based on its size, limited habitat diversity, and location within a developed area. Additionally, exposure modeling of potential food chain effects to higher trophic level organisms indicated that Muggett's Pond is not a source of significant risk to wildlife.
	Ravine 1b (Inorganics)	No	No	Inorganic constituents detected above the Criteria do not appear to be having an impact on downgradient sediment or surface water. Lead was detected at 50.1 ppm, which is above the Criteria for lead (27 ppm) but near the lowest effect level for sensitive aquatic organisms (31 ppm). The concentration detected is well below the concentration specified for severe effect level (250 ppm). Lead was not detected above the MRFA Criteria at downstream sampling locations. The RA indicates these constituents do not pose a risk to human health. The stream within the ravine provide only limited habitat for aquatic invertebrates, the most likely receptor. Any possible adverse effect to aquatic invetebrates would be limited to the headwaters of the ravine 1b stream.

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Malta Rocket Fuel Area Site

Media*	Locations with Exceedances of MRFA Comparative Criteria (from RI)	Evidence of Impact to Ground-water	Requires Remedial Alternative Evaluation	Rationale
Dry Wells, Floor Drains, Catch Basins	Building 1 (Mercury, SVOCs, PCBs) Building 1 open sump (Inorg., PCBs) Building 2 (Inorganics, SVOCs, Pest.) Building 3 (Arsenic, PCBs) Building 4 (VOCs, SVOCs) Building 5 (Inorganics, PCBs, Pest.) Building 15 (Inorganics, PCBs, Pest.) Building 20 (Inorganics, SVOCs) Building 24 (Inorganics, SVOCs, PCBs, Pesticides) Former GE/Exxon Building (SVOCs)	No	No	In general, the constituents detected in the dry wells, catch basins, and floor drains are the more immobile constituents, and they are contained. The RI indicates that additional sampling below and adjacent to the dry wells, which found no constituents exceeding the Criteria, confirms that constituents are not migrating away from the dry wells, and have not migrated into the surrounding soil or groundwater. The RA indicates that these features do not pose a risk to human health or the environment. At EPA's request, these features are being addressed in a separate proposal to EPA rather than as part of the FS.

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*	Groundwater will be evaluated in the FS, although it is not included in this table.
**	Based on the exposure pathways presented in the Pathway Analysis Report, Environ Corporation, February 1995.
***	From NYSDEC Sediment Guidelines.
N/A	Not Applicable

Table 1-11
Areas and Media Evaluation
Malta Rocket Fuel Area Site

Media*	Locations with Exceedances of MRFA Comparative Criteria (from RI)	Evidence of Impact to Ground-water	Requires Remedial Alternative Evaluation	Rationale
Subsurface Soil	Area D-1 (VOCs)	Yes (Historically)	No	Based on the area's historical use, in addition to the RI findings, Area D-1 appears to have been a historical source of organic constituents to the soil and groundwater. Elevated VOC concentrations in subsurface soil sample P-78/6-8 and in groundwater samples, the crushed drums in test pit P-78, and the former burn pit structure in test pit P-83 support historical disposal activities in this area. However, the RA indicates that the VOCs in soil, at the concentrations detected, do not pose an unacceptable risk to human health or the environment**.
	Area D-2 (Vanadium, Benzo(a)Pyrene)	No	No	The northeastern portion of Area D-2 is a landfill area primarily containing inert construction and demolition debris and office wastes. The vanadium and benzo(a)pyrene above the Criteria may be associated with the buried waste. The RI indicates that this area does not appear to contribute to the observed distribution of constituents in groundwater. The RA indicates that these compounds, in the concentrations detected, do not pose an unacceptable risk to human health or the environment**.
	Area D-5 (Cadmium)	No	No	The concentration of cadmium detected in sample P-70/2-4 appears to be localized as no detections above the Criteria were found in samples from soil borings located radially around, and vertically beneath, P-70/2-4. The RI indicates that this area does not appear to contribute to the observed distribution of constituents in groundwater. The RA indicates that cadmium, at the concentration detected, does not pose an unacceptable risk to human health or the environment**.
	Area D-6 (Arsenic)	No	No	In sample P-11/2-4, arsenic (9.1 ppm) was detected at only slightly above the Criteria (8.1 ppm). This low concentration is unlikely to have a significant impact on groundwater. The RA indicates that arsenic, at the concentration detected, does not pose an unacceptable risk to human health or the environment**.
Surface Water	Building 3 - Quench Pit (Inorganics, Pesticides) Building 4 - Quench Pit (Inorganics) Building 25 - Quench Pit (Inorganics)	No	No	The RI indicates that constituents in the quench pit surface water do not contribute to the observed distribution of constituents in groundwater. The quench pits, which are lined with concrete and are adjacent to buildings and other facilities, contain limited bottom sediment and no vegetation. Therefore, they are not aquatic environments, and they are unlikely to provide habitat for any ecological receptors.

Table 1-11
Areas and Media Evaluation
Malta Rocket Fuel Area Site

Media*	Locations with Exceedances of MRFA Comparative Criteria (from RI)	Evidence of Impact to Ground-water	Requires Remedial Alternative Evaluation	Rationale
	Building 25S (Lead, Antimony, Copper)	No	No	Lead, antimony and copper do not appear to have contributed to the observed distribution of constituents in groundwater. The RA indicates Site soil does not pose an unacceptable risk to human health**. Although some potential ecological risk was identified, the Building 25 and 25s area is developed and offers limited suitable habitat for wildlife receptors, thus limiting exposure. The RA concludes remedial action is not necessary to protect ecological receptors.
	Muggett's Pond Drainage Ditch (Mercury, PCBs)	No	Yes	The RA indicates the Site soil does not pose an unacceptable risk to human health**. Although some potential ecological risk was identified, by removing the elevated concentrations of mercury at this location, the risks to potential ecological receptors are reduced.
Subsurface Soil	Area S-2 (Acetone) Building 11 (Acetone) Building 24 (Acetone)	No	No	At Area S-2, Building 11, and Building 24, acetone concentrations (300, 580, and 710 ppb, respectively) exceeded the Criteria (200 ppb). The RI concludes that these areas do not appear to have contributed constituents to groundwater. The RA indicates that acetone is not a COC in soil due to its concentration and/or frequency of detection, and therefore, it does not pose an unacceptable risk to human health or the environment**.
	Building 6 (Tetrachloroethene)	No	No	The concentration of tetrachloroethene equalled the Criteria. The RI concludes that Building 6 activities have not contributed to the observed distribution of constituents in groundwater. The RA indicates that Site soil does not pose an unacceptable risk to human health or the environment**.
	Building 14 (VOCs, SVOCs)	No	No	A sample contained VOCs and SVOCs that may be indicative of a petroleum spill (possibly fuel oil). The concentrations diminish within 4 feet vertically and 20 to 30 feet laterally. The detected compounds do not appear to contribute to the observed distribution of constituents in groundwater. The RA indicates that these constituents do not pose an unacceptable risk to human health or the environment at the levels detected at the Site**.
	Building 25 (Phenol)	No	No	Estimated concentrations of phenol were detected in S-75/2-4 (140 ppb) and S-80/0-2 (46 ppb) above the Criteria (30 ppb). The RI indicates that these concentrations are isolated and do not contribute to the observed distribution of constituents in groundwater. The RA indicates that phenol, in the concentrations detected, does not pose an unacceptable risk to human health or the environment**.

Table 1-11
Areas and Media Evaluation
Malta Rocket Fuel Area Site

Media*	Locations with Exceedances of MRFA Comparative Criteria (from RI)	Evidence of Impact to Ground-water	Requires Remedial Alternative Evaluation	Rationale
Surface Soil	Area S-1 (PCBs)	No	No	Sample SS-S1 contains 1.2 ppm of PCBs, which is well below the typical cleanup goal of 25 ppm used at other restricted-access industrial sites with PCBs. PCBs are highly insoluble and therefore, are not likely to pose a threat to groundwater. The RA indicates that the site soil does not pose an unacceptable risk to human health or the environment**.
	Building 6 (SVOCs) Building 24 (SVOCs) Buildings 27B and 27C (SVOCs)	No	No	At Building 6, benzo(a)pyrene (91 ppb) slightly exceeded the MRFA Comparison Criteria (61 ppb). At Building 24, five SVOCs were detected at levels exceeding the Criteria. At Buildings 27B and 27C, the three SVOCs detected were localized and probably derived from the adjacent asphalt roadway. Concentrations only slightly exceed the Criteria. The RI concludes that activities at Buildings 6, 24, 27B and 27C have not contributed to the observed distribution of constituents in groundwater. The RA indicates that Site soil does not pose an unacceptable risk to human health or the environment**. Although some potential ecological risk was identified at Building 6, this area is developed and offers limited suitable habitat for wildlife receptors, thus limiting exposure. The RA concludes remedial action is not necessary to protect ecological receptors.
	Building 20 (Mercury)	No	No	Sample SS-20, containing mercury, is isolated. Mercury in surface soil does not appear to have contributed to the observed distribution of constituents in groundwater. The RA indicates Site soil does not pose an unacceptable risk to human health or the environment**.
	Building 21 (Mercury, PCBs)	No	No	Sample contains 1.6 ppm of PCBs, which is well below the typical cleanup goal of 25 ppm used at other restricted-access industrial sites with PCBs. The sample containing mercury, SS-21, is isolated. Mercury in surface soil does not appear to have contributed to the observed distribution of constituents in groundwater. The RA indicates Site soil does not pose an unacceptable risk to human health** or the environment.
	Building 23P (PCBs, Lead)	No	Yes	With the assumption that this area will be remediated, the RA indicates that Site soil does not pose an unacceptable risk to human health**. By removing the elevated concentrations of PCBs and lead at this location, the risks to potential ecological receptors are reduced. Concentrations of PCBs do not exceed the typical cleanup goal of 25 ppm used at other restricted-access industrial sites with PCBs.

Table 1-10

Sediment TBCs for Detected Compounds
Malta Rocket Fuel Area Site

Fraction	Analyte	NYSDEC Sediment Screening Criteria *	USEPA Interim Sediment Criteria **
Semivolatiles	Benzo(a)anthracene		1317
	Benzo(a)pyrene		1063
	Fluoranthene	25.5 (AT)	620
	4-Methylphenol	0.0125 (AT) ***	
	Phenanthrene	3 (AT)	180
	Pyrene		1311
Pesticides/PCBs	Total PCBs	0.035 (WB)	
	DDE 4,4'-	0.025 (WB)	
	DDT 4,4'-	0.025 (WB)	
	gamma-Chlordane	0.00015 (WB)	
Inorganics	Antimony	2 *(25)*	
	Arsenic	6 *(33)*	
	Cadmium	0.6 *(9)*	
	Chromium	26 *(110)*	
	Copper	16 *(110)*	
	Iron	20000 *(40,000)*	
	Lead	31 *(110)*	
	Manganese	460 *(1,100)*	
	Mercury	0.15 *(1.3)*	
	Nickel	16 *(50)*	
	Silver	1 *(2.2)*	
	Zinc	120 *(270)*	

Notes:

1) All results expressed in mg/Kg (ppm).
2) "*" NYSDEC Technical Guidance for Screening Contaminated Sediments, November 1993. An organic carbon value of 2.5% was used to calculate the organic sediment criteria. The lowest effect level sediment criteria is listed for the inorganics, with the severe effect level identified in ( ) and italics.
3) "**" USEPA Interim Sediment Criteria Values for Nonpolar Hydrophobic Organic Contaminants, May 1988 and USEPA 1993 criteria statements for acenapthene, phenanthrene and fluoranthene.
4) "(AT)" indicates that the standard is based on Aquatic Toxicity to benthic organisms. "(WB)" indicates that the standard is based on Wildlife Bioaccumulation. If more than one standard is applicable to a particular analyte, the more stringent standard appears on this table.
5) "***" indicates that the standard is for Phenols, total unchlorinated.
6) Does not include Muggett's Pond Drainage Ditch sample results (SDDD), since these are considered soil samples.

Table 1-9

Soil TBCs for Compounds Detected
Malta Rocket Fuel Area Site

Location	Fraction	Analyte	NYSDEC TAGM 4046 * Recommended Soil Cleanup Objective
Shallow Subsurface Soil **(>1 foot to < 50 feet)** ***(continued)***	Semivolatiles *(continued)*	4-Nitroaniline	50 **
		Phenanthrene	50 **
		Pyrene	50 **
	Pesticides/PCBs	Aldrin	0.041
		Total PCBs	10 ****
		beta-BHC	0.2
		4,4'-DDD	2.9
		4,4'-DDE	2.1
		4,4'-DDT	2.1
		delta-BHC	0.3
		Endosulfan II	0.9
		Heptachlor Epoxide	0.02
		Methoxychlor	10 **
	Inorganics	Aluminum	7243 (SB)
		Antimony	13.2 (SB)
		Arsenic	7.5 or SB
		Barium	300 or SB
		Beryllium	0.33 (SB)
		Cadmium	1 or SB
		Calcium	7065 (SB)
		Chromium	10 or SB
		Cobalt	30 or SB
		Copper	25 or SB
		Cyanide	***
		Iron	12424 (SB)
		Lead	4.5 (SB)
		Magnesium	1931 (SB)
		Manganese	318 (SB)
		Mercury	0.1
		Nickel	13 or SB
		Potassium	1321 (SB)
		Selenium	2 or SB
		Silver	0.73 (SB)
		Sodium	57.7 (SB)
		Thallium	0.14 (SB)
		Vanadium	150 or SB
		Zinc	20 or SB
Surface Soil **(0 to 1 foot)**	Volatiles	Acetone	0.2
		Chloroform	0.3
		Methylene Chloride	0.1
		Xylene (Total)	1.2
	Pesticides/PCBs	Total PCBs	1 ****
		4,4'-DDT	2.1
	Inorganics	Aluminum	9596 (SB)
		Antimony	10.5 (SB)
		Arsenic	7.5 or SB
		Barium	300 or SB
		Beryllium	0.4 (SB)
		Boron	none
Surface Soil	Inorganics	Cadmium	1 or SB

Table 1-9

Soil TBCs for Compounds Detected
Malta Rocket Fuel Area Site

Location	Fraction	Analyte	NYSDEC TAGM 4046 * Recommended Soil Cleanup Objective
(0 to 1 foot)	*(continued)*	Calcium	573.4 (SB)
(continued)		Chromium	10 or SB
		Cobalt	30 or SB
		Copper	25 or SB
		Cyanide	***
		Iron	2000 or SB
		Lead	23.8 (SB)
		Magnesium	1410 (SB)
		Manganese	1035 (SB)
		Mercury	0.1
		Nickel	13 or SB
		Potassium	563 (SB)
		Selenium	2 or SB
		Silver	0.78 (SB)
		Sodium	141 (SB)
		Thallium	0.14 (SB)
		Vanadium	150 or SB
		Zinc	29.2 (SB)

Notes:

1) All results expressed in mg/Kg (ppm).
2) "*" NYSDEC Division Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Cleanup Levels (HWR-94-4046, January 24, 1994 REVISED)
3) "SB" denotes Site Background.
4) "(SB)" denotes that the value reported is considered Site Background.
5) "**" As per TAGM 4046, total VOCs < 10 ppm, total SVOCs < 500 ppm, individual SVOCs < 50 ppm and total pesticides < 10 ppm.
6) "***" TAGM 4046 notes that site-specific forms of cyanide should be taken into consideration when establishing a soil cleanup objective.
7) "MDL" denotes Method Detection Limit.
8) "****" As per TAGM 4046 the recommended soil cleanup objective for PCBs in surface soil is 1 ppm and sub-surface soil is 10 ppm.

Table 1-8

TBC Guidance
Malta Rocket Fuel Area Site

FEDERAL	• USEPA Office of Water Regulations and Standards, Interim Sediment Criteria Values for Nonpolar Hydrophobic Organic Contaminants; May 1988, Updated for specific contaminants (primarily PAHs) in 1993; • USEPA Office of Science and Technology, Interim Guidance on Interpretation and implementation of Aquatic Life Criteria for Metals. • Safe Drinking Water Action National Primary Drinking Water Regulations, Maximum Contaminant Level Goals (MCLGs); • Proposed Maximum Contaminant Levels (50 Federal Register 46936-47022); • Proposed Federal Air Emission Standards for Volatile Organic Control Equipment (52 Federal Register 3748) (air stripper controls); • USEPA Drinking Water Health Advisories; • USEPA Health Effects Assessment (HEAs); • TSCA Health Data; • Toxicological Profiles, Agency for Toxic Substances and Disease Registry, U.S. Public Health Service; • Policy for the Development of Water-Quality-Based Permit Limitations for Toxic Pollutants (49 Federal Register 9016); • Cancer Assessment Group (National Academy of Science Guidance); • Groundwater Classification Guidelines; • Groundwater Protection Strategy; • Waste Load Allocation Procedures; • USEPA Soil Screening Guidance (EPA/540/R-94/101); • The USEPA PCB Spill Policy; • Fish and Wildlife Coordination Act Advisories; and, • Executive Order 11990, "Protection of Wetlands".
STATE	• TAGM 4046, Determination of Soil Cleanup Objectives and Cleanup Levels, January 1994; • NYSDEC, Spill Technlology and Remediation Series (STARS) Memorandum No. 1, Petroleum-Contaminated Soil Guidance Policy, August 1992; • NYS Division of Fish and Wildlife, Technical Guidance for Screening Contaminated Sediments, November 1993; • NYS Underground Injection/Recirculation at Groundwater Remediation Sites (Technical Operating Guidance Series (TOGS) 7.1.2); • New York State Analytical Detectability for Toxic Pollutants; • New York State Toxicity Testing for the SPDES Permit Program (TOGS 1.3.2); • New York State Regional Authorization for Temporary Discharges (TOGS 1.6.1); • New York State Air Guidelines for the Control of Toxic Ambient Air Contaminants (Air Guide 1); • Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites (TAGM 4031); • Selection of Remedial Actions at Inactive Hazardous Waste Sites (TAGM 4030); and • Technical Guidance for Regulating and Permitting Air Emissions from Air Strippers, Soil Vapor Extraction Systems and Cold-Mix Asphalt Units (Air Guide 29).

Table 1-9

Soil TBCs for Compounds Detected
Malta Rocket Fuel Area Site

Location	Fraction	Analyte	NYSDEC TAGM 4046 * Recommended Soil Cleanup Objective
Deep Subsurface Soil **(>50 feet)**	Volatiles	Carbon Tetrachloride	0.6
		Chlorobenzene	1.7
		Methylene Chloride	0.1
		Tetrachloroethene	1.4
		Toluene	1.5
		1,1,1-Trichloroethane	0.8
	Semivolatiles	Anthracene	50 **
		bis(2-Ethylhexyl)phthalate	50 **
	Pesticides/PCBs	Total PCBs	10 ****
	Inorganics	Aluminum	7243 (SB)
		Antimony	13.2 (SB)
		Arsenic	7.5 or SB
		Barium	300 or SB
		Beryllium	0.33 (SB)
		Cadmium	1 or SB
		Calcium	7065 (SB)
		Chromium	10 or SB
		Cobalt	30 or SB
		Copper	25 or SB
		Iron	2000 or SB
		Lead	4.5 (SB)
		Magnesium	1931 (SB)
		Manganese	318 (SB)
		Mercury	0.1
		Nickel	13 or SB
		Potassium	1321 (SB)
		Selenium	2 or SB
		Sodium	57.7 (SB)
		Vanadium	150 or SB
		Zinc	23.3 (SB)
Shallow Subsurface Soil **(>1 foot to < 50 feet)**	Volatiles	Acetone	0.2
		Carbon Tetrachloride	0.6
		Chloroform	0.3
		Ethylbenzene	5.5
		Tetrachloroethene	1.4
		Toluene	1.5
		Trichloroethene	0.7
		Xylene (Total)	1.2
	Semivolatiles	Benzo(a)anthracene	0.224 or MDL
		Benzo(a)pyrene	0.061 or MDL
		Benzo(b)fluoranthene	1.1
		Benzo(k)fluoranthene	1.1
		Chrysene	0.4
		2,4-Dimethylphenol	50 **
		Fluoranthene	50 **
		Fluorene	50 **
		2-Methylnaphthalene	36.4
		2-Methylphenol	0.1 or MDL
		4-Methylphenol	0.9

Table 1-6

Surface Water ARARs for Detected Compounds
Malta Rocket Fuel Area Site

Location	Fraction	Analyte	NYSDEC Class C Surface Water Standard
Muggetts Pond	Inorganics	Aluminum	0.1 *(ionic)*
		Beryllium	0.011 (a)
		Cadmium	0.00093 *(calc)*
		Iron	0.3
		Zinc	0.06675 *(calc)*
Ravine 1B	Inorganics	Aluminum	0.1 *(ionic)*
		Arsenic	0.19 *(dissolved)*
		Beryllium	0.011 (a)
		Cadmium	0.00269 *(calc)*
		Copper	0.03454 *(calc)*
		Iron	0.3
		Lead	15.7574 *(calc)*
		Selenium	0.001 *(acid-soluble)*
		Silver	0.0001 *(ionic)*
		Zinc	0.24001 *(calc)*

Notes:

1) All results expressed in mg/L (ppm).
2) "*" NYSDEC Ambient Water Quality Standards and Guidance Values (TOGS 1.1.1, October 1993).
3) "(a)" denotes a standard of 0.011 if hardness <75ppm, 1.1 if hardness is > 75ppm. The more conservative value has been presented regardless of the actual hardness for comparison purposes.
4) "(ionic)" denotes that the standard applies only to the ionic form of the analyte.
5) "(dissolved)" denotes that the standard applies only to the dissolved form of the analyte.
6) "(acid-soluble)" denotes that the standard applies only to the acid-soluble form of the analyte.
7) "(calc)" denotes that the standard is calculated based upon the hardness of the sample. The hardness values for the actual samples have been calculated using the following formula: 2.497 * (calcium concentration in mg/L) + 4.118 * (magnesium concentration in mg/L). The standards were calculated using the applicable formula listed below:

Cadmium	exp(0.7852*ln(ppm hardness) - 3.49)/1000
Copper	exp(0.8545*ln(ppm hardness) - 1.465)/1000
Lead	exp(1.266*ln(ppm hardness) - 4.661)/1000
Zinc	exp(0.85*ln(ppm hardness) + 0.50)/1000

Table 1-7

Action-Specific ARARS
Malta Rocket Fuel Area Site

FEDERAL	• Polychlorinated biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions (40 CFR 761); • CWA (Clean Water Act) - NPDES Permitting Requirements for Discharge of Treatment System Effluent (40 CFR 122-125); • CWA Discharge to Publicly-Owned Treatment Works (POTW) (40 CFR 403); and • Occupational Safety and Health Standards for Hazardous Responses and General Construction Activities (29 CFR 1904, 1910, 1926). • Underground Injection Control (UIC) Program (40 CFR Part 144)
STATE	• New York State Pollution Discharge Elimination System (SPDES) Requirements (Standards for Storm Water Runoff, Surface Water, and Groundwater Discharges) (6 NYCRR 750-757) • New York State regulations regarding water quality standards and discharge limitations (6 NYCRR Parts 700 - 703) • New York State Sanitary Code, Chapter 1, Subpart 5.1, which regulates public water supplies; and • New York State Air Emission Requirements (VOC Emissions for Air Strippers and Process Vents, General Air Quality) (6 NYCRR Parts 200-212).

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Table 1-4

Chemical-Specific ARARs
Malta Rocket Fuel Area Site

Requirement	Synopsis	Application
STATE:		
NYSDEC Quality Standards for Groundwater (6 NYCRR Part 703)	Establishes standards for Class GA groundwater.	Groundwater in overburden/bedrock deposits.
NYS Surface Water Quality Standards and Discharge Limitations (6 NYCRR Parts 701, 702, and 704)	Establishes standards for surface water quality.	Surface waters of New York.
NYSDOH Public Water Systems MCLs (10 NYCRR Part 5, Subpart 5-1)	Establishes maximum contaminant levels for drinking water.	Potential drinking waters.
FEDERAL:		
Safe Drinking Water Act Maximum Contaminant Levels (MCLs) (40 CFR 141.11-.16)	Enforceable standards for public drinking water systems.	Finished drinking water delivered to the consumer.
Effluent Limitations (40 CFR Part 301 and 302)	Enforceable standards for effluent discharges.	Liquid discharges from the Site.
Toxic Substances Control Act (40 CFR 761)	Regulates management and disposal of materials containing PCBs	Site soil cleanup levels

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Note: If RCRA hazardous wastes are identified on site, the appropriate RCRA requirements would be followed.

Table 1-5
Groundwater ARARs for Detected Compounds
Malta Rocket Fuel Area Site

Location	Fraction	Analyte	NYSDEC Groundwater Standard * (mg/L)	USEPA Drinking Water Standard ** (mg/L)	NYSDOH Drinking Water Standard *** (mg/L)
Former GE/Exxon Building	Volatiles	Carbon Tetrachloride	0.005	0.005	0.005
		Methylene Chloride	0.005	0.005	0.005
	Semivolatiles	bis(2-Ethylhexyl)phthalate	0.05	0.006	0.05
		di-n-Butylphthalate			0.05
	Inorganics	Antimony		0.006	
		Barium	1	2	2
		Beryllium		0.004	
		Calcium			
		Chromium	0.05	0.1	0.1
		Copper	0.2	1.3 (1)	1.3
		Iron	0.3	(0.3)	0.3
		Lead	0.025	0.015	0.015
		Magnesium			
		Manganese	0.3 (b)	(0.05)	0.3
		Nickel		0.1	
		Potassium			
		Sodium	20		
		Zinc	0.3	(5)	5
Malta Test Station	Volatiles	Acetone			0.05
		Benzene	0.0007	0.005	0.005
		Bromodichloromethane		0.1 (c)	0.1 (c)
		Carbon Disulfide			0.05
		Carbon Tetrachloride	0.005	0.005	0.005
		Chloroform	0.007	0.1 (c)	0.1 (c)
		Chloromethane	0.005		0.005
		1,1-Dichloroethene	0.005	0.007	0.005
		Hexachlorobutadiene	0.005		0.005
		2-Hexanone			0.05
		Methylene Chloride	0.005	0.005	0.005
		Tetrachloroethene	0.005	0.005	0.005
		1,2,3-Trichlorobenzene	0.005		0.005
		1,1,1-Trichloroethane	0.005	0.2	0.005
		Trichloroethene	0.005	0.005	0.005
		Trichlorofluoromethane	0.005		0.005
		Naphthalene			0.05
	Semivolatiles	bis(2-Ethylhexyl)phthalate	0.05	0.006	0.05
		Diethylphthalate			0.05
		di-n-Butylphthalate			0.05
	Pesticides/PCBs	beta-BHC	ND(a)		
	Inorganics	Antimony		0.006	
		Barium	1	2	2
		Beryllium		0.004	
		Boron	1		
		Cadmium	0.01	0.005	0.005
		Chromium	0.05	0.1	0.1
		Copper	0.2	1.3 (1)	1.3
		Iron	0.3	(0.3)	0.3
		Lead	0.025	0.015	0.015
		Magnesium			
		Manganese	0.3 (b)	(0.05)	0.3
		Nickel		0.1	
		Potassium			
		Sodium	20		
		Zinc	0.3	(5)	5

Notes:

1) All results expressed in mg/L (ppm).
2) "*" NYSDEC Ambient Water Quality Standards and Guidance Values (TOGS 1.1.1, October 1993).
3) "**" USEPA National Primary Drinking Water Standards (as per 49 CFR Part 140-149). Secondary standards are in ( ).
4) "***" NYSDOH Title 10, Part 5 Drinking Water Standards (1992).
5) "(a)" denotes that the value listed applies to the sum of all Hexachlorocyclohexane isomers.
6) "(b)" denotes that the sum of the Iron and Manganese results may not exceed 500 mg/L.
7) "(c)" denotes that the Total Trihalomethanes result may not exceed 0.10 mg/L. Trihalomethanes include the following compoun
Chloroform, bromoform, bromodichloromethane and dibromochloromethane.

Table 1-2

Summary of Excess Lifetime Cancer Risks and Noncarcinogenic Risks (Hazard Indices) to Hypothetical Receptors Malta Rocket Fuel Area Site

RECEPTOR	Total Excess Lifetime Cancer Risks						Noncarcinogenic Risks					
	Former GE/Exxon Building(1)		Malta Test Station(2)		Site-Wide(3)		Former GE/Exxon Building(1)		Malta Test Station(2)		Site-Wide(3)	
	Excluding Building 23P	Including Building 23P	Excluding Building 23P	Including Building 23P	Excluding Building 23P	Including Building 23P	Excluding Building 23P	Including Building 23P	Excluding Building 23P	Including Building 23P	Excluding Building 23P	Including Building 23P
Current On-Site Employee			4.5×10^{-6}	6.8×10^{-5}					8×10^{-2}	5×10^{-1}		
Current/Future Utility Worker					2.7×10^{-7}						3×10^{-3}	
Current/Future Trespasser					1.5×10^{-11}						2×10^{-3}	
Future Excavation Worker					1.6×10^{-8}	3.2×10^{-6}					3×10^{-3}	2×10^{-2}
Future Adult Resident	1.0×10^{-5}	1.7×10^{-4}	6.6×10^{-5}	2.2×10^{-4}			5×10^{-2}	2×10^{0}	7×10^{-1}	2×10^{0}		
Future Child Resident (1-6 years old)	1.2×10^{-5}	2.1×10^{-4}	7.1×10^{-5}	2.7×10^{-4}			4×10^{-2}	1×10^{0}	6×10^{-1}	2×10^{0}		
Future Child Resident (6-15 years old)					3.8×10^{-6}						7×10^{-2}	

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Notes:

(1) Assumes the adult/child resides on property located at the former GE/Exxon Building.

(2) Assumes on-site worker is exposed to effluent from the on-site air stripper-treated Malta Test Station groundwater or the adult/child resides on property located at the Malta Test Station.

(3) No exposure to groundwater for the receptors indicated.

Table 1-3
Location-Specific ARARs*
Malta Rocket Fuel Area Site

Requirement	Synopsis	Application
STATE:		
Use and Protection of Waters (6 NYCRR Part 608; ECL 15-0501 and 15-0505)	Under this regulation, a permit is required to change, modify, or disturb any protected stream, its bed or banks, sand, gravel, or any other material; or to excavate or place fill in any of the navigable waters or in any marsh, estuary or wetland, contiguous to any of the navigable waters of the State.	Possibly applicable. If disturbance of a stream is required as part of the remedy, a permit from the NYSDEC may be required.
New York State Ambient Water Quality Standards (6 NYCRR Parts 700-705)	Defines surface water and aquifer classification and lists specific chemical standards.	Applicable. Classifications and standards can be used to help establish remedial cleanup goals.
Endangered and Threatened Species of Wildlife (6 NYCRR Part 182)	Site activities must minimize impact on identified endangered or threatened species of fish or wildlife.	Possibly applicable. No endangered species have been identified at the Site. However, the NYSDEC has identified lupines, a food source for the Karner Blue butterfly at the Site.
FEDERAL:		
Clean Water Act, Section 404(b)(1)/U.S. Army Corps of Engineers Nationwide Permit Program (33 CFR 330)	Activities involving the construction or alteration of bulkheads, dikes, or navigable waters, including wetlands, are regulated by the Corps of Engineers.	Possibly applicable for ravine streams/ associated wetlands and/or Muggett's Pond.
Fish and Wildlife Coordination Act (16 USC 662)	Any action that proposes to modify a body of water or wetland requires consultation with the U.S. Fish and Wildlife Service.	Possibly applicable if Muggett's Pond or ravine streams are affected by a remedial action at the Site.
Endangered Species Act (50 CFR 200, 402)	Site activities must minimize impacts on identified endangered plant and animal species.	Possibly applicable. No endangered species have been identified at the Site. However, the NYSDEC has identified lupines, a food source for the Karner Blue butterfly at the Site.
National Historic Preservation Act (PL 89-665, Oct 15, 1966)	Program for the preservation of additional historic properties throughout the nation.	Possibly applicable to the buildings and structures on the Test Station.
Farmland Protection Policy Act (PL 97-98, Dec 22, 1991)	Policy enacted to minimize the extent to which federal programs contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses. It also addresses actively managed forestland.	Possibly applicable to the Luther Forest area that is actively forested.

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* Local zoning ordinances and building codes may be applicable but are not listed.

Table 1-1
Summary of Previous Investigations
Malta Rocket Fuel Area Site

Report/Date	Nature of Investigation/Findings
Dunn Geoscience Corporation (Dunn), 1977	Investigation conducted to assess the feasibility of developing a water resource to supply the proposed Luther Forest housing development. Included an evaluation of local geologic and hydrogeologic conditions and aquifer characteristics. Concluded that a fine to coarse-grained, 30 foot thick aquifer exists southwest of the MRFA Site. Transmissivity values ranged from 10,000 to 40,000 gallons per day per foot. Two water supply wells with an estimated long-term yield of 100 and 125 gallons per minute (gpm) were installed to serve the Luther Forest development.
C.T. Male Associates, P.C., 1979	A site assessment of the Test Station was prepared for NYSERDA. The assessment described the condition of the natural site environment, existing buildings, roads, traffic patterns, utilities (water supply wells and distribution system, fire protection, sanitary sewage disposal, storm-water drainage, electrical, gas, and telephone), existing landfill and incinerator sites, metal reclamation locations, and waste disposal areas.
C.T. Male Associates, P.C., 1985	Tap water from the NYSERDA field office bathroom was sampled in March 1985, but analytical results are unavailable. However, a C.T. Male letter report dated 12 April 1985 states that elevated levels of PCBs, boron, chloroform, carbon tetrachloride, and trichloroethene (TCE) were present. Resampling the tap and sampling the four water supply wells at the site to confirm these results was conducted in April 1985. Analytical results showed concentrations of PCBs, boron, chloroform, carbon tetrachloride, TCE, and some additional organic compounds and inorganic analytes.
Geraghty & Miller, Inc., 1985	Soil, groundwater, and ambient air quality investigation at the Berth 24 test pad (Building 24) was conducted to obtain background data prior to renovations. The soil and groundwater investigation consisted of drilling two soil borings and completing one of the borings as a shallow groundwater monitoring well (MW-9S). The monitoring well has since been destroyed. Two composite soil samples, one from each boring, were submitted for laboratory analysis for the organic compounds and inorganic analytes on the priority pollutant list. Methylene chloride was detected in the samples, but its presence was attributed to laboratory contamination. Several inorganic analytes were detected in both soil samples. One unfiltered groundwater sample from monitoring well MW-9S showed detectable concentrations of carbon tetrachloride and methylene chloride. The methylene chloride was attributed to laboratory/field contamination. Several inorganic analytes were also detected. Four ambient air samples were collected in and around the Berth 24 test pad. No contamination was detected in these samples.
Geraghty & Miller, March 1985	MW-9S was resampled to confirm the analytical results of the previous sampling event. One filtered sample was collected from monitoring well MW-9S and samples were also collected from two production wells (Wells 1D and 2D). Analytical results for organic compounds showed detectable concentrations of carbon tetrachloride, chloroform, and TCE. Results also showed detectable concentrations of cadmium and zinc. The remaining inorganics detected in the previous unfiltered sample from this well were not detected in this filtered sample.
Geraghty & Miller, October 1985	Investigation conducted to evaluate soil excavated from Area D-6 that was used as cover material at Berth 24 (Building 24) during regrading activities. The investigation included installation of ten hand auger soil borings to a maximum depth of ten feet. One composite soil sample was submitted for laboratory analysis from each boring for VOC and semi-volatile organic compound (SVOC) analysis. Analytical results showed detectable concentrations of benzene and toluene in one of the ten samples and bis (2-ethylhexyl) phthalate in seven of the ten samples.
New York State Department of Health (NYSDOH), April 1985	Samples were collected from the Test Station water supply wells. These groundwater samples contained chloroform, carbon tetrachloride, TCE, dibromochloromethane, copper, and lead. To remediate the Test Station drinking water supply, groundwater from the supply wells is now being treated by air stripping.

Table 1-1
Summary of Previous Investigations
Malta Rocket Fuel Area Site

Report/Date	Nature of Investigation/Findings
O'Brien & Gere Engineers, Inc.,1986	OBG evaluated the Test Station for NYSERDA to assess the source of VOCs in groundwater and to identify areas of possible concern. The report included a review of previous studies, a description of a site visit and field reconnaissance, and a review of aerial photographs, and a summary of the hydrogeologic conditions previously described by C.T. Male Associates, P.C. (1979). A brief description of the Test Station water supply system and a summary of previous groundwater data from samples collected by NYSDOH and C.T. Male Associates, P.C. in 1985 were also provided. C.T. Male reported carbon tetrachloride, TCE, chloroform, and PCBs had been detected in the Test Station water supply wells and distribution system at maximum concentrations of 840 ug/l, 230 ug/l, 58 ug/l, and 1.3 ug/l, respectively. Mercury (0.085 mg/1), chromium (0.018 mg/1), lead (0.025 mg/1), copper (0.09 mg/1), and boron (0.099 mg/1) were also detected in the supply wells and/or distribution system. Aerial photographs were reviewed and the approximate time periods during which disposal activities occurred at Areas D-1 through D-5 were estimated. The report concluded that the most likely source(s) of VOCs in groundwater was the area northeast of water supply well 2D (the second water supply well for the Test Station) where drums had been stored (i.e., Buildings 10 and 28), and/or disposal Areas D-2, D-4, and D-5. Other potential sources identified included Area D-3, the PTI impoundment, and Area D-6. A small mound located adjacent to PTI (Building 25) was also identified by O'Brien & Gere Engineers, Inc. (1986), although review of aerial photographs during the RI did not confirm the presence of a mound.
Geraghty & Miller, Inc., 1986	Shallow soil samples were collected and four monitoring wells (MW-1 through MW4) were installed adjacent to the southeastern boundary of the Test Station (Triangular Parcel) as part of a site assessment for GE in advance of constructing a proposed testing area on the Triangular Parcel. A soil vapor testing program was performed by hand augering a number of locations and measuring the total organic vapors with a portable photoionization detector. The soil vapor measurements (maximum concentration was 22 ppm) were attributed to naturally occurring volatile organic compounds. To confirm this, two shallow soil samples (1.5-2.0 feet below land surface) were collected from the areas of highest soil vapor measurements and a single soil boring was advanced for the collection of a deeper soil sample (four to five feet below land surface). Priority pollutant VOCs were not detected in any of the soil samples. The monitoring wells were installed to assess the groundwater flow direction and quality in the vicinity of the Triangular Parcel. Water level measurements from the four wells indicated that groundwater flow is to the southwest. Analytical results of the groundwater samples show that TCE was detected in monitoring well MW-2 only. Several SVOCs were detected in two of the monitoring wells (MW-1 and MW-2). Low concentrations of PCBs were reported in MW-1. Analytical results for inorganic analytes showed detectable concentrations of zinc in MW-1 and MW-2. A magnetometer survey was also performed, and no buried ferromagnetic material was identified. Construction of the proposed testing area never occurred on the Triangular Parcel.
Blasland & Bouck Engineers, P.C., 1986	A hydrogeologic and water quality investigation was performed. Eleven monitoring wells and two well points were installed and sampled, surface water samples were collected from some of the ravines around the Site, and a pump test was performed on production well 1D. Surface water samples were collected from some of the ravines. Groundwater samples were also collected from production well 2D and the two well points installed in Ravine 2 adjacent to the midstream and downstream surface water sampling locations. Production well 2D was sampled to determine the list of analytical parameters for sampling all designated project monitoring wells at the site. Approximately six weeks later, groundwater samples were collected from the 15 designated monitoring wells.
NYSDOH, 1989	NYSDOH summarized the site history, provided a table of NYSDOH water sampling results, and discussed the quality of the drinking water supply at the Test Station and the air stripper installations. The report described NYSDOH monitoring of the Luther Forest water supply wells located approximately 6,000 feet southwest of the Test Station, and stated that no contamination had been detected. The Test Station supply wells were reported to have concentrations of carbon tetrachloride, TCE, and chloroform. The highest concentrations were detected in production well 2D, which contained chloroform (25 ug/1), carbon tetrachloride (220 ug/1), and TCE (120 ug/1). Certain on-site monitoring wells also contained these chemicals. The off-site surface water also contained chloroform (4 ug/1), carbon tetrachloride (36 ug/1), and TCE (27 ug/1). NYSDOH recommended that the RI/FS be completed prior to preparation of a health assessment.

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Source: Remedial Investigation Report, Malta Rocket Fuel Area Site, ERM-Northeast, Inc., February 1995.

D. Steenberge

ENVIRONMENTAL CONSERVATION DEPT.
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OCT 20 1995
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BUREAU OF EASTERN REMEDIAL ACTION
DIVISION OF HAZARDOUS
WASTE REMEDIATION

October 18, 1995

Ms. Alison Hess
U.S. Environmental Protection Agency
290 Broadway, 20th Floor, NYCSFB2
New York, NY 10007-1866

RE: Feasibility Study - Tables for Section 1.0
Malta Rocket Fuel Area Site

Dear Ms. Hess:

The tables for Section 1.0 of the Feasibility Study for the Malta Rocket Fuel Area Site were inadvertently omitted when the document was sent to you on October 6, 1995. Two copies of Tables 1-1 through 1-11 are enclosed for insertion into the documents previously sent to you. All tables should be placed immediately following page 1-26 and before Figure 1-1.

I apologize for the inconvenience. Please call me at (518) 435-7254 if you have questions or require additional information.

Sincerely,

Barbara C. Hotchkin

Barbara C. Hotchkin
Senior Project Manager

enclosure

cc: Kristen Begor (without enclosure)
Hal Brodie
Victor Cardona (three copies)
Don Hooker
Claudine Jones Rafferty

TABLE OF CONTENTS

TABLE OF CONTENTS
(CONTINUED)

TABLE OF CONTENTS
(CONTINUED)

Chapter Page

TABLE OF CONTENTS
(CONTINUED)

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS
(CONTINUED)

Table (Continued)

LIST OF APPENDICES

Appendix

1.0 INTRODUCTION

Under the requirements of a 1989 Unilateral Administrative Order (UAO) from the United States Environmental Protection Agency (USEPA), the Malta Participating Parties[1] (Malta PPs) have performed a Feasibility Study (FS) for the Malta Rocket Fuel Area Site (MRFA Site or Site), located in Saratoga County, New York. Prior to the completion of the Remedial Investigation (RI) conducted at the Site, also as part of the UAO, the Malta PPs retained RUST Environment & Infrastructure (RUST) to prepare the FS Work Plan and conduct the FS.

1.1 Purpose and Organization of Report

The purpose of the FS is to identify and analyze remedial alternatives that: are protective of human health and the environment; attain, to the maximum extent practicable, applicable or relevant and appropriate requirements (ARARs); and are cost effective. Accordingly, the MRFA Site FS is based on objectives, methodologies, and evaluation criteria as generally set forth in the following federal regulations and guidelines:

- the Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA) and the Superfund Reauthorization Act of 1986 (SARA);
- the National Oil and Hazardous Substances Contingency Plan (NCP);

- Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (USEPA, October 1988); and

- CERCLA Compliance with Other Laws Manual, 1988, OSWER Directive No. 9234.1-01 and -02.

The remainder of Section 1.0 contains background information about the Site, and a brief summary of the scope of the RI and pertinent RI findings including the physical systems, nature and extent of contamination, and contaminant fate and transport. Section 1.0 also provides a summary of the baseline risk assessment (RA), including the methodology and results for both the human health and ecological portions of the RA. Section 2.0 identifies the remedial action objectives, general response actions, and remedial technologies, and presents the screening of the remedial technologies on the basis of effectiveness, technical implementability, and cost. In Section 3.0, the technologies are grouped into remedial alternatives, which are then screened to eliminate those that are not suitable. In Section 4.0, a detailed analysis of the alternatives retained is presented, and the recommended remedial alternative is identified and described.

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[1] The Participating Parties undertaking the Remedial Investigation/Feasibility Study are General Electric Company (GE), New York State Energy Research and Development Authority (NYSERDA), and the U.S. Department of Defense (DOD).

1.2 Background Information

1.2.1 Description of the MRFA Site

The MRFA Site, also known as the Saratoga Research and Development Center, is located on Plains Road in the Towns of Malta and Stillwater, Saratoga County, New York. The Site includes a square parcel of approximately 165 developed acres, known as the Malta Test Station, and a portion of the predominantly undeveloped woodlands surrounding the Test Station. Figure 1-1 identifies the location of the Site as described in the 1989 UAO, and Figure 1-6 shows additional areas of the Site to the northeast and southwest of the Test Station that were identified during the RI.

The Test Station is surrounded by a restrictive "easement area" consisting of approximately 1,800 acres of woodlands. The restrictive easement area is further described in Section 1.2.3.

Thirty-three buildings have been constructed at the Test Station during its use as a research and development facility. In addition, numerous quench pits (concrete structures), leach fields/septic tanks, dry wells, storage areas, and disposal areas are also present on site. In addition, a fence surrounding most of the 165-acre Test Station and a single access road restrict public access to the Test Station. The only surface water body on the Test Station is Muggett's Pond, which is a small (0.07 acre) artificial pond.

An area of undeveloped forest adjacent to and southeast of the Malta Test Station, known as the Triangular Parcel, is owned by the Wright-Malta Corporation. Wright-Malta installed a fence surrounding the Triangular Parcel in 1993 to prevent trespassing. This area was evaluated in 1986 as a potential testing area, but has never been used for testing.

The former GE/Exxon Building is located near the edge of a one-mile safety easement along the access road near Plains Road. It was built between 1968 and 1970 by New York State Atomic and Space Development Authority (NYSASDA) and was historically used for experiments on the low-level radioactive sanitation of medical equipment and food preservation. It was later used for a gas centrifuge uranium enrichment research project conducted by GE and Exxon Nuclear Company. The rear portion of the former GE/Exxon Building property is also fenced. This building is currently leased to Optimum Air Corporation, a manufacturer of equipment used to capture fumes associated with application of industrial coatings, including primers, sealants, and paint.

A former disposal area known as Area D-3, reportedly used by the New York State Department of Transportation during the construction of Interstate I-87 for construction and demolition debris, is located on the southwest side of the Test Station access road, approximately midway between the Test Station and the former GE/Exxon Building. Area D-3 consists of a ravine partially filled with debris and vegetated cover soil.

The MRFA Site has its own water supply wells, water treatment system, and water distribution system. The supply wells (1D and 2D) are currently pumped simultaneously, on demand, at a collective pumping rate estimated by Wright-Malta to average less than 1,000 gallons per day (0.7 gallons per minute). The recovered groundwater is treated by air stripping prior to use. Additional information on the water treatment system is provided in Section 1.2.8.

The vegetative cover types at the MRFA Site include northern-pine hardwood forest, mowed lawn/pine-northern hardwood forest, pine plantation, red maple-hardwood swamp, successional northern shrub, and successional old field. Potential wetland/aquatic habitats on the Site are limited to Muggett's Pond and a small stream within a wooded ravine (Ravine 1b). There are many varieties of trees and shrubs as well as birds and mammals at the Site, although no special resources or significant habitats are present. There are no known rare or endangered species.

1.2.2 Site History

The United States (U.S.) Government established the 165-acre Malta Test Station in 1945 for rocket development and testing. Until 1964, it was operated under the direction of various U.S. Government agencies for a wide range of rocket and weapon testing programs and space research activities. The U.S. Government leased the Site from 1945 until 1955 from the Luther family. In 1955, it acquired the property and established a perpetual restrictive easement prohibiting human habitation within a one-mile radius of the center of the Test Station.

Since 1945, portions of the property have been leased to a variety of companies acting as contractors to agencies of the U.S. Government. These companies included: GE; Wright-Malta Corporation; Exxon Nuclear Company, Inc.; Olin Corporation; Advanced Nuclear Fuels; Iso-Nuclear Corporation; Gamma Processing Company; Mechanical Technology, Inc. (MTI); and Power Technologies, Inc. (PTI).

In 1964, NYSASDA, the predecessor of the New York State Energy Research and Development Authority (NYSERDA), purchased the Test Station and the U.S. Government's interest in the easement area. Four years later, the State purchased the 280 adjacent acres, 273 of which were part of the easement. Since 1968, portions of the Site have been leased to GE, Wright-Malta Corporation, Exxon Nuclear Company, MTI, PTI and Optimum Air Corporation.

In 1984, NYSERDA sold 81 acres of the original Malta Test Station property to the Wright-Malta Corporation. Currently, NYSERDA and Wright-Malta own portions of the Test Station, while the Luther Forest Corporation owns the peripheral easement property.

In 1985 and 1986, groundwater at the Site was sampled and found to contain carbon tetrachloride, trichloroethene (TCE), and chloroform, along with several metals. In 1987, an air stripper was installed by Wright-Malta to treat groundwater prior to on-site use. Because public water supply wells serving the Luther Forest Development are located approximately 6,000 feet southwest of the Site boundary, an early warning mechanism referred to as the Early Warning Monitoring System (EWMS) was established by the Malta PPs in 1987. This monitoring assesses the quality of the groundwater and surface water between the Test Station and the Luther Forest Well Field, and serves to determine if the MRFA Site groundwater contamination is migrating towards the Luther Forest Well Field.

The MRFA Site was placed on the National Priorities List (NPL) in July 1987. The UAO was issued to the Malta PPs and five other potentially responsible parties[2] (PRPs) in September 1989 under Section 106(a) of CERCLA. The UAO required the PRPs to conduct an RI/FS. The RI, which was initiated by the PPs in 1990, is described in Section 1.3. A draft RI Report was submitted to the USEPA in February 1993, and a Revised RI Report was submitted on September 30, 1994. Conditional approval of the RI Report was obtained on February 1, 1995. The final RI Report was issued in February 1995.

1.2.3 Easement Area

A restrictive "easement area" surrounding the Test Station was created by the U.S. government when it acquired the Test Station property in 1955. The easement is a circular area within a one-mile radius of the approximate geographic center of the Test Station. The easement area, which consists of approximately 1,800 acres of woodlands, acts as a safety buffer for neighboring residents. The holder of the easement has the right to: prohibit hunting and human habitation, remove buildings being used for human habitation, post signs, and enter the easement area to exercise the above rights.

The restrictive easement was transferred to New York State with the Test Station property in 1964. It was subsequently extinguished with respect to the 445-acre site owned by New York State (State). In 1984, the restrictive easement with respect to the balance of the easement area was transferred to the Wright-Malta Corporation with an 81-acre portion of the Test Station. The remaining 364 acres retained by the State are specifically excluded from the restrictive easement.

1.2.4 Description of the Surrounding Area

The Site is located in the Towns of Malta and Stillwater, approximately one and one-half miles south of Saratoga Lake and two miles northeast of Round Lake. The populations of the Towns of Malta and Stillwater are approximately 11,600 and 8,000, respectively. The population within a two-mile radius of the Site is approximately 12,000.

The Luther Forest Housing Development (Town of Malta) approaches within approximately 200 feet of the west boundary of the MRFA Site near the former GE/Exxon Building. Potable water for the Luther Forest Development is obtained from two different well fields: the Luther Forest Well Field and the Cold Springs Well Field. Both of these public water supply well fields are located approximately one mile from the MRFA Site. The Luther Forest Well Field, also in Malta, is located approximately one mile southwest of the MRFA Site north of Knapp Road. This well field consists of five production wells, which are operated by the Saratoga Water Company and connected to the Luther Forest water distribution system. The Cold Springs Well Field is located approximately one mile northeast of the MRFA Site along Cold Springs Road in the Town of Stillwater. This well field consists of one well that was installed in 1990, and connected to the Luther Forest water distribution system in March 1993. The low permeability Lake Albany clay and silt prevents direct hydraulic connection between the water-bearing materials beneath the MRFA Site and the well field aquifers.

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[2] The other five PRPs are Advanced Nuclear Fuels, Inc., Curtiss-Wright Corporation, Mechanical Technology, Inc. (MTI), Olin Corporation, Power Technologies, Inc. (PTI), and Wright-Malta Corporation.

In addition, there are two other production wells in the area, the Saratoga Hollow Well and Saratoga Ridge Well, both of which are located along Lake Road north of the Cold Springs Well Field. These wells are not connected to the Luther Forest water distribution system. They provide service to the Saratoga Glen Hollow Housing Development and the Saratoga Ridge Townhouse Development, respectively. Like the Cold Springs Well Field, these production wells are not hydraulically connected to the water bearing materials beneath the MRFA Site.

Five large surface water bodies (Saratoga Lake, Mechanicville Reservoir, Round Lake, Little Round Lake, and Ballston Creek) and eight New York State Department of Environmental Conservation (NYSDEC)-regulated wetlands are present within two miles of the Site. Southwest and northeast of the MRFA Site boundaries, several springs in ravines create small streams (Ravines la, lb, 2a, 2b, 2c, 3, 4, 5, 6a, 6b, 7, and 8) that eventually flow to Round Lake to the south and Saratoga Lake to the north. The NYSDEC Wildlife Resources Center identified one significant habitat, the Luther Forest, located within 0.25 miles of the Site.

1.2.5 Land Use and Zoning

The MRFA Site has been used for industrial purposes since 1945. The land uses in Malta and Stillwater are primarily residential, with some commercial and light industrial land uses. The primary land uses near the Site are residential and forest land, as indicated on Figure 1-2. The forest land within the one-mile safety easement is logged by the Luther Forest Corporation. The closest residence to the Site is located in the Town of Malta in the Luther Forest Housing Development approximately 200 feet west of the westernmost MRFA Site boundary near the former GE/Exxon Building, and 3,800 feet from the Test Station boundary.

The commercial area closest to the Site is in the Town of Malta at the corner of Routes 9 and 67, approximately one mile west of the westernmost Site boundary and two miles northwest of the center of the Test Station. This commercial area consists of a gas station, restaurants, retail stores, and a shopping center.

Figure 1-3 depicts the zoning of the Site and the surrounding area. The majority of the Site, which is in the Town of Malta, is not zoned; it is identified as "New York State Energy Research and Development Authority" on the Town of Malta Zoning Map. The surrounding area to the north, south, and west of the Site has been zoned as Planned Development District (PDD) #9 since 1976 when a resolution amending the Town of Malta Zoning Ordinance was adopted. The portion of the Site within the Town of Stillwater is zoned rural residential, as is the area to the east, northeast, and southeast of the Site. The area within the restrictive easement is zoned as PDD or Rural Residential District (RRD).

1.2.6 Previous Investigations

A number of relevant investigations have been conducted at the Site. Table 1-1 contains a brief summary of pertinent investigations. These investigations are summarized in more detail in the Literature Search Report (Geraghty and Miller, 1992) and the RI Report (ERM-Northeast, 1995). The following sections provide pertinent information on the EWMS and the on-site groundwater treatment system.

1.2.7 Early Warning Monitoring System (EWMS)

In 1987, GE retained Dunn Geoscience Corporation (DUNN) to perform a hydrogeologic and water quality investigation to establish monitoring locations for the EWMS. During the 1987 investigation, six monitoring wells (three well pairs) were installed between the Test Station and Luther Forest Well Field. These six wells along with four surface water sample locations comprised the initial EWMS monitoring locations. Groundwater and surface water samples from these locations were collected quarterly to detect the potential presence of constituents in the water. Groundwater samples were analyzed for volatile organic compounds (VOCs) and three inorganics (aluminum, boron, and lead), while the surface water samples were analyzed for selected VOCs and inorganics.

The EWMS has evolved over time, and various modifications have been incorporated. As of February 1995, the EWMS program consists of sampling seven monitoring well locations (DGC-3S, DGC-4S, 13S, M-27S, M-27-D, M-33S, and M-33I) and three surface water locations (SW-A, SW-B, and SW-D). Groundwater and surface water samples from these locations are now collected semi-annually (May and October). All samples except 13S are analyzed for VOCs. Samples from 13S, 27S, M-27D, and SW-B are analyzed for unfiltered total chromium and hexavalent chromium. Monitoring reports are submitted to the USEPA and NYSDEC.

Since the beginning of the EWMS program, very low concentrations of carbon tetrachloride (0.3 to 1.1 μg/1) have been occasionally detected in one surface water sample from the upper portion of Ravine 2a; however, this compound has not been detected in the surface water near the well field. This constituent likely volatilizes into the ambient air prior to recharge of the surface water into the aquifer tapped by the Luther Forest water supply wells due to the volatility of carbon tetrachloride.

Carbon tetrachloride has been detected at low concentrations (4.4 to 24 μg/1) in the two former EWMS wells closest to the Test Station (10S and 13S), but not in any of the other EWMS wells closer to the Luther Forest well field. Total chromium has been detected in several EWMS wells at concentrations ranging from 5.1 to 62.2 μg/l, with higher concentrations (172 to 562 μg/1) detected in wells 13S and 13D. Unfiltered and filtered total chromium and unfiltered hexavalent chromium concentrations in well 13S indicate nearly all of the chromium in well 13S is hexavalent and is dissolved in groundwater. Likewise, nearly all of the chromium in well 13D is trivalent and insoluble. TCE, benzene, carbon disulfide, and aluminum have also been detected sporadically in EWMS wells at concentrations below groundwater standards.

1.2.8 On-Site Water Supply and Groundwater Treatment System

The Test Station's water supply is derived from two private water supply wells (1D and 2D) located within the boundary of the Test Station. Groundwater is pumped on an on-demand basis for use by Wright-Malta, MTI and Optimum Air Corporation. Between 1979 and 1992 the average water usage was approximately 5,000 gpd. According to Wright-Malta, current water usage averages 600 to 1,000 gallons per day (gpd). Flow rates are not monitored during routine inspection and maintenance of the water supply system.

Groundwater from the two water supply wells is pumped through an air stripping tower into a stainless steel transfer tank, then into a 100,000-gallon underground reservoir which supplies the Site water distribution system. A float switch located in the 100,000-gallon reservoir controls the pumps in both wells 1D and 2D, which operate simultaneously, except during periods of pump maintenance. The intermittent pumping rate of the individual wells probably ranges between 5 and 20 gpm with an average daily pumping rate for each well ranging between 300 to 500 gpd (0.2 to 0.4 gpm). This respresents an average overall pumping rate from the two wells of approximately 600 to 1,000 gpd (0.4 to 0.8 gpm).

As previously indicated, recovered groundwater is being treated by air stripping to remove VOCs such as carbon tetrachloride and TCE. The air stripper, an Oil Recovery System (ORS) Air Stripper Model 1109004, was installed on Wright-Malta property in January 1987. The air stripper was permitted by the NYSDEC and approved by the New York State Department of Health (NYSDOH) in January 1987. Until recently, influent and effluent water from the air stripper were sampled monthly to monitor performance of the air stripper. Since January 1995, following receipt of NYSDOH approval, monitoring has been conducted quarterly. To date, the air stripper has been effective in reducing all VOC concentrations below the NYS drinking water standards.

1.3 Summary of Remedial Investigation

The RI was initiated in 1990. A draft RI Report was submitted to the USEPA in February 1993, and a revised RI Report was submitted on September 30, 1994 for review and approval. Conditional approval from USEPA was obtained on February 1, 1995. The final RI Report was issued in February 1995. This section briefly describes the scope of the RI and its pertinent findings. Additional information regarding the RI can be obtained by referring to the RI Report (ERM-Northeast, 1995).

1.3.1 Scope of the Malta RI

The purpose of the RI was to determine the nature and extent of contamination of the MRFA Site, to adequately characterize the Site, and to gather the data necessary to support the FS. A total of 48 distinct areas of the MRFA Site were investigated. In selecting sample locations, efforts were made to target those areas believed to have contributed constituents to the environment (e.g., chemical and domestic waste disposal areas, equipment and chemical storage areas, a burn pit, testing complexes, buildings and a metals reclamation facility) and/or those areas identified through field screening as the most likely to have the highest concentrations of constituents (based on soil gas screening results, headspace results taken during the subsurface soil investigation, and soil staining). The RI also addressed dry wells, catch basins, retention basins and floor drains (collectively referred to as"dry wells") and septic tanks.

In addition to surface water, sediment, surface soil, subsurface soil, dry well, septic tank and groundwater investigations, activities conducted during the RI included a radiation survey, geophysical survey, and soil gas survey. These activities are briefly described below. Sample location maps are provided in Appendix A.

MRFA Comparative Criteria (criteria) were developed to assess the significance of the RI data (surface water, sediment, surface soil, subsurface soil, groundwater and dry well results) and identify areas that required further investigation. These criteria were approved by USEPA as useful indicators of where additional characterization and potential risk evaluation were warranted; they were not intended as cleanup criteria or preliminary remediation goals.

- Radiation Survey. A radiation survey was conducted to assess the potential presence of residual radiation at the former GE/Exxon Building where radioactive materials reportedly had been used in the past.

- Geophysical Surveys. Geophysical surveys were conducted at 19 areas to identify locations potentially containing buried metal. Based on the results, a total of 82 anomalies in 13 of the 19 areas surveyed were interpreted as representing areas of possible buried metal. Subsurface investigations (81 test pits and nine soil borings) were performed to further investigate these anomalies.

- Soil Gas Survey. Soil gas surveys were performed at 46 areas on the MRFA Site, with a total of 844 soil gas points installed and sampled. These surveys were used as a screening-level tool that provided a semi-quantitative evaluation of the extent of VOCs in the shallow vadose zone. The soil gas analytical results were used in selecting locations for borings and monitoring wells for collecting samples to obtain quantitative analytical results of constituents in the environment.

- Surface Water Investigation. Fourteen surface water samples were collected and analyzed from six water bodies on or adjacent to the MRFA Site (Ravines 1b and 6a, Muggett's Pond, and three quench pits[3]). Analytical results from the three samples from Ravine 6a are representative of background conditions and were used in conjunction with available regulatory standards and criteria to establish the surface water MRFA Comparative Criteria.

- Sediment Investigation. Sediment samples were collected and analyzed from six water bodies (Ravines 1b and 6a, Muggett's Pond, and the three quench pits) and the Muggett's Pond Drainage Ditch[4]. Analytical results from the three samples from Ravine 6a were interpreted to be representative of background conditions and were used in conjunction with available regulatory standards and criteria to establish the sediment MRFA Comparative Criteria.

- Surface Soil Investigation. A total of 67 surface soil samples, including duplicates, were collected and analyzed from 60 locations in 37 areas of concern on the Test Station and two locations at the former GE/Exxon Building. In addition, 21 surface soil samples, including one duplicate, were collected and analyzed as part of the background soil quality investigation at the MRFA Site. The background inorganic analyte results were used to calculate statistically-derived maximum background concentrations for each inorganic

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[3] The quench pits are lined with concrete, are adjacent to buildings and other facilities, and contain no vegetation; therefore, they are unlikely to provide habitat for ecological receptors.

[4] Although samples from Muggett's Pond Drainage Ditch were initially identified as sediment samples, they were found to be more representative of the soil matrix, and therefore, were evaluated as soil samples in the RI Report and the RA.

analyte in surface soil. These maximum concentrations were used in conjunction with available regulatory standards and criteria to establish the surface soil MRFA Comparative Criteria.

- Subsurface Soil Investigation. A total of 254 shallow subsurface soil samples, including duplicates, and three deep subsurface soil samples were collected and analyzed from 127 shallow borings, three deep borings (>50 feet), and 23 test pit locations at the Test Station, Area D-3, and/or the former GE/Exxon Building. In addition, 33 soil samples, including two duplicates, were collected and analyzed as part of the background soil quality investigation at the MRFA Site. The background inorganic analyte results were used to calculate statistically-derived maximum background concentrations for each analyte. These maximum concentrations were used in conjunction with available regulatory standards, guidance values, and criteria as well as health-based criteria to establish the subsurface soil MRFA Comparative Criteria.

- Groundwater Investigation. Twenty-five monitoring wells were installed at the MRFA Site in 1992 to supplement the existing network of 18 monitoring wells and water supply wells. Five additional wells were installed in 1993 to further supplement the monitoring well network, resulting in a total of 48 wells (monitoring and production) at the MRFA Site. Samples were collected and analyzed from the 43 wells installed prior to 1993 on two occasions (June 1992 and November 1992) to assess groundwater quality. An additional sampling event was conducted in 1994 during which the five most recently installed monitoring wells and one previously installed well (MW-4) were sampled. The MRFA Comparative Criteria for groundwater were established using a combination of maximum background concentrations and available regulatory standards, guidance values, and criteria for inorganic analytes, while the available regulatory standards, guidance values, and criteria were used for organic compounds. The analytical results from the June and November 1992 sampling events for the monitoring wells around the Triangular Parcel (MW-1, MW-2, MW-3, MW-4, and 14D) were used to establish the maximum background concentrations in groundwater. These five monitoring wells are upgradient/sidegradient of the Test Station. As indicated in the RA, MW-21 is upgradient of the former GE/Exxon Building.

- Dry Wells. Thirty-one soil and sediment samples, including duplicates, were collected and analyzed from 23 dry well features (dry wells, catch basins, floor drains, one swale, and an open sump) at the MRFA Site. The analytical results for these samples were compared to either the surface soil, subsurface soil, or sediment MRFA Comparative Criteria to evaluate the quality of the soil/sediment in each dry well.

- Septic Tanks. Seven liquid samples were collected from six septic tanks, while two sludge samples were collected from one septic tank. The analytical results for the seven liquid septic tank samples were compared to the NYSDEC groundwater effluent standards, which were used as the MRFA Comparative Criteria. No criteria were established for the septic tank sludge sample since there are no available standards/guidance.

1.3.2 RI Findings

The physical setting, nature and extent of contamination, and contaminant fate and transport are described below. Additional detail is provided in the RI Report (ERM-Northeast, 1995).

1.3.2.1 Physical Setting

The topography of the MRFA Site and surrounding area is characterized by gently undulating uplands with occasional rises and extensive ravines incised in the unconsolidated overburden materials. The land surface elevations range from 300 to 350 feet above mean sea level. Elevations drop severely to about 250 feet above mean sea level in the ravines surrounding the Site. The only surface water body on the MRFA Site is Muggett's Pond, which is a small (0.07 acre) artificial pond used for storm water retention purposes. Southwest and northeast of the MRFA Site boundaries, several springs in deep ravines create small streams (Ravines la, lb, 2a, 2b, 2c, 3, 4, 5, 6a, 6b, 7, and 8) that eventually flow to Round Lake to the south and Saratoga Lake to the north.

The subsurface geology at the MRFA Site has been defined by extensive soil sampling performed during RI monitoring well installation and by previous studies. A surficial layer of aeolian deposits, varying in thickness from 0 to 14 feet, is underlain by a thick sequence of glacio-lacustrine deposits, which becomes progressively finer-grained with depth. The top of this sequence is a layer of glacio-lacustrine fine-medium sands 30 to 60 feet thick. These deposits occur at the surface where the aeolian deposits are not present. Below the glacio-lacustrine fine-medium sands is a 30 to 40 foot layer of glacio-lacustrine fine sand and silt.

Underlying the glacio-lacustrine sand and silt layer is a glacio-lacustrine clay and silt layer about 75 feet thick. Dineen and Hanson (1983) report a 60 to over 100-foot thick layer of glacio-lacustrine clay below the glacio-lacustrine clay and silt, overlying 10 to 25 feet of dense glacial till that rests directly upon the Canajoharie Shale bedrock. A single deep boring (M-33) drilled to bedrock during the RI confirmed these relative thicknesses. Below the lacustrine sands, a lacustrine silt and clay with traces of fine sand was observed from approximately 85 to 120 feet below grade. Below 120 feet, the fine sand content disappears and silts and clays extend down to approximately 220 feet below land surface where traces of fine sand were again observed within the silts and clays. Between 235 feet and 248.5 feet a dense glacial till was observed consisting of shale fragments, silts and clays. Directly above bedrock (251 feet) and immediately below the glacial till, a thin layer (less than two feet) of ice-contact sands was observed. The depth to bedrock is reportedly greatest near the northwest corner of the MRFA Site (up to 280 feet) and is least near the eastern margin of the Test Station.

The depth to groundwater ranges from about 20 to 50 feet below the land surface across the MRFA Site. The groundwater table typically occurs in the lower 10 to 20 feet of the lacustrine sand unit. The groundwater flow direction varies across the Site and with depth. In the shallow groundwater system within the glacio-lacustrine fine-medium sand, groundwater beneath the Test Station generally flows westward and southwestward toward Ravines lb, 2a, 2b, and 2c (Figure 1-4), although a mound in the water table in the vicinity of monitoring well M-30 (Area D-5) causes some localized flow to the north and northeast. At the former GE/Exxon Building, the shallow groundwater in the glacio-lacustrine sand flows southeast toward Ravine la. In the deep groundwater system within the glacio-lacustrine fine sand and silt, the groundwater beneath the Test Station flows westward toward Ravines lb, 2a, 2b, and 2c and northward probably toward Ravines 6b and 7 (Figure 1-5). The existing Site water supply wells are screened in this fine sand and silt layer. Pumping of these wells locally alters groundwater flow direction and rate.

Vertical hydraulic conductivity laboratory testing demonstrated that the glacio-lacustrine silt and clay below the Test Station is low permeability material. At the M-29 location (94 to 96.5 feet below land surface) the vertical hydraulic conductivity of the tested sample was 3.6 x 10^{-7} cm/sec (0.001 ft/day), and at the M-31 location (79 to 81.5 feet below land surface), it was 1.7 x 10^{-7} cm/sec (0.0005 ft/day). These values are believed to be representative and sufficiently low to prevent significant percolation of constituents below the lacustrine silt and clay layer, regardless of hydraulic gradient.

Horizontal hydraulic conductivity (slug) tests indicated an average horizontal hydraulic conductivity for the shallow glacio-lacustrine sand material of 1.5 x 10^{-3} cm/sec (4.3 feet/day), while the hydraulic conductivity for the deeper glacio-lacustrine sand and silt material was 1.1 x 10^{-3} cm/sec (3.1 feet/day). These numbers represent moderately low permeabilities and are generally typical of fine sands.

1.3.2.2 Nature and Extent of Contamination

The analytical results for surface water, sediment, soil gas, surface and subsurface soil, groundwater, septic tanks, and dry wells are summarized below. Summary tables from the RI Report identifying the constituents detected above the MRFA Comparative Criteria are provided in Appendix B.

The RI results indicate that most areas of concern identified previously in the RI Work Plan and Project Operations Plan do not appear to be constituent source areas. The RI did identify a few other isolated locations with relatively immobile constituents at concentrations above the MRFA Comparative Criteria. The results also indicate that one area (Area D-1) appears to have contributed the majority of chemical constituents to groundwater.

Surface Water

Surface water analytical results showed organic compounds and inorganic analytes to be present, some of which exceeded the MRFA Comparative Criteria. Constituents detected above the criteria include pesticides and several inorganic analytes. Additional sampling of soil, sediment, and groundwater showed the constituents detected in the surface water to be localized. At Muggett's Pond and the quench pits, the constituents appear to be contained within the surface water features. At Ravine lb, the constituents do not appear to be migrating downstream. When the groundwater emerges at ravine springs and contacts the open air, it becomes oxygenated and the solubility of the inorganic analytes is reduced. This causes the inorganics to precipitate out of the water and onto the sediment. As a result, the concentrations of the analytes, the number of analytes detected, and the number of analytes in the surface water above the MRFA Comparative Criteria decreases downstream.

Sediment

Analytical results of sediment samples showed the presence of volatile organic compounds (VOCs), polychlorinated biphenyls (PCBs), semi-volatile organic compounds (SVOCs) and inorganic analytes above the MRFA Comparative Criteria in Muggett's Pond and the quench pits, while only inorganic analytes exceeded the Criteria in Ravine lb. As with the surface water results, additional sampling at each of these areas showed these constituents to be localized and not migrating to the surrounding soil or groundwater. Constituents detected in Ravine lb generally decrease downstream and do not appear to be migrating downstream. The increased headwater concentrations are due to natural precipitation of inorganics from the spring water onto the sediment as the water chemistry equilibrates with the open air.

Soil Gas

Soil gas was investigated throughout the Site. Soil gas results indicated that there are several locations on the MRFA Site with relatively elevated VOC concentrations. Almost all of the areas of elevated concentrations that were investigated indicated the presence of target compounds (carbon tetrachloride, TCE, toluene, and 1,2-dichloroethene (DCE)). Target compounds most frequently detected in the soil gas at the Test Station were carbon tetrachloride followed by TCE, while 1,2-DCE was detected most frequently at the former GE/Exxon Building. Comparison of soil gas results with other media analytical results (surface water, sediment, surface soil, and subsurface soil) indicates little or no correlation. The localized areas of soil gas VOCs do not match the VOC distribution detected in soil and groundwater. The soil gas distribution seems to be caused by small historical spills, vapor trapping beneath paved or compacted areas, and possibly volatilization from groundwater near an upgradient source (i.e., Area D-1).

Surface Soil

Surface soil results showed organic compounds and/or inorganic analytes present above the MRFA Comparative Criteria in isolated occurrences at ten areas (Buildings 3, 6, 20, 21, 23P, 24, 25S, 27, Area S-1, and Muggett's Pond Drainage Ditch Intersection). Each exceedance appears to be spatially distinct and unrelated to each other. Sampling, analyses and visual observations showed the constituents detected above the criteria to be limited horizontally and vertically. Analytical results from the subsurface soil and groundwater sampling programs also helped to confirm the limited and isolated nature of these occurrences in the surface soil.

Subsurface Soil

Analytical results for the shallow subsurface soil samples showed that the MRFA Comparative Criteria were exceeded at 15 of the areas sampled across the Site. These areas (which include subsurface dry well samples) were S-2, D-1, D-2, D-5, D-6, and Buildings 1, 2, 4, 6, 11, 14, 15, 24, 25, and the former GE/Exxon Building. Constituents detected above the criteria included SVOCs, VOCs, and/or several inorganic analytes. The occurrence of each exceedance appears to be spatially distinct and unrelated. Additional sampling performed around several of these locations showed the constituent concentrations to be isolated.

At Area D-1, tetrachloroethene (PCE) was detected in a soil sample collected from test pit P-78 at 2,200 μg/kg and also in a groundwater sample collected from well M-35S at 57 μg/l. Based on the intermedia comparisons, only Area D-1 appears to have contributed constituents to groundwater. All other shallow subsurface soil MRFA Comparative Criteria exceedances appear to result from isolated occurrences that did not contribute constituents to groundwater.

Deep subsurface soil does not appear to have been significantly affected by Site constituents. Analytical results of three deep subsurface soil samples showed no inorganic analytes or organic compounds to be present above MRFA Comparative Criteria. Furthermore, comparison of the analytical results of the three deep soil samples with the analytical results of groundwater samples, collected from identical locations as the soil samples, shows only two constituents (carbon tetrachloride and 1,1,1-trichloroethane) in common. These detections in soil may have resulted from the concentration of these constituents in the associated pore space groundwater. The inorganic analytes detected in each of the three subsurface soil samples were similar, suggesting a natural origin (i.e. background).

Groundwater

The groundwater analytical results showed a maximum of six VOCs and 19 unfiltered inorganic analytes (only 9 filtered) present in groundwater at concentrations above the MRFA Comparative Criteria. The observed concentrations and number of detections were higher at the water table (shallow groundwater) than in the basal portion of glacio-lacustrine silt and sand (deep groundwater). Results between the first two rounds of groundwater sampling were generally consistent, although inorganic analyte concentrations tended to decrease in the second round of samples.

Of the VOCs detected, carbon tetrachloride, TCE, chloroform, chloromethane, 1,1,1-trichloroethane, and PCE were detected on at least one occasion at concentrations above MRFA Comparative Criteria. Carbon tetrachloride and TCE were detected most frequently and at the highest concentrations. The maximum concentration for carbon tetrachloride in the shallow groundwater was 220 μg/l at well M-19 in the second round of sampling (November, 1992) and the maximum concentration in deep groundwater was 90 μg/l at well 2D in the first round (June, 1992). The maximum TCE concentration in shallow groundwater was 280 μg/l at well M-19 in the second round, and in deep groundwater, at well 2D where TCE was detected at an estimated concentration of 68 μg/l in the first round. The interpreted approximate location of the plume, which is defined by groundwater containing individual VOCs greater than 5 ppb, is shown on Figure 1-6. The concentrations of VOCs in groundwater are currently reduced through natural attenuation and degradation processes (such as dilution, dispersion, adsorption and possibly biological and chemical degradation) as groundwater flows through the Test Station toward nearby ravines. At the ravines, which serve as discharge points for the water bearing zone, VOCs are naturally removed through volatilization. Also depicted is the central portion of the plume, where the highest VOC concentrations were detected. This area is defined by groundwater containing individual VOCs greater than 50 ppb. The configuration of both of these areas is defined by the carbon tetrachloride plume, which encompasses the plumes of all other site related VOCs. VOCs were not detected in the wells at the former GE/Exxon Building.

SVOCs were detected in many shallow and deep wells, but most are suspected laboratory artifacts.

Bis (2-ethylhexyl) phthalate was the only SVOC detected above the MRFA Comparative Criteria. This SVOC exceeded the criteria in only one well during each of the first two sampling events (1D in the first sampling event and 4D in the second sampling event). Well 4D also contained several SVOCs that may be associated with petroleum products.

No pesticides or PCBs were detected in any well, with the exception of M-35 where beta BHC was detected at a low concentration (0.029 ppb).

At the Test Station, a maximum of 19 inorganic analytes exceeded the criteria in the unfiltered samples, while a maximum of nine analytes exceeded the criteria in the filtered samples. At the former GE/Exxon Building, a maximum of 17 analytes exceeded the criteria in the unfiltered samples, while a maximum of two analytes exceeded in the filtered samples. The inorganic constituent concentrations appear to be associated with turbidity (i.e., suspended solids and possibly dissolutioning by organic constituents), rather than a specific inorganic release associated with past MRFA Site activities.

The area of concern that appears to have contributed the majority of constituents to the groundwater in the past is Area D-1. Groundwater in the vicinity of Building 3 (well M-19) contained the highest concentrations of VOCs at the MRFA Site. However, Building 3 is approximately 500 feet immediately downgradient of Area D-1, and based on the measured hydraulic conductivity (4.3 ft/day) and hydraulic gradient (0.0037 ft/ft), it would require less than 20 years for constituents from Area D-1 to migrate to Building 3. This fits reasonably well with the time frame that the Area D-1 burn pit was last used. It is likely that the Test Station water supply well 2D (which is about 250 feet downgradient of Building 3) and water supply well 1D, have been capturing constituents, thereby mitigating downgradient migration. As reported in the RI report, in comparison to historical levels, concentrations of VOCs are decreasing. As such, the source area thought to have formerly contributed the majority of VOCs to groundwater, i.e. D-1, is likely depleted and no longer contributing constituents to groundwater.

Dry Wells and Septic Tanks

In efforts to locate potential sources of constituent loadings to groundwater, numerous dry wells and septic tanks were sampled. Analytical results showed various concentrations of VOCs, SVOCs, pesticides, PCBs and inorganic analytes in dry wells and septic tanks. Subsurface soil and groundwater in the vicinity of these features do not appear to be affected. The constituents detected in the dry wells (i.e., dry wells, catch basins and floor drains) above the MRFA Comparative Criteria were primarily the more immobile constituents (i.e., SVOCs, pesticides, PCBs, and inorganics). Some VOCs were detected in certain dry wells and septic tanks. Additional sampling performed beneath and around selected dry wells confirmed that the constituents detected above the MRFA Comparative Criteria in the dry wells are confined inside the dry well structures. The structural design of many of the dry wells (i.e., catch basins) and septic tanks aids in the entrapment of sediments and constituents, thereby helping to prevent any migration of constituents to surrounding soil or groundwater.

In summary, constituents detected above MRFA Comparative Criteria in surface water, sediment, surface soil, subsurface soil, dry wells, and septic tanks appear to be isolated and confined. The constituents detected in these media do not appear to be increasing the concentrations of constituents found in surrounding soil or groundwater. Organic compounds detected in groundwater appear to have originated primarily from Area D-1. No areas of the Site currently appear to be contributing or continuing to contribute constituents to groundwater. Constituents in groundwater appear to be largely confined to the MRFA Site with only minor concentrations extending toward, but not beyond, the one-mile easement boundary.

Other Findings

Monitoring for radiation indicated no radiation above ambient background levels.

Intrusive investigations (test pits and borings) performed during RI field activities defined several areas of on-site disposal. Buried, empty chemical containers were observed in several areas on the Test Station, as summarized below. Chemicals (solid and liquid caustics) were found only in Area D-5.

- Area S-1. An unlabeled compressed gas cylinder and two areas of buried crushed drums were identified. The cylinder (identified as containing boron trifluoride) was excavated, decommissioned, and shipped off-site for disposal. The drums were left in place under the direction of the USEPA.

- Area D-1. The former burn pit structure was located, and an area of buried, crushed drums was identified about 100 feet east of the burn pit. The area of drums was left in place under the direction of the USEPA.

- Area D-2. This landfill area was found to contain construction and demolition (C&D) debris, domestic trash, and some empty chemical containers. Any containers encountered in this area were removed and overpacked.

- Area D-4. A large single compressed gas cylinder labeled as containing pentaborane was excavated, decommissioned, and removed from the Site for appropriate disposal. Except for the cylinder and a minor amount of domestic trash, Area D-4 was free of buried waste.

- Area D-5. Containerized chemicals and empty chemical containers were found. These containers were buried in several, separate locations throughout Area D-5. Any chemicals and empty containers encountered were removed and overpacked.

In addition, general construction and demolition debris and some domestic trash were observed in Areas S-7, D-2, D-3, and the Firing Range Pond.

1.3.2.3 Contaminant Fate and Transport

Potential routes of migration for constituents detected in the soil, surface water, sediment, and groundwater at the Site include wind-blown dust, volatilization, storm water runoff, infiltration and deep percolation, and groundwater transport. Chemical constituents detected at the MRFA Site will migrate predominantly via groundwater flow. Features that affect migration are described below by medium. Additional information on contaminant fate and transport is provided in Section 7.0 of the RI Report (ERM-Northeast, 1995) and in Section 4.0 of the Risk Assessment.

Soil

For migration of constituents from the soil into the air, ground cover is an important limiting factor. Migration of chemical constituents by wind-blown dust is expected to play only a minor role due to the small area of land on-site that is sparsely vegetated and the forested easement area that serves as a wind break. Therefore, soil is unlikely to act as a source for airborne emissions under existing conditions. Future disturbance to the Site, e.g., extensive construction activity, could increase the potential for airborne migration unless appropriate precautions are taken.

Inorganics may be leached by rainfall infiltrating through soil, and then transported in groundwater. Other constituents present in soil, such as PAHs and PCBs, would not be expected to migrate due to their low soil solubilities and high adsorptive tendencies.

Groundwater

Dissolved compounds that reach groundwater will tend to migrate with groundwater as part of the overall groundwater flow regime. In the shallow groundwater system, the Test Station groundwater migration direction is to the west towards Ravines lb, 2a, 2b, and 2c (Figure 1-4). A deep groundwater divide trends northwest to southeast across the Test Station cutting approximately across Building 20, 6, and 5. In the deep groundwater system, the groundwater migration direction is from the portion of the Test Station south of the divide westward toward Ravines lb, 2a, 2b, and 2c and northward toward Ravines 6a, 6b and 7 north of the divide (Figure 1-5). It appears that most of the VOC constituents in groundwater are south of the divide and migrating towards the west.

Constituents in the shallow groundwater may have the potential to move to the deeper groundwater system under the influence of downward gradients observed in most shallow and deep well pairs. The highest downward vertical hydraulic gradient are typically observed in the vicinity of the pumping wells. The low permeability glacio-lacustrine silt and clay will prevent migration below a depth of approximately 80 to 90 feet below land surface. The ravine springs serve as aquifer discharge boundaries (sinks) releasing groundwater from the subsurface. These springs typically occur where low permeability strata below the water table are exposed or incised by the ravines.

Infiltration of precipitation and dispersion within the aquifer significantly dilute the concentrations of VOCs detected at the Test Station, and volatilization of these trace levels of VOCs in the ravine streams essentially eliminates their presence in the surface water.

Surface Water and Sediment

Surface water runoff at the Test Station ultimately drains to Muggett's Pond or to one of the storm water retention basins (the former ponds at PTI, Building 7 and the Magazine Area). At these areas, surface water will infiltrate the sandy soils to eventually reach the groundwater table. Suspended sediments with adsorbed constituents will remain at the ground surface, potentially leading to a preferential concentration of some constituents at these locations, as evidenced by the SVOC, pesticide, and PCB concentrations in the sediments. Dissolved constituents may be carried to the water table, although most constituents will adsorb onto subsurface soil particles and/or be trapped by capillary wetting.

Stormwater may also serve to transport compounds to ditches, retention ponds, and dry wells. Constituents could be transported by being adsorbed onto suspended sediments in the water and/or dissolved in the water.

1.4 Summary of Risk Assessment

A human health and ecological RA for the MRFA Site was prepared by ENVIRON Corporation of Princeton, New Jersey. The purpose of the RA was to evaluate, in accordance with current USEPA guidelines, potential impacts to human health and the environment posed by chemical contaminants associated with the Site for different reasonable exposure scenarios. These estimated risks were compared with USEPA guidelines for acceptable risk to assess which, if any, media, structures or areas of the Site may require remediation. The results of the RA will allow comparison of the potential risks posed by the MRFA Site in the absence of remediation with those associated with different remedies proposed in the FS.

The RA was conducted in accordance with a Work Plan dated January 1995 and approved by the USEPA. It was also conducted in accordance with an USEPA-approved Pathway Analysis Report dated February 1995. The methodology and results of the human health and ecological portions of the RA are summarized below. These results are used to establish the constituents of concern (COC) in the FS, identify the media requiring remediation, and formulate the remedial action objectives.

1.4.1 Human Health Risk Assessment

1.4.1.1 Methodology

The human health risk assessment was primarily a quantitative analysis based on RI field sampling and analytical results, facility production well data, and EWMS data. It included the selection of COCs, an exposure assessment, a toxicity and dose-response assessment and risk characterization. Potential carcinogenic and noncarcinogenic risks associated with the identified COCs in groundwater, surface and subsurface soils, sediment and surface water were evaluated for current and future land use scenarios. Potential receptors quantitatively evaluated in the RA included both currently exposed individuals (present employees, trespassers, and utility workers) and potential future receptors (residents, utility workers, trespassers, and excavation workers). Exposure parameters for the MRFA Site RA were obtained from USEPA guidance or peer-reviewed literature. Some assumptions were reasonable maximum exposure estimates that would not likely underestimate exposure, while other assumptions were average estimates.

One area of the Site, the Building 23P area, contains elevated concentration of PCBs and lead.. Risks associated with exposure to soils were evaluated both excluding the Building 23P samples and including the Building 23P samples. The Malta PPs and USEPA agreed that surface soil in this area will be removed and backfilled with soils containing less than 1 ppm PCBs as part of any remedial activities. Thus, the results obtained using data excluding Building 23P samples are most appropriate for decision-making activities.

USEPA has not identified a single value that represents a significant incremental cancer risk. The NCP acceptable carcinogenic risk range for Superfund Sites has been set at approximately 1×10^{-4} to 10^{-6} per environmental medium (NCP 1990). Total excess cancer risks were determined by summing the risks associated with the individual exposure scenarios for the various receptors. Noncarcinogenic risk, expressed as the Hazard Quotient, was summed from the COCs to produce a rough estimate of pathway-specific risk. A Hazard Index that exceeds one suggests a greater likelihood of developing an adverse health risk.

1.4.1.2 Results

Table 1-2 summarizes the results of the human health risk assessment, including the total excess lifetime cancer risks and the noncarcinogenic risks to the receptors evaluated in the RA. As indicated in the table, both the estimated excess lifetime cancer risks and the estimated noncarcinogenic health effects expected from exposure to the COCs at the MRFA Site fall within acceptable levels based on USEPA criteria. No unacceptable risks are obtained using data excluding Building 23P; however, slightly elevated risks are obtained using data including Building 23P. Because of the use of conservative assumptions and methods, it is anticipated that actual risks are unlikely to be higher and are more likely to be lower than those estimated

1.4.2 Ecological Risk Assessment

1.4.2.1 Methodology

The objectives of the ecological risk assessment were to determine the ecological resources present at the Site or in areas potentially affected by the Site, identify any potential risks or existing impacts to these resources from constituents present at or migrating from the Site, and contribute to the development of remediation criteria, if unacceptable risks are identified. A phased approach to the ecological risk assessment was used. The Phase 1 assessment is provided in the RA Report. Based on the Phase 1 conclusions, Phase 2 ecological studies are not recommended.

The Phase 1 ecological assessment consisted of a screening level baseline assessment using conservative (i.e., reasonable worst case) exposure assumptions and criteria-based or toxicological-derived thresholds to determine the likelihood of ecological risk to those indicator species and/or nonspecific receptor groups (e.g., aquatic organisms or terrestrial plants) for which exposure pathways are likely to exist. The process for evaluating potential risks to ecological resources consisted of four parts: problem formulation, exposure assessment, ecological effects assessment, and risk characterization.

As part of problem formulation, a conceptual site model was developed to describe the stressors associated with the Site, identify the ecological components (receptors) potentially affected by these stressors, and select ecological endpoints. The assessment endpoints for the Phase 1 assessment were as follows:

- No significant adverse effects (growth and reproduction) to selected plant and lower trophic level animal indicator species or species groups;

- No significant adverse effects (reproduction) to selected upper trophic level animal indicator species; and

- No significant exceedances of ecologically-based surface water and sediment criteria/guideline values designed to protect aquatic and semi-aquatic species (including the effects of bioaccumulation on higher trophic levels).

Assessment endpoints were evaluated using toxicological threshold values obtained from the literature (which are based on laboratory and field data and/or criteria/guideline values) as measurement endpoints. Exposure to ecological receptors was evaluated using RI data pertaining to constituent concentrations in surface soil, surface water, and sediment. These data allowed exposure point concentrations (EPCs) to be determined for selected indicator species under a reasonable worst case exposure scenario. Effects were evaluated using chronic toxicological threshold values obtained from the literature for each selected indicator species and applicable exposure pathway. Ecologically-based surface water and sediment criteria or guideline values were also used in the effects assessment. Risk was characterized using the quotient method. EPCs were compared to toxicological threshold values and/or available criteria or guideline values for each selected indicator species and applicable exposure pathway. If an EPC was less than the corresponding toxicological threshold or criteria/guideline value, then negligible risk was predicted. The degree of conservatism in exposure and toxicity assumptions was considered when describing the potential risks associated with an EPC exceeding a toxicological threshold. The uncertainties inherent in the assessment were also evaluated.

1.4.2.2 Results

Based on the RA Report conclusions summarized below, Phase 2 ecological studies were not recommended.

- Risks to aquatic receptors that may inhabit Muggett's Pond are minimal. Although measured levels of several metals exceeded chronic surface water benchmarks, these exceedances are not expected to be ecologically significant because they were based on unfiltered samples. Dissolved metals (filtered samples) would represent the fraction that is bioavailable, and therefore, potentially toxic. Total (unfiltered) metal levels tend to significantly overestimate potential risks. In sediment, exceedances of sediment benchmarks occurred for mercury and PCBs. Although these sediment exceedances suggest that some adverse effects are possible to aquatic receptors, Muggett's Pond is a very small (0.07 acre) waterbody located in the middle of a fenced-in facility. Based on its size, limited habitat diversity, and location within a developed area, it is likely to provide very limited habitat for aquatic receptors. Exposure modeling of potential food chain effects to higher trophic level organisms (represented by the barn swallow) indicates that Muggett's Pond is not a source of significant risk to wildlife.

- Risks to aquatic receptors that may inhabit Ravine 1b are minimal. Although measured levels of several metals exceeded chronic surface water benchmarks based on unfiltered samples, these exceedances occurred primarily at the headwaters of the Ravine lb stream. As discussed for Muggett's Pond, these benchmarks are conservative and are likely to overestimate potential risks. Manganese is the only constituent with a hazard quotient exceeding one (based on mean concentrations) in Ravine lb stream sediments, and again, only in the headwater area. The total measured manganese also likely overestimates bioavailability, and therefore, risk. The stream within Ravine lb, which is approximately three feet wide and several inches deep at the headwaters, provides only minimal habitat for fish and wildlife species, and only limited habitat for aquatic invertebrates. Therefore, any possible adverse effects to aquatic invertebrates (the most likely potential receptors) would be limited to the headwaters of the Ravine lb stream.

- In terrestrial habitats, risks to ecological receptors are negligible at the former GE/Exxon Building area. At the Test Station, removal of contaminated soils near Building 23P and within Muggett's Pond Drainage Ditch will reduce exposures and potential risks to wildlife that inhabit the area. Within the Test Station, the potential for risks are highest in some of the developed areas (which offer the least attractive habitat for ecological receptors). The risks are of potential ecological significance in only very limited portions of the field/shrub habitats, and they are ecologically insignificant in the forested habitats. The potential risks in the developed areas are attributable to small areas with relatively high surface soil concentrations of lead, mercury, zinc, and/or PCBs. These areas, which are near buildings, provide little, if any, habitat for most wildlife receptors, thus limiting exposure. Adverse effects to wildlife populations would be unlikely from such localized contamination in these developed habitats and no known rare or endangered species are present on the Site. In addition, evidence of stressed vegetation or other significant ecological effects attributable to soil contamination are lacking.

1.5 Applicable or Relevant and Appropriate Requirements

Applicable or relevant and appropriate requirements (ARARs) are defined in Section 121(d) of CERCLA (P.L.96-510), as amended by SARA (P.L.99-499), as any federal or State standard, requirement, criteria, or limitation that is legally applicable to the contaminants of concern or which is relevant and appropriate under the circumstances of the contaminant release or threatened release. Section 121(d) of CERCLA, as amended by SARA, establishes standards that govern the degree of cleanup required at a site. The selected remedy must attain a level or standard of control that satisfies ARARs except under certain conditions.

The potential ARARs are identified in the sections below and the associated tables. ARARs may be specific to either the site location, the contaminants present, or the remedial actions planned. In addition, State and federal guidance documents and other unpromulgated criteria are "to be considered" (TBC) and can be used to aid in the evaluation and selection of a remedial alternative. TBCs are also discussed below.

1.5.1 Location-Specific ARARs

Location-specific ARARs, which relate to requirements for wetlands protection, floodplain management, fish and wildlife conservation, and historic preservation, apply to remedial alternatives within specific geographical locations. Potential location-specific ARARs and their applicability to the Site are identified in Table 1-3.

1.5.2 Chemical-Specific ARARs

Chemical-specific ARARs are federal or State standards (promulgated by regulation) or health/risk-based numerical values that are used to establish acceptable amounts or concentrations of constituents allowed in the environment. Sources of promulgated standards and criteria are identified on Table 1-4. Chemical-specific ARARs for constituents detected in the groundwater or surface water at the Site are presented in Tables 1-5 and 1-6, respectively.

There are no promulgated federal or State ARARs for soil or sediments. NYS guidance regarding soil and sediments is identified in Section 1.5.4, Potential TBC Guidance.

1.5.3 Action-Specific ARARs

Action-specific ARARs apply to specific treatment and disposal activities, and may set controls or restrictions on the design, performance and implementation of the remedial actions taken at a site. For example, RCRA requirements will be applicable if the remediation constitutes treatment, storage or disposal of a hazardous waste as defined under RCRA. Other examples of action-specific requirements are Clean Water Act standards for discharge of treated groundwater and New York State regulations 6 NYCRR Part 703, which establish surface water and groundwater quality standards and groundwater effluent standards.

Table 1-7 identifies the action-specific ARARs that are potentially applicable to the MRFA Site. Since action-specific ARARs apply to discrete remedial activities, their evaluation is presented with the detailed analysis of alternatives for each retained alternative. In addition, if a technology is used that may result in emissions of compounds into the air, emissions must comply with federal and State air quality standards.

1.5.4 Potential TBC Guidance

There are instances when ARARs do not exist for a particular chemical or remedial action. In these instances, other State and federal criteria, advisories and guidance may be used to aid in the evaluation and selection of a remedial alternative for a site. The TBC guidance or advisories that may be relevant to the MRFA Site are identified on Table 1-8. Soil and sediment TBCs are presented on Tables 1-9 and 1-10, respectively.

1.6 Media and Areas Addressed in FS

1.6.1 Media Carried Through the FS

The media to be carried through the FS are groundwater and surface soil. These media were selected based on the RI results and the human and ecological RA.

Groundwater beneath the Malta Test Station currently supplies drinking water to employees at the facility. The water is rendered potable by removing volatile organics using an air stripper and solids settling in reservoirs prior to distribution. Exposure to treated groundwater does not present an unacceptable risk to human heath under current and future land use scenarios. However, exposure to untreated groundwater would result in an unacceptable risk to human health. Therefore, groundwater is carried through the FS process. The constituents present in groundwater include the following VOCs: carbon tetrachloride, chloroform, chloromethane, PCE, and TCE.

Soil at specific locations is also carried through the FS process. The COCs present in soil at these locations are PCBs, lead, or mercury. The human health RA calculated risk both with and without assuming that the surface soil at the Building 23P area would be remediated. Assuming the remediation occurred, the RA found that the remaining site soil does not pose an unacceptable risk to human health. The Building 23P area provides only limited suitable habitat for ecological receptors. By removing the elevated concentrations of PCBs and lead in surface soil at this location, the risks to potential ecological receptors are significantly reduced. Similarly, remediation of surface soil at the Muggett's Pond Drainage Ditch intersection, which had elevated concentrations of mercury, was also assumed, since mercury is known to biomagnify in terrestrial food chains. After assuming remediation of the surface soil at both of these areas, the RA found that remaining site soils do not pose an unacceptable risk to human health or the environment for present and future exposure scenarios.

1.6.2 Media Not Carried Through the FS

Although constituents were detected in sediments and surface water, based on the RI and the RA results, these media are not considered media of concern for the FS, and will not be addressed further in the FS.

The quench pits, which are lined with concrete and are adjacent to buildings and other facilities, contain limited bottom sediment and no vegetation. Therefore, they are not aquatic environments, and they are unlikely to provide significant habitat for any ecological receptors.

The RA found that sediments in Muggett's Pond and Ravine 1b resulted in no significant risk to human health. In Muggett's Pond sediment, exceedances of sediment benchmarks occurred for mercury and PCBs, suggesting that some adverse effects are possible to aquatic receptors inhabiting the pond. However, Muggett's Pond is a small waterbody (0.07 acre) located in the middle of a fenced-in industrial facility. It provides very limited habitat for aquatic receptors based on its size, limited habitat diversity, and location within a developed area. Exposure modeling of potential food chain effects to higher trophic level organisms indicated that Muggett's Pond is not a source of significant risk to wildlife.

In the Ravine 1b stream, manganese is the only constituent with a hazard quotient exceeding one (based on mean concentrations) in sediments, and the exceedance occurs only in the headwater area. Total manganese upon which the exceedance is based likely overestimates bioavailability, and therefore, risk. The Ravine 1b stream, which is approximately three feet wide and several inches deep at the headwaters, provides only minimal habitat for fish and wildlife species, and only limited habitat for aquatic invertebrates. Therefore, any possible adverse effects to aquatic invertebrates (the most likely potential receptors) would be limited to the headwaters of the Ravine lb stream.

The RA found that surface water in Muggett's Pond and Ravine 1b result in no risk to human health. With regard to ecological risks, in Muggett's Pond, although measured levels of several metals exceeded chronic surface water benchmarks, these exceedances are not expected to be ecologically significant because they were based on unfiltered samples. Dissolved metals (filtered samples) would represent the bioavailable, and therefore potentially toxic, fraction. Total (unfiltered) metal levels are likely to significantly overestimate potential risks. In the Ravine 1b stream (primarily at the headwaters), the levels of several metals exceeded chronic surface water benchmarks based on unfiltered samples. It is believed that upwelling groundwater feeds the stream. Based on a comparison of filtered and unfiltered groundwater data, metals concentrations in filtered stream samples would be significantly reduced, resulting in insignificant ecological risks.

1.6.3 Areas Addressed in the FS

The RI Report indicates that areas/locations containing constituents above the MRFA Comparative Criteria will be addressed in the RA and the FS. Tables from the RI showing constituents above the MRFA criteria are provided in Appendix B. Each of these areas is addressed on Table 1-11, which indicates whether or not each area will be carried through the FS, and provides the rationale for this determination.

The specific areas that will be carried through the FS are the Building 23P area and the Muggett's Pond Drainage Ditch intersection. As mentioned previously, the human health RA assumed that the Building 23P area would be remediated. With this assumption, the RA found that site surface soil does not pose an unacceptable risk to human health. Additionally, by removing the surface soil containing elevated concentrations of PCBs and lead at this location, the risks to potential ecological receptors are reduced, even though this area provides limited suitable habitat for ecological receptors. The soil remediation alternatives for Building 23P presented in the FS are for surface soil containing greater than 10 ppm of PCBs and subsurface soil (i.e., below 1 foot depth) containing greater than 25 ppm of PCBs based on the Toxic Substances Control Act (TSCA) and information provided in Appendix C, and soil containing greater than 1,000 ppm of lead (Pb). The lead cleanup level for the Site, which is an industrial setting, is based on the upper bound of the Center for Disease Control's recommended cleanup level for residential settings (500-1,000 ppm of Pb) based on elevation of blood Pb levels in children, a sensitive sub-population (see USEPA OSWER Directive No. 9355.4-02). Excavated areas at the Building 23P area would be backfilled with clean fill material, graded to blend with surrounding areas and revegetated.

Similarly, based on risk calculations, remediation of the concrete-lined Muggett's Pond Drainage Ditch intersection is recommended since mercury is known to biomagnify in terrestrial food chains. Soil remediation alternatives presented in the FS for the Muggett's Pond Drainage Ditch intersection are for soil containing greater than 2 ppm of mercury. Risk-based calculations for soil remediation levels for mercury and areas targeted for remediation (delineated on Site plans) are provided in Appendix C.

The RI also indicated that certain areas of buried debris would be addressed in the FS. These areas include two areas of buried drums (Areas S-1 and D-1) and an area of buried solid waste (Area D-2). At the request of USEPA, a separate proposal was submitted to remove the areas of buried drums, since the remedial approach was straightforward and did not require assessment of multiple alternatives. (This response activity, as well as others that have been conducted or are in progress, are described in Section 1.7.) Area D-2 is a landfill area primarily containing inert construction and demolition debris and office wastes. It is not located in an area with significantly elevated groundwater concentrations, and does not appear to be contributing to the observed distribution of constituents in groundwater (ERM, 1995). Soil samples collected from Area D-2 were included in the RA, which found that site soil does not pose an unacceptable risk to human health or the environment (ENVIRON, 1995). Therefore, Area D-2 is not carried through the FS.

1.7 Response/Remedial Activities Conducted or in Progress

In accordance with Paragraph 87 of the UAO, several response activities were performed during the course of and pursuant to the RI/FS. These activities included the following: Compressed Gas Cylinder Decommissioning; Buried Crushed Drum Excavation and Recycling; and Septic Tank, Catch Basin and Dry Well Cleanouts. A brief description of each of these response activities is provided below.

- Compressed Gas Cylinder Decommissioning
  During test pitting activities in October 1993, two intact compressed gas cylinders were unearthed. One unlabeled, high pressure cylinder was unearthed in Area S-1 and one low pressure cylinder, labeled as containing pentaborane, was unearthed in Area D-4. These cylinders were staged next to the locations where they were unearthed and were subsequently decommissioned in October 1994. In accordance with a USEPA-approved Work, Safety, Health, and Emergency Response Plan (ERC, 1994), the on-site cylinder decommissioning was performed by Earth Resources Corporation (ERC), an experienced cylinder decommissioning remediation company. The details of the decommissioning activities and disposition of associated waste streams will be summarized in a report currently under preparation.

- Buried Crushed Drum Excavation and Recycling
  Two locations in Area S-1 and one location in Area D-1 were identified as potentially containing crushed metal drums. The locations of the crushed drums were identified through the use of geophysical techniques (e.g., terrain conductivity) and confirmed by visual observations during test pitting activities. After consultation with the USEPA, these test pits were closed with the crushed drums left in place and covered with soil, with the intent that the crushed drums would be addressed at a later date. In June 1995, a Work Plan for the Excavation and Removal of Crushed Buried Drums (ERM, 1995)

was prepared and subsequently approved by the USEPA. Drum excavation activities began on 7 July 1995 and were completed on 18 July 1995. The drums are scheduled to be recycled in October 1995. A report summarizing site activities will be prepared and submitted to the USEPA.

- Septic Tank, Catch Basin and Dry Well Cleanouts
  Septic tanks and dry wells (including catch basins) at the site were sampled and analyzed for the TCL/TAL parameters. Based on the analytical results, eight septic tanks (at Buildings 13, 14, 17, 20, 25, and the former GE/Exxon Building), four catch basins (at Buildings 5 and 24), and one dry well (at Building 3) were proposed to be cleaned out. A 30 June 1995 Work Plan for Septic Tank, Catch Basin, and Dry Well Clean Outs (ERM, 1995) was prepared and approved by the USEPA. Implementation of the Work Plan commenced in July 1995 and is scheduled to be completed in October 1995. A final report will be prepared detailing the cleanouts and ultimate disposition of the waste materials.

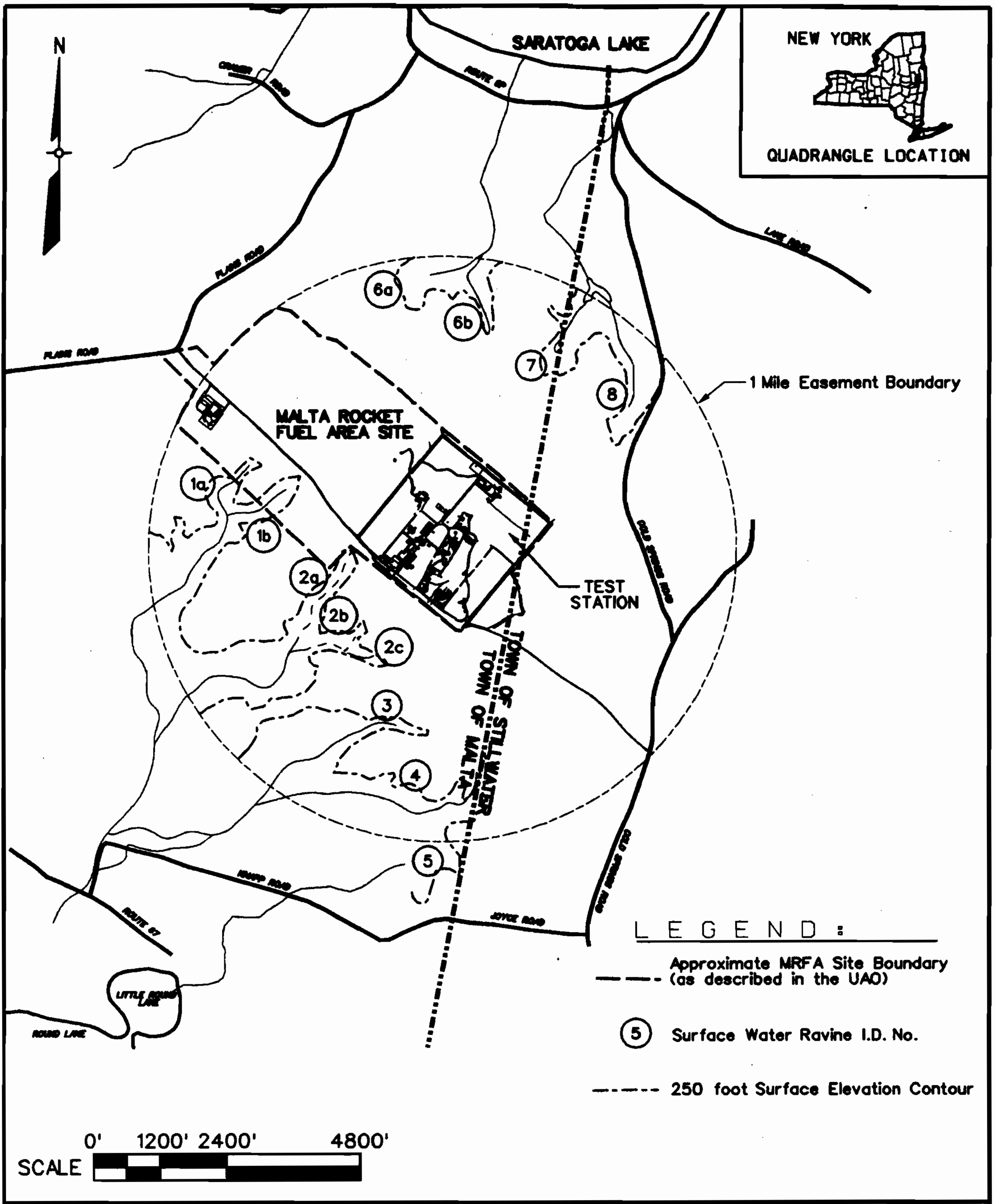
Several additional activities have been performed as part of the on-going RI/FS. These activities included the following: Building 1A Sump Cleanout; Area S-2 Surface Scrap Cleanup; and Investigative-Derived Waste (IDW) Management. A brief description of each of these activities is provided below.

- Building 1A Sump Cleanout
  Sediment from a small sump designed to collect surface runoff from a concrete pad behind (southeast of) Building 1 was sampled as part of the RI on 11 May 1992. This sediment sample (designated as DW-1A-2 in the RI report) was analyzed for TCL/TAL volatiles, semi-volatiles, metals, and pesticides/PCBs. The results of the sediment sample analysis indicated elevated concentrations of VOCs, SVOCs and PCBs. In accordance with a USEPA approved workplan (ERM, 1992), this sump was cleaned out on 14 October 1992. The details of the sump cleanout are described in a 4 January 1993 "Report for the Cleanup of the Building 1A Sump at the MRFA Site" (ERM, 1993).

- Area S-2 Surface Scrap Cleanup
  Surface debris in Area S-2 was removed and disposed at an off-site construction and demolition (C&D) landfill. This debris was removed on 6 October 1993 in order to allow surface geophysical surveys to be completed without interference from the debris. The debris consisted of wood and metal including pallets, fiberglass panels, electrical conduit, scrap lumber, empty drums and drums filled with concrete, styrofoam pieces, tires, etc.. All of the debris, except the empty drums, was shipped to the Rock City Falls, New York C&D Landfill. The empty drums are scheduled to be recycled as part of the crushed drum recycling effort in October 1995.

- Investigation Derived Waste (IDW) Management
  Thirty seven (37) drums of drill cuttings and eight (8) drums of drilling mud have already been spread on the ground in the immediate vicinity of the wells from which they were generated, pursuant to USEPA approvals dated 6 November 1992 and 8 June 1995. Fifty three (53) drums and forty (40) trash bags of IDW generated during the RI remain stored

onsite. The current inventory of IDW includes drill cuttings, used personal protective equipment (PPE), plastic sheeting and decontamination rinsates. Also on site are five (5) drums containing "other" wastes (such as sodium hydroxide, etc.) discovered during the RI. The drill cuttings are stored next to the wells from which they were generated while the remaining IDW are stored in Building 25G on the MRFA Site. A proposed workplan for the proper characterization and final disposition of all IDW is currently under preparation.



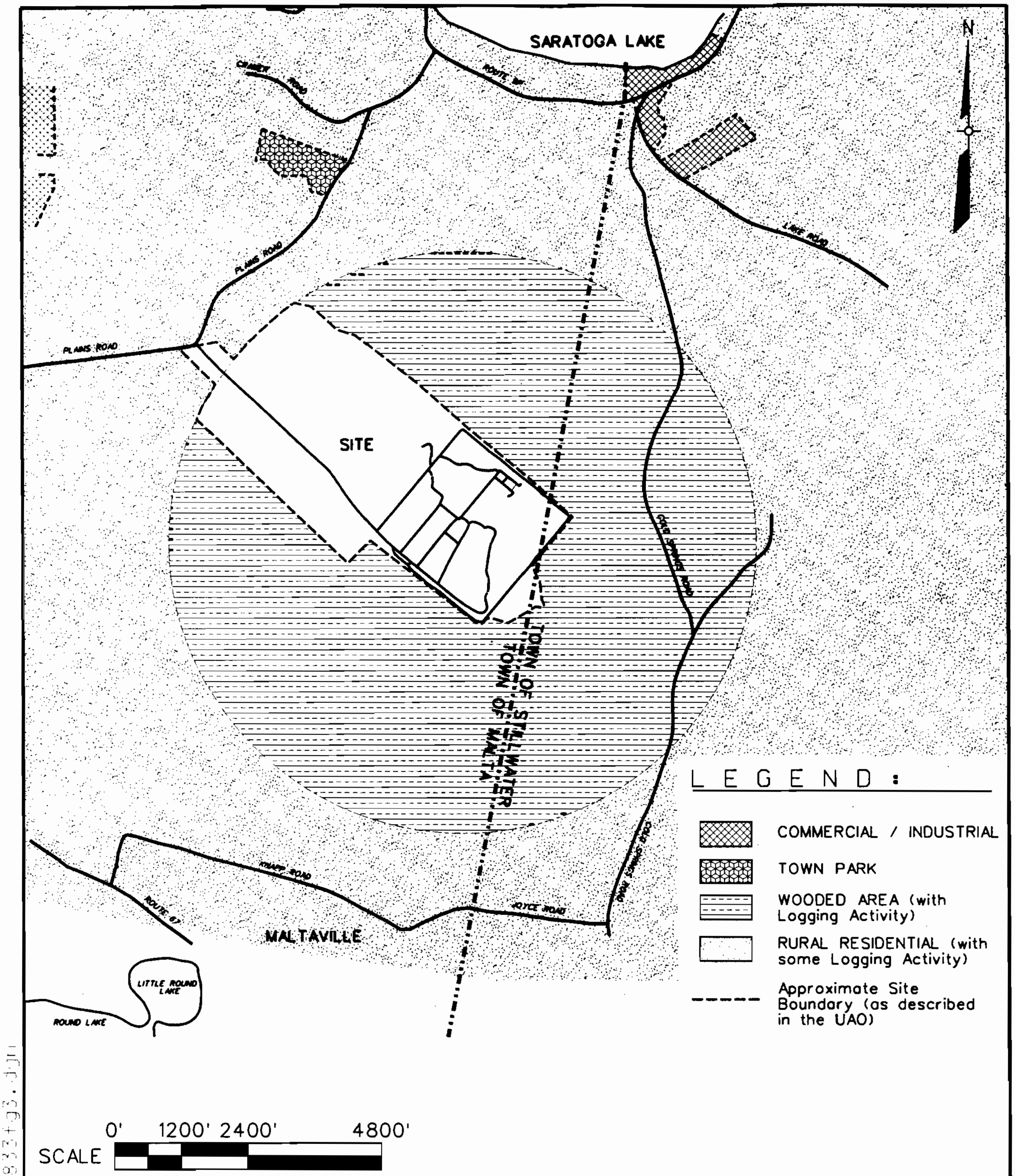
RUST ENVIRONMENT & INFRASTRUCTURE

LOCATION MAP

MALTA ROCKET FUEL AREA SITE
FEASIBILITY STUDY

PROJECT No. 38833.080 | DATE 4/11/95 | DWG. No. 38833FG2 | SCALE 1" = 2400' | FIGURE No. 1-1

DRAWING No. 38833fg2.dgn



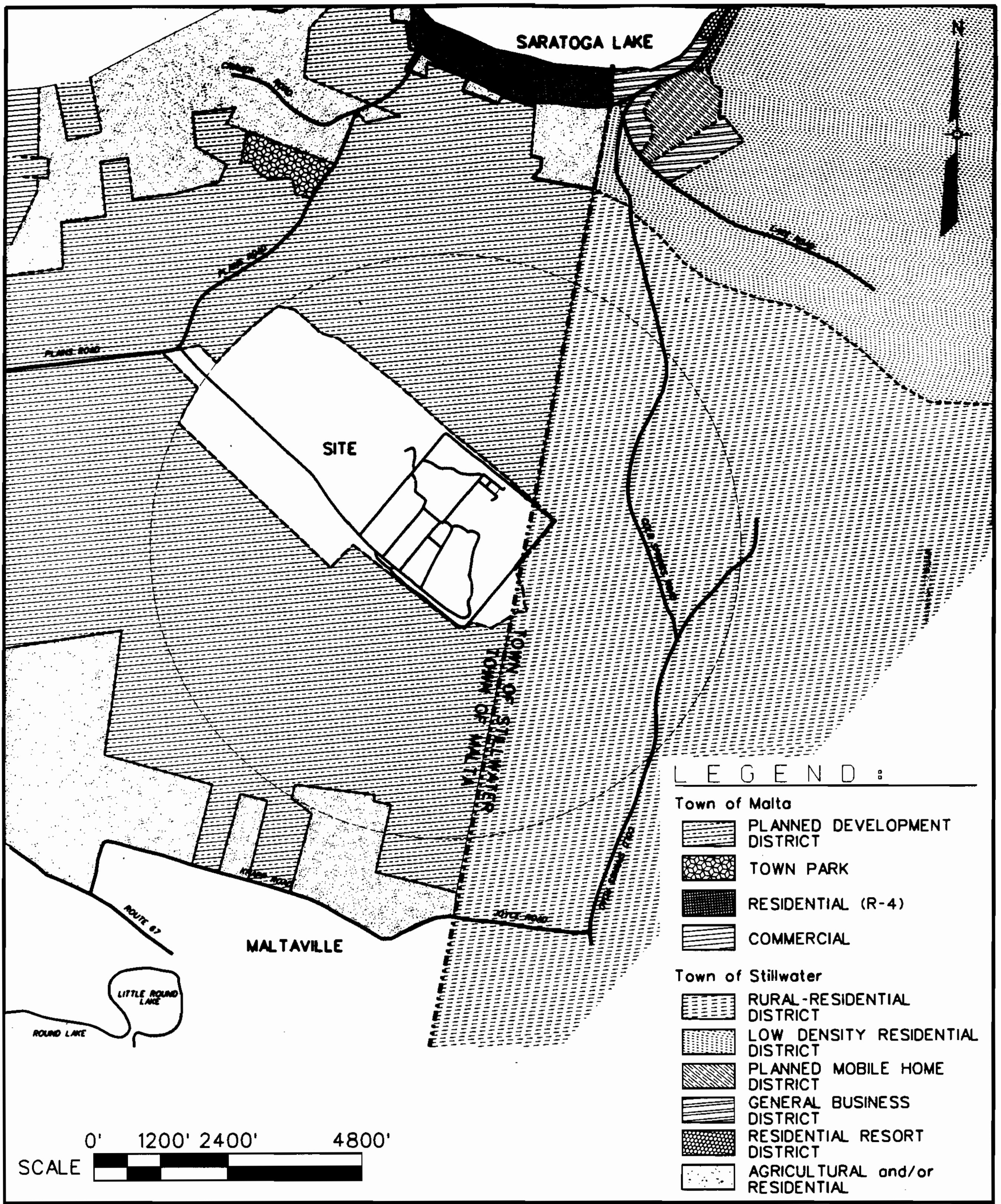
DRAWING No. 38833fg3.dgn

RUST ENVIRONMENT & INFRASTRUCTURE

LAND USE MAP

MALTA ROCKET FUEL AREA SITE
FEASIBILITY STUDY

PROJECT No. 38833.080	DATE 4/11/95	DWG. No. 38833FG3	SCALE 1" = 2400'	FIGURE No. 1-2



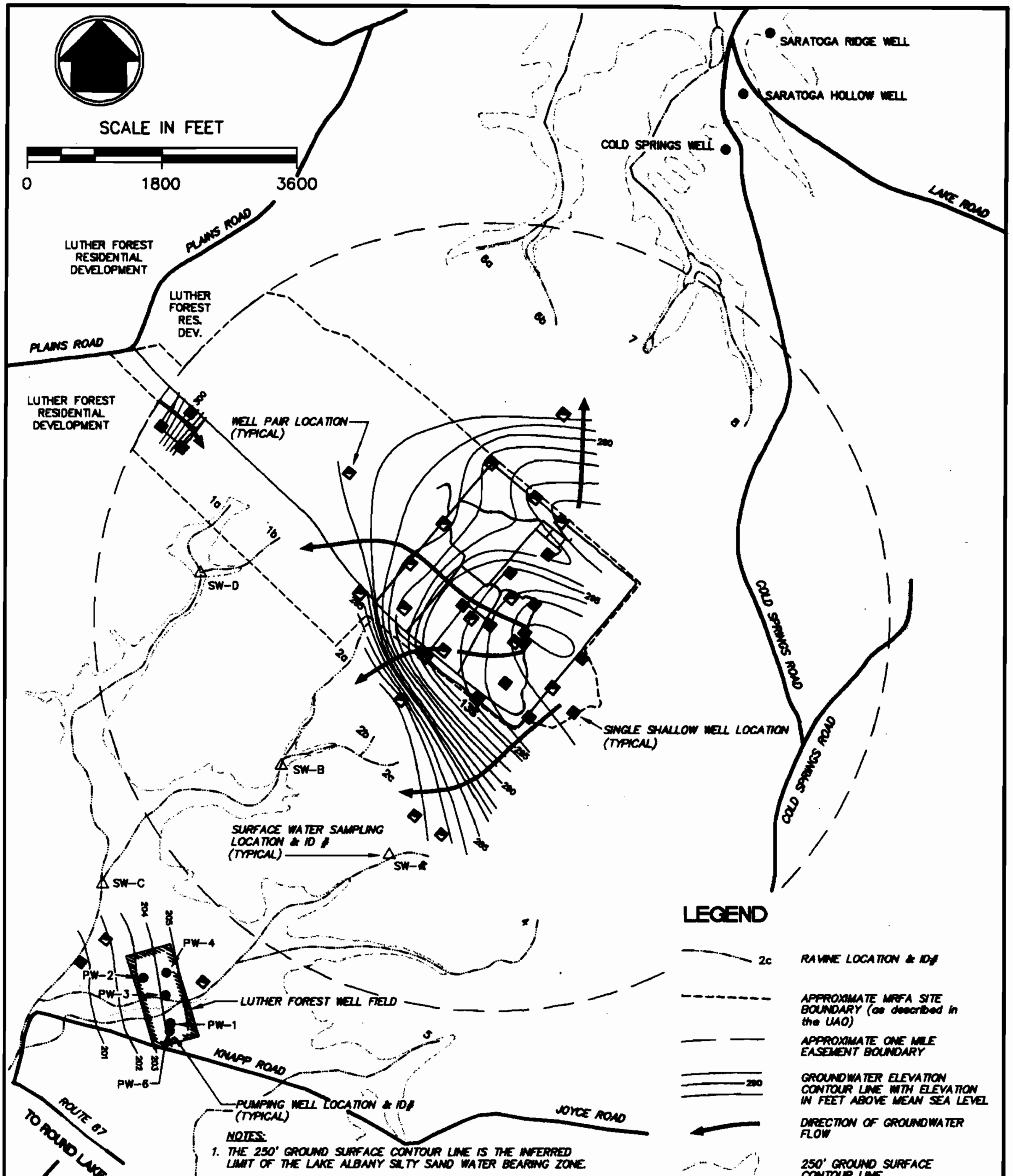
RUST ENVIRONMENT & INFRASTRUCTURE

ZONING MAP

MALTA ROCKET FUEL AREA SITE
FEASIBILITY STUDY

PROJECT No. 38833.080	DATE 4/11/95	DWG. No. 38833FG1	SCALE 1" = 2400'	FIGURE No. 1-3

DRAWING No. 38833fg1.dgn



NOTES:

1. *THE 250' GROUND SURFACE CONTOUR LINE IS THE INFERRED LIMIT OF THE LAKE ALBANY SILTY SAND WATER BEARING ZONE.*
2. *DRAWING BASED ON FIGURE 4 OF SAMPLING AND ANALYSIS PLAN, EARLY WARNING MONITORING SYSTEM, PREPARED BY EPM NORTHEAST, FEBRUARY 1995.*

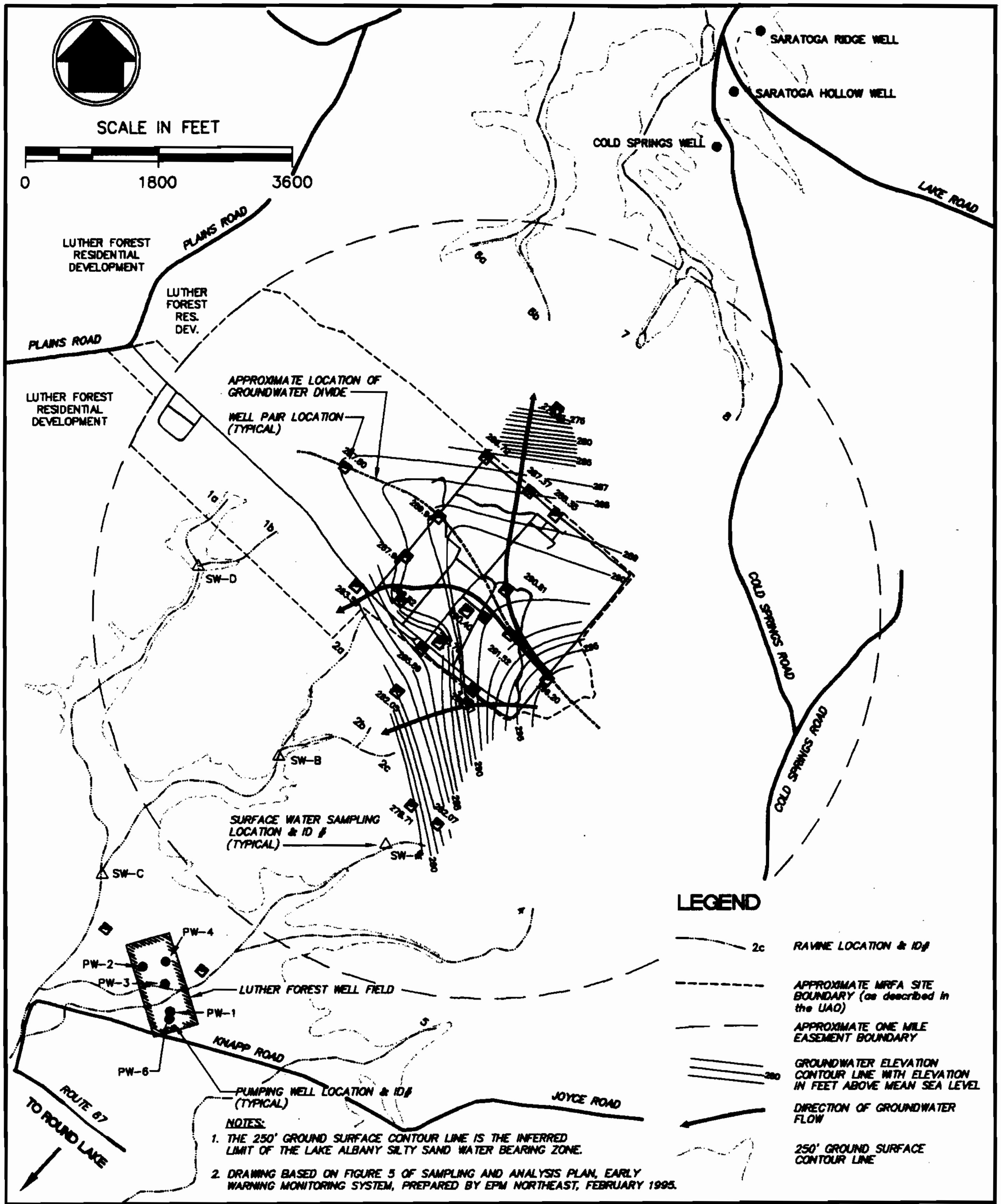
RUST ENVIRONMENT & INFRASTRUCTURE

SHALLOW GROUNDWATER ELEVATION CONTOUR MAP AUGUST 23, 1994

MALTA ROCKET FUEL AREA SITE
FEASIBILITY STUDY

PROJECT No. 38833.070	DATE 4/28/95	DWG. No. 940265_b	SCALE 1" = 1800'	FIGURE No. 1-4

DRAWING No. 940265_B.DWG



NOTES:

1. THE 250' GROUND SURFACE CONTOUR LINE IS THE INFERRED LIMIT OF THE LAKE ALBANY SILTY SAND WATER BEARING ZONE.
2. DRAWING BASED ON FIGURE 5 OF SAMPLING AND ANALYSIS PLAN, EARLY WARNING MONITORING SYSTEM, PREPARED BY EPM NORTHEAST, FEBRUARY 1995.

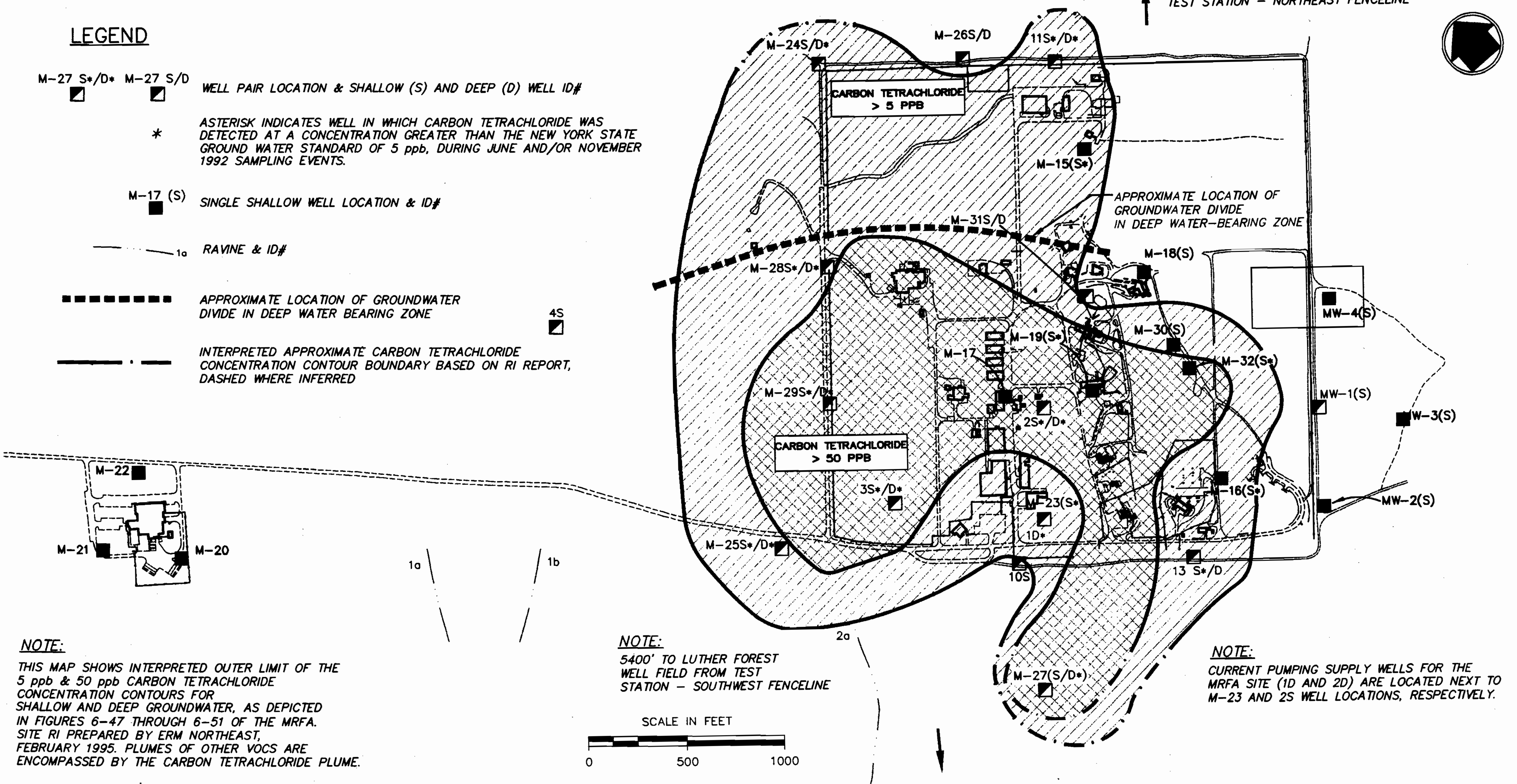
RUST ENVIRONMENT & INFRASTRUCTURE

DEEP GROUNDWATER ELEVATION CONTOUR MAP – AUGUST 23, 1994

MALTA ROCKET FUEL AREA SITE
FEASIBILITY STUDY

PROJECT No. 38833.070	DATE 4/28/95	DWG. No. 940236_B	SCALE 1" = 1800'	FIGURE No. 1-5

DRAWING No. 940236_B.DWG



LEGEND

M-27 S*/D* ◩ M-27 S/D ◩	WELL PAIR LOCATION & SHALLOW (S) AND DEEP (D) WELL ID#
*	ASTERISK INDICATES WELL IN WHICH CARBON TETRACHLORIDE WAS DETECTED AT A CONCENTRATION GREATER THAN THE NEW YORK STATE GROUND WATER STANDARD OF 5 ppb, DURING JUNE AND/OR NOVEMBER 1992 SAMPLING EVENTS.
M-17 (S) ■	SINGLE SHALLOW WELL LOCATION & ID#
—— · · —— 1a	RAVINE & ID#
■ ■ ■ ■ ■ ■ ■ ■	APPROXIMATE LOCATION OF GROUNDWATER DIVIDE IN DEEP WATER BEARING ZONE
—— · ——	INTERPRETED APPROXIMATE CARBON TETRACHLORIDE CONCENTRATION CONTOUR BOUNDARY BASED ON RI REPORT, DASHED WHERE INFERRED

4S ◩

NOTE:

THIS MAP SHOWS INTERPRETED OUTER LIMIT OF THE 5 ppb & 50 ppb CARBON TETRACHLORIDE CONCENTRATION CONTOURS FOR SHALLOW AND DEEP GROUNDWATER, AS DEPICTED IN FIGURES 6-47 THROUGH 6-51 OF THE MRFA. SITE RI PREPARED BY ERM NORTHEAST, FEBRUARY 1995. PLUMES OF OTHER VOCS ARE ENCOMPASSED BY THE CARBON TETRACHLORIDE PLUME.

NOTE:

CURRENT PUMPING SUPPLY WELLS FOR THE MRFA SITE (1D AND 2D) ARE LOCATED NEXT TO M-23 AND 2S WELL LOCATIONS, RESPECTIVELY.

NO.	REVISIONS	MADE	CHK	DATE

	NAMES	DATE
DRAWN:	RAC	4/28/95
DESIGN:		
CHECKED:		
PE:		
APP'D:		
APP'D:		
APP'D:		

AREA OF
CARBON TETRACHLORIDE PLUME
JUNE & NOVEMBER 1992

MALTA ROCKET FUEL AREA SITE
FEASIBILITY STUDY

RUST ENVIRONMENT & INFRASTRUCTURE

PROJECT NUMBER 38833.080

DATE 9/21/95

RUST DWG NUMBER 940154-E

FIGURE NUMBER 1-6

CLIENT DWG NUMBER 380.037-940154

SHEET NUMB

CAD AME: 940154-E.DWG

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

2.1 Introduction

This section identifies the remedial action objectives, general response actions, and remedial technologies for the MRFA Site. A wide range of remedial technologies is identified as potentially capable of meeting the remedial action objectives. Each remedial technology is evaluated, and the most appropriate technologies are retained for use in developing remedial action alternatives for the Site.

2.2 Remedial Action Objectives

Remedial action objectives for the Site are developed based on the constituents of concern, media of concern, identified exposure pathways, and potential receptors identified in the RI and the RA. The remedial action objectives, which are media-specific, provide for protection of human health and/or the environment. They have been selected to minimize or reduce to target levels, the potential for human exposure to or environmental damage due to the presence or migration of site-related contaminants. The site-specific remedial action objectives for groundwater and soil are as follows:

Groundwater

- Prevent ingestion of groundwater with concentrations of site-related constituents (primarily the VOCs carbon tetrachloride and TCE) above current federal drinking water standards or, if more stringent, New York State groundwater standards.
- Prevent ingestion of groundwater with concentrations of site-related VOCs that pose an unacceptable risk to human health (total excess cancer risk greater than $1x10^{-4}$ or having a non-carcinogenic hazard index greater than 1).
- Prevent further migration of the groundwater plume containing site-related VOCs above current federal drinking water standards or, if more stringent, New York State groundwater standards.
- Restore groundwater quality so that concentrations of site-related VOCs in the water bearing zone are reduced to current federal drinking water standards or, if more stringent, New York State groundwater standards.

Soil

- Prevent human exposure to surface soil at the Building 23P area that contains site-related constituents (polychlorinated biphenyls [PCBs] and lead [Pb]) posing an unacceptable risk to human health (excess cancer risk greater than $1x10^{-4}$).
- Prevent exposure to soil having a non-carcinogenic hazard index greater than 1.
- Prevent unacceptable ecological risks attributable to mercury (Hg) in surface soil at the Muggett's Pond Drainage Ditch intersection.

2.3 General Response Actions

General response actions are actions that will satisfy the remedial action objectives. They may include treatment, containment, excavation, extraction, disposal, institutional controls, or monitoring, individually or in combination. The general response actions selected for groundwater and soil at the MRFA Site are identified below.

Groundwater

- no action
- institutional controls
- containment
- collection, treatment, and discharge

Soil

- no action
- institutional controls
- removal
- disposal
- containment (capping) in place or at a common on-site location
- in situ treatment

On-site ex-situ treatment technologies will not be considered because it would be cost prohibitive to mobilize treatment equipment and operate a treatment unit for the relatively small quantity of soil that requires remediation.

The soil areas that may require remediation have been identified and the volumes to which the identified general response actions might be applied have been estimated to the extent possible. These areas and volumes are summarized below. The basis for the volume estimates is provided in Appendix C. In general, the volumes were estimated by making simple assumptions based on analytical data presented in the RI, and taking past land use and geological information into account. Refinement of areas and volumes may be necessary during the remedial design phase.

Building 23P: 5 cubic yards
Muggett's Pond Drainage Ditch Intersection: 3 cubic yards

2.4 Identification and Screening of Remedial Technologies

USEPA program guidance recommends screening alternative remedial technologies using the criteria of effectiveness, implementability, and cost (USEPA 1988). In this section, a broad range of remedial technologies is identified and screened to eliminate from further consideration those technologies and processes that may be of limited effectiveness, may not be able to be implemented at the Site, or may be cost-prohibitive. The purpose of this screening is to better focus the FS on those technologies that offer the greatest promise of being effective and that can be implemented at the Site.

Potentially applicable remedial technologies are identified for groundwater and soil, the media of concern, to satisfy each of the general response actions specified in Section 2.3. The remedial action objectives, general response actions, and remedial technologies are identified on Table 2-1 for groundwater and Table 2-2 for soil. These remedial technologies are evaluated based on site-specific information and are screened initially for technical applicability. Technologies are considered applicable if, individually or in combination, they would achieve the remedial action objectives. Technologies are not retained for further analysis if the area or volume estimates for the media of concern are such that these technologies can be presumed infeasible. Tables 2-3 and 2-4 provide the results of the initial screening of the remedial technologies, including the technical justification for eliminating technologies from further consideration.

Those technologies retained after the initial screening are further evaluated/screened based on effectiveness, implementability, and cost. The anticipated effectiveness of a technology refers to the ability of that technology to contribute to a remedial program that is protective of human health and the environment, and capable of meeting the stated remedial action objectives. In assessing the effectiveness of each technology, the demonstrated successful performance of each technology is considered. Implementability is the feasibility and the ease with which the technology can be applied at the Site. Implementability takes into consideration such practical factors as:

- Are the hazardous substances present at the Site compatible with the technology?
- Is there sufficient room at the Site to install and/or operate the technology?
- Is the use of the technology compatible with surrounding land uses?
- Will application of the technology unacceptably interfere with other ongoing uses of the Site?
- What permitting and other regulatory requirements apply to use of the technology?
- Does the technology require resources of a type or in a quantity that is not readily available at the Site?
- Are there experienced contractors that can provide, install, and operate the technology?

During this secondary phase of the screening process, the relative costs of the alternative technologies are also considered. Tables 2-5 and 2-6 present the results of the second level of screening for groundwater and soil, respectively.

2.5 Summary of Remedial Technologies

2.5.1 Remedial Technologies Retained for Further Consideration

The groundwater remedial technologies retained for further consideration following the secondary phase of the screening process are listed below.

- no action
- access (deed) restriction
- monitoring
- plume management or groundwater collection using extraction wells
- treatment through aeration/stripping
- on-site discharge of extracted groundwater

Consideration of the no action alternative is required by the NCP and EPA guidance. A deed restriction for the effected area could be implemented at minimal cost. Monitoring is retained since existing monitoring wells could be used or, if necessary, new wells could be readily installed at reasonable costs to characterize groundwater quality and flow conditions over time. Similarly, installation of recovery wells could be readily implemented, if necessary, to hydraulically manage the affected plume or to optimize the recovery of affected groundwater. Aeration/stripping is retained since it has been proven effective for the removal of TCE and carbon tetrachloride from groundwater at the Site. The on-site system could be used or modified to accommodate varying pumping rates. Finally, on-site discharge of treated water is retained. Routing of treated water to the Site storm water drainageways, retention basins, sanitary system, a surface water location (such as a ravine), or reinjection/infiltration would be effective as long as water quality is in compliance with Federal, State or local water discharge requirements.

The soil remedial technologies retained for further consideration following the secondary phase of the screening process are listed below.

- no action
- deed restriction
- capping
- surface controls
- excavation
- on-site disposal
- off-site disposal

Consideration of the "No Action Alternative" is required by the NCP and EPA guidance. A deed restriction could be implemented at minimal cost. Caps composed of asphalt, concrete, clay, soil or a synthetic membrane are effective for isolating and preventing exposure to or contact with soil containing PCBs or mercury, and installation of a layer of soil, asphalt or concrete over areas of contaminated soil would be readily implementable. Capital and long-term maintenance costs would be relatively low. The installation of clay and synthetic membrane would require the addition of an overlying protective layer. Diverting surface water flow and reducing the potential for soil erosion through the installation of stabilization fabrics such as erosion mats would effectively eliminate the potential for migration of soil in drainage ditches. Diversions may be necessary if surface water drainage ditches or retention basins are disrupted due to excavation or capping activities.

Excavation is a proven method for remediation of affected soils. It is an effective long-term technology because the source of potential threat to human health or the environment is permanently removed. With regard to disposal, eligible soil from the small areas of affected soil could be consolidated into one location for closure. Covering the consolidated excavated material with asphalt, concrete or native soil material would effectively eliminate the potential for human exposure. Construction of an on-site consolidation area could be implemented with commonly available equipment at reasonable costs. Treatment and/or disposal of soil at an appropriate permitted off-site facility would effectively reduce or minimize the toxicity, volume and mobility of the constituents. Permitted disposal facilities are available to receive soil containing PCBs and mercury.

2.5.2 Technologies Eliminated from Further Consideration

Groundwater technologies that are not retained for further consideration include the following:

- alternate water supply
- plume management or groundwater collection using an interceptor trench or vertical groundwater flow barrier
- treatment using carbon adsorption, off-site treatment at a POTW, off-site treatment at a RCRA facility, air sparging, bioremediation, or permeable treatment beds
- discharge at a POTW

Although extending an off-site water supply to the Site would be an effective means of supplying potable water, the closest off-site water supplies are the Luther Forest Well Field and the Cold Spring Well Field. Extending these supplies to the Site would require piping in excess of a mile[1] and would require more effort and cost than using the on-site treatment system. Installing a new on-site water supply well in place of the existing wells (1D and 2D) would not be effective, since groundwater removed from the unconsolidated material would likely require treatment, and the underlying material is not likely to yield a water supply comparable to the existing overburden wells. Therefore, an alternative water supply is not retained for further consideration.

Although plume management or groundwater collection using an interceptor trench is ordinarily an effective and simple means of collecting groundwater, it may not be effective at the MRFA Site because the deep water table and heterogeneities within the relatively thick stratigraphic units could allow contaminated groundwater to flow beneath the trench. Because the interceptor trench would have to be unusually deep and long to fully capture impacted groundwater, this technology is impractical and is not retained. Plume management or groundwater collection using a vertical groundwater flow barrier is not retained for further consideration. A groundwater flow barrier such as a cut-off wall, grout curtain or sheet pile wall would need to be extremely deep and long due to the wide-spread nature of the VOCs in groundwater. This technology is not practical for a site with wide-spread, low-level concentrations of VOCs. Furthermore, recovery wells, a technology already demonstrated to be effective at the Site and retained for further evaluation, could achieve the same objective and would have lower capital costs.

Off-site discharge at a POTW is not retained. Sewer-use ordinances typically require pretreatment of water containing hazardous constituents. The closest access to a POTW is likely to be on Plains Road, associated with the Luther Forest Housing Development. This technology would require construction of over one mile of sanitary sewer line to convey the effluent to the location of the nearest POTW. Alternatively, on-site storage tanks and provision for trucking of effluent to the POTW would be required. The lack of a nearby sanitary sewer line and the potential pretreatment requirements make this technology impractical.

Treatment technologies such as carbon adsorption, off-site treatment at a POTW, off-site treatment at a RCRA facility, air sparging, bioremediation, or permeable treatment beds are not retained. Adsorption by granular activated carbon (GAC) is effective, and adsorption equipment is readily available; however, the GAC could become a hazardous waste as a result of its use and be subject

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[1] Unless the existing piping from the Test Station to the former GE/Exxon Building could be used.

to regulatory restrictions, and pretreatment of groundwater may be necessary to remove suspended solids that can foul the GAC. Since the aeration/stripping technology is equally as effective as carbon adsorption, and an air stripping system already exists on the Site, air stripping would be more practical and cost effective than carbon adsorption. The lack of a nearby sanitary sewer line and the potential pretreatment requirements make off-site treatment at a POTW impractical. The lack of a nearby RCRA facility and the costs associated with transporting water over long distances makes off-site treatment at a RCRA facility impractical. Although air sparging has been used effectively at sites with VOCs in groundwater, this technology is not practical for low concentrations of VOCs over wide-spread areas. Due to the wide distribution of low levels of VOCs in the groundwater, air sparging combined with vapor extraction would be only marginally effective, impractical to build, and costly. With regard to bioremediation, conditions at the Site (the low concentrations of compounds resulting from the biodegradation of TCE and carbon tetrachloride) do not appear to be conducive to growth of TCE and carbon tetrachloride metabolizing bacteria. A treatment bed would have to be very long and keyed into the lake silty clay to capture VOCs in the overlying units, and the VOC-containing carbon may require removal and disposal at a future date. The cost and effort to install a long, deep trench make this technology impractical.

No soil technologies were eliminated during the secondary phase of the screening process.

Table 2-1
Groundwater: Remedial Action Objectives, General Response Actions, and Remedial Technologies
Malta Rocket Fuel Area Site

Environmental Media/ Remedial Action Objectives	General Response Action	Remedial Technology	Process Options
Groundwater • Prevent ingestion of groundwater with concentrations of site-related constituents (primarily the VOCs carbon tetrachloride and TCE) above current federal drinking water standards or, if more stringent, New York State groundwater standards. • Prevent ingestion of groundwater with concentrations of site-related VOCs that pose an unacceptable risk to human health (total excess cancer risk greater than $1\text{x}10^{-4}$ or having a non-carcinogenic hazard index greater than 1. • Prevent further migration of the groundwater plume containing site-related VOCs above current federal drinking water standards or, if more stringent, New York State groundwater standards. • Restore groundwater quality so that concentrations of site-related VOCs in the water bearing zone are reduced to current federal drinking water standards or, if more stringent, New York State groundwater standards.	No Action	Non-technology based	Not Applicable
	Institutional Actions	Access Restrictions (Non-technology based)	Deed Restrictions
		Alternate Water Supply	City Water Supply
			New Community Well
		Monitoring	Groundwater Monitoring
	Collection	Extraction	Extraction Wells
			Extraction/Injection Wells
		Subsurface Drains	Interceptor Trenches
	Discharge	Onsite Discharge	Local Surface Water Body
			Recharge (Reinjection/Infiltration)
			Stormwater System
			Sanitary System
		Offsite Discharge	Deep Well Injection
			POTW
			Pipeline to river
	Containment	Extraction	Extraction Wells
		Subsurface Drains	Interceptor Trench
		Cap	Clay and Soil
			Asphalt
			Concrete
			Multimedia Cap
		Vertical Barriers	Slurry Wall
			Grout Curtain
			Vibrating Beam
		Horizontal Barriers	Grout Injection
			Block Displacement
	Treatment	Biological treatment	Aerobic
			Anaerobic
		Physical/Chemical Treatment	Precipitation
			Stripping
			Carbon Adsorption
			UV Oxidation
			Reverse Osmosis
			Ion Exchange
		Offsite Treatment	POTW
			RCRA Facility
		In Situ Treatment	Bioremediation
			Air Sparging
			Permeable Treatment Beds
			Chemical Reaction

Table 2-2
Soil: Remedial Objectives, General Response Actions, and Remedial Technologies
Malta Rocket Fuel Area Site

Environmental Media/ Remedial Objective	General Response Action	Remedial Technology	Process Options
Soil • Prevent human exposure to surface soil at the Building 23P area that contains site-related constituents (polychlorinated biphenyls [PCBs] and lead [Pb]) posing an unacceptable risk to human health (excess cancer risk greater than 1x10^{-4}). • Prevent exposure to soil having a non-carcinogenic hazard index greater than 1. • Prevent unacceptable ecological risks attributable to mercury (Hg) in surface soil.	No Action	Non-technology Based	Not Applicable
	Institutional Actions	Access Restrictions	Deed Restrictions
	Containment	Cap	Engineered Clay
			Soil
			Asphalt
			Concrete
			Synthetic Membrane
		Vertical Barriers	Slurry Wall
			Sheet Pile
			Grout Curtain
			Vibrating Beam
		Horizontal Barriers	Grout Injection
			Block Displacement
		Surface Controls	Diversion/Collection
			Grading
	Removal	Excavation	Solids Excavation
	Treatment	Biological Treatment	Landfarming (Treatment Cells)
		Physical Treatment	Solidification/Stabilization
			Soil Washing
		Chemical Treatment	Chemical Extraction
			Glycolate Dechlorination
			Nucleophilic Substitution
		Thermal	Rotary Kiln
			Fluidized Bed
			Infrared Thermal
			Low Temperature Thermal
		In Situ Treatment	Bioremediation
			Vitrification
			Solidification/Stabilization
			Soil Vapor Extraction
			Steam Stripping
	Disposal	On site Disposal	Common On-site Facility
		Off-site Disposal	Off-site Facility

Table 2-3
Groundwater: Initial Screening of Remedial Technologies
Malta Rocket Fuel Area Site

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
No Action	Non-technology Based	Not Applicable	No action is taken.	Potentially Applicable
Institutional Actions	Access Restrictions (non-technology based)	Deed Restrictions	Deeds would include restrictions on groundwater use, as appropriate	Potentially Applicable
	Alternate Water Supply	City Water Supply	Extension of existing municipal well system to serve residents in the area of influence	Potentially Applicable
		New Community Well	New uncontaminated wells to serve residents in the area of influence	Potentially Applicable
	Monitoring	Groundwater Monitoring	Ongoing Monitoring of Wells	Potentially Applicable
Collection	Extraction	Extraction Wells	Series of wells to extract contaminated groundwater	Potentially Applicable
		Extraction/Injection wells	Injection wells inject uncontaminated water to increase flow to extraction wells	Potentially Applicable
	Subsurface Drains	Interceptor Trenches	Perforated pipe in trenches backfilled with porous media to collect contaminated water	Potentially Applicable
Discharge	On-site Discharge	Local Stream	Extracted water discharged to local surface water body	Potentially Applicable
		Recharge (Reinjection/Infiltration)	Extracted water discharged to on-site through reinjection/infiltration.	Potentially Applicable
		Stormwater System	Extracted water discharged to on-site stormwater system	Potentially Applicable
		Sanitary System	Extracted water discharged to on-site sanitary system	Potentially Applicable
	Off-site Discharge	Deep Well Injection	Extracted water discharged to deep well injection system	Deep aquifer not suitable for injection of contaminated water.
		POTW	Extracted water discharged to local POTW for treatment	Potentially Applicable
		Pipeline to river	Extracted water discharged to river off site	Not applicable because no rivers are in the site vicinity
Containment	Extraction	Extraction Wells	Recovery wells pumped to extract groundwater and hydraulically contain flow	Potentially Applicable
	Subsurface Drains	Interceptor Trenches	Perforated pipe in trenches backfilled with porous media to collect groundwater and hydraulically contain flow	Potentially Applicable
	Cap	Clay and Soil	Compacted clay covered with soil over areas of contamination	Not applicable due to large size of site and lack of significant groundwater contamination source
		Asphalt	Application of a layer of asphalt over areas of contamination	Not applicable due to large size of site and lack of significant groundwater contamination source
		Concrete	Installation of concrete slab over areas of contamination	Not applicable due to large size of site and lack of significant groundwater contamination source
		Multimedia Cap	Clay and synthetic membrane covered by soil over areas of contamination	Not applicable due to large size of site and lack of significant groundwater contamination source
	Vertical barriers	Slurry Wall	Trench around areas of conamination is filled with a soil (or cement) bentonite slurry	Potentially Applicable
		Grout curtain	Pressure injection of grout in a regular pattern of drilled holes	Potentially Applicable
		Vibrating Beam	Force to advance beams into the ground with injection of slurry as beam is withdrawn	Potentially Applicable

Table 2-3
Groundwater: Initial Screening of Remedial Technologies
Malta Rocket Fuel Area Site

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Containment	Horizontal Barriers	Grout Injection	Pressure injection of grout at depth through closely spaced drilled holes	Not applicable due to large size of site and lack of significant groundwater contamination source
		Block Displacement	In conjunction with vertical barriers, injection of slurry in notched injection holes.	Not applicable due to large size of site and lack of significant groundwater contamination source
Treatment	Biological Treatment	Aerobic	Degradation of organics using microorganisms in an aerobic environment	Not applicable; existing air stripper is proven effective; adding this technology would unduly complicate existing system
		Anaerobic	Degradation of organics using microorganisms in an anaerobic environment	Not applicable; existing air stripper is proven effective; adding this technology would unduly complicate existing system
	Physical/Chemical Treatment	Precipitation	Alteration of chemical equilibria to reduce solubility of the contaminants	Not applicable to organic contaminants found in groundwater at the site
		Stripping	Mixing large volumes of air with water in a packed column or shallow trays to promote transfer of VOCs to air	Potentially Applicable
		Carbon Adsorption	Adsorption of contaminants onto activated carbon by passing water through carbon column	Potentially Applicable
		UV Oxidation	Dissolved organic contaminants are destroyed using chemical oxidation	Not applicable; existing air stripper is effective; adding this technology would unduly complicate existing system
		Reverse Osmosis	Use of high pressure to force water through a membrane leaving contaminants behind	Not applicable to organic contaminants
		Ion Exchange	Contaminated water is passed through a resin bed where ions are exchanged between resin and water	Not applicable; existing air stripper is proven effective; adding this technology would unduly complicate existing system
	Off-site Treatment	POTW	Extracted groundwater discharged to local POTW for treatment	Potentially Applicable
		RCRA Facility	Extracted groundwater discharged to licensed RCRA facility for treatment and/or disposal	Potentially Applicable
	In Situ Treatment	Bioremediation	System of injection and extraction wells, introduce bacteria and nutrient to degrade contamination	Potentially Applicable
		Air Sparging	System of wells to inject air into groundwater to remove volatiles by air stripping	Potentially Applicable
		Permeable Treatment Beds	Downgradient trenches backfilled with activated carbon to remove contaminants from water	Potentially Applicable
		Chemical Reaction	System of injection wells to inject oxidizer such as hydrogen peroxide to degrade contaminants	Not proven applicable to organic contaminants

Table 2-4
Soil: Initial Screening of Remedial Technologies
Malta Rocket Fuel Area Site

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
No Action	Non -technology Based	Not Applicable	No action is taken	Potentially Applicable
Institutional Actions	Access Restrictions (non-technology based)	Deed Restrictions	Restriction to future use of affected areas are specified in the property deed	Potentially Applicable
Containment	Cap	Engineered Clay	Place and compact controlled layers of clay over areas of contamination	Potentially Applicable
		Soil	Cover areas of contamination with a layer of soil	Potentially Applicable
		Asphalt	Apply a layer of asphalt over areas of contamination	Potentially Applicable
		Concrete	Installation of concrete slab over areas of contamination	Potentially Applicable
		Synthetic Membrane	Install synthetic membrane with soil over areas of contamination	Potentially Applicable
	Vertical barriers	Slurry Wall	Trench around areas of contamination is filled with a soil (or cement) bentonite slurry	Not applicable due to shallow depth, limited volume, and immobility of PCB-contaminated soil
		Sheet Pile	Drive interlocking steel sheet piles around areas of contamination	Not applicable due to shallow depth,limited volume, and immobility of PCB-contaminated soil
		Grout Curtain	Pressure injection of grout in a regular pattern of drilled holes	Not applicable due to shallow depth, limited volume, and immobility of PCB-contaminated soil
		Vibrating Beam	Force beams into the ground and inject a slurry as beam is withdrawn	Not applicable due to shallow depth, limited volume, and immobility of PCB-contaminated soil
	Horizontal Barriers	Grout Injection	Pressure injection of grout at depth through closely spaced drilled holes	Not applicable due to limited volume of contaminated soil.
		Block Displacement	In conjunction with vertical barriers, injection of slurry in notched injection holes	Not applicable due to limited volume of contaminated soil
	Surface Controls	Diversion/Collection	Modify drainage to prevent or control soil erosion and sedimentation	Potentially Applicable
		Grading/Revegetation	Modify soil topography and revegetate areas of contamination to prevent or control soil erosion	Potentially Applicable
Removal	Excavation	Solids Excavation	Remove soil by conventional excavation equipment	Potentially Applicable
Treatment	Biological Treatment	Landfarming (Treatment Cells)	Innoculate and spread soil in controlled shallow cells to encourage biodegradation	Not applicable due to limited volume of contaminated soil
	Physical Treatment	Solidification/ Stabilization	Introduce specially designed admixtures to excavated soil to improve its physical properties	Not applicable due to limited volume of contaminated soil
		Soil Washing	Soil is mechanically mixed, washed, and rinsed with water to remove contaminants	Not applicable due to limited volume of contaminated soil

Table 2-4
Soil: Initial Screening of Remedial Technologies
Malta Rocket Fuel Area Site

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Treatment	Chemical Treatment	Chemical Extraction	Similar to soil washing, except that solvents rather than water are used to extract contaminants	Not applicable due to limited volume of contaminated soil; process also generates waste solvents
		Glycolate Dechlorination	Catalysts and elevated temperatures are used to break down organic compounds and convert them to lower toxicity water soluble materials	Not applicable due to limited volume of contaminated soil
		Nucleophilic Substitution	Nucleophilic reagents are added to dechlorinate aromatic organics in a substitution reaction	Not applicable due to limited volume of contaminated soil
	Thermal Treatment	Rotary Kiln	Combustion in a horizontally rotating cylinder designed for uniform heat transfer	Not applicable due to limited volume of contaminated soil
		Fluidized Bed	Waste injected into hot agitated bed of sand where combustion occurs	Not applicable due to limited volume of contaminated soil
		Infrared Thermal	Combustion using thermal radiation (beyond the red end of the visible spectrum) as the material passes on a conveyor belt through a treatment unit	Not applicable due to limited volume of contaminated soil.
		Low Temperature Thermal	Soil is heated at low (non-combustible) temperatures to cause volatilization of contaminants	Not applicable due to limited volume of contaminated soil
	In Situ Treatment	Bioreclamation	Soil is treated through microbial decomposition	Not applicable due to limited volume of contaminated soil
		Vitrification	Soil is heated to the melting point to destroy, volatilize, or immobilize contaminants in a monolithic mass	Not applicable due to limited volume of contaminated soil
		Solidification/ Stabilization	A solidification/stabilization agent and water are added to convert the affected soil to a hardened mass	Not applicable due to limited volume of contaminated soil
		Soil Vapor Extraction	Organic compounds are removed by drawing a vacuum toward vertical or horizontal vapor extraction wells	Not applicable to PCBs; also not applicable due to limited volume of contaminated soil
		Steam Stripping	Using wells, inject and recover steam to mobilize and remove volatile/semi-volatile compounds	Not applicable to PCBs; also not applicable due to limited volume of contaminated soil
Disposal	On site Disposal	Common On-site Facility	Excavated material is placed in a common on-site disposal area	Potentially Applicable
	Off-site Disposal	Off-site Facility	Excavated material is transported to an appropriate off-site facility for final disposition	Potentially Applicable

Table 2-5
Groundwater: Remedial Technology Screening
Malta Rocket Fuel Area Site

General Response Action	Remedial Technology	Description	Screening
No Action	Non-technology Based	No action is taken to remove, treat or control groundwater.	**Comments:** RETAINED. As required by the NCP and EPA Guidance (1988), this technology is retained for comparison to other alternatives.
Institutional Actions	Deed Restriction/ Institutional Controls	Restrictions to future use of the Site, portions of the Site, or groundwater, as appropriate, are specified in property deeds.	**Effectiveness:** A deed restriction could be an effective means of controlling future use of the Site or groundwater Restrictions could include continued apply to the Site or portions of the Site, and could include such things as: restricted Site access, continued use of the Site for commercial/industrial purposes, restricted use of groundwater, and continued use/maintenance of the one-mile restrictive easement that prohibits human habitation and limits access to the Site. **Implementability/Cost:** Deed restrictions could be readily implemented at a minimal cost. **Comments:** RETAINED.
	Alternate Water Supply	Extension of an existing municipal water supply or installation of a new water supply well.	**Effectiveness:** Extending an off-site water supply to the Site would be an effective means of supplying potable water to Site workers or future residents. Any new wells installed in unconsolidated material on site would require treatment prior to use for water supply. The unconsolidated material is underlain by shale which is not likely to yield a water supply comparable to the overburden wells. **Implementability/Cost:** The closest off-site water supplies are the Luther Forest Well Field and the Cold Spring Well Field. Extending these supplies to the Site would require piping in excess of a mile (unless the existing piping from the Test Station to the former GE/Exxon Building could be used). Use of the existing (or modified) treatment system would require less effort and would be less costly than extending an off-site water supply. **Comments:** ELIMINATED. Supplying off-site water would require more effort and cost than using the on-site treatment system. Installing a new water supply well on-site would not be effective.
	Monitoring	Ongoing Monitoring of Wells	**Effectiveness:** Monitoring wells are effective for characterizing groundwater quality and flow conditions over time. Monitoring wells could be used in conjunction with institutional controls, or to evaluate the effectiveness of a hydraulic containment or collection system. **Implementability/Cost:** Existing monitoring wells could be used or, if necessary, new wells could be readily installed at reasonable costs. **Comments:** RETAINED.
Collection	Extraction Wells (1)	A system of extraction wells is used to extract groundwater from the saturated zone of the underlying water bearing unit.	**Effectiveness:** Groundwater recovery wells have proven effective in sandy unconsolidated aquifers such as that present at the Site. The water bearing unit underlying the MRFA Site is likely to yield sufficient groundwater to affect hydraulic gradients over significant distances as demonstrated by the effect of the MRFA Site water supply wells on the groundwater level contours. Removal of VOCs is dependent on the characteristics of the TCE and carbon tetrachloride and the nature of the unsaturated and saturated portions of the water bearing unit. **Implementability/Cost:** Installation of recovery wells could be readily implemented, if necessary, to control hydraulic gradients and to optimize recovery of impacted groundwater. **Comments:** RETAINED.

Table 2-5
Groundwater: Remedial Technology Screening
Malta Rocket Fuel Area Site

General Response Action	Remedial Technology	Description	Screening
Collection	Subsurface Drains (Interceptor Trench)	A gravel-filled trench is placed towards the downgradient edge of the impacted groundwater.	**Effectiveness:** Although a trench is ordinarily an effective and simple means of collecting groundwater, it may not be effective at the MRFA Site because inhomogeneities within the relatively thick stratigraphic units could allow impacted groundwater to flow beneath the trench. The interceptor trench would have to be unusually deep and long to fully capture impacted groundwater. **Implementability/Cost:** Construction of an interceptor trench requires commonly available equipment and methods. To capture the wide-spread lateral extent of impacted groundwater, a long trench (3,000 to 4,000 feet) would be required at the leading edge of the plume. The relatively deep groundwater (17 to 53 feet below ground surface) would require a deep trench. Installation of a long deep trench would be costly. **Comments:** ELIMINATED. The cost and effort to install a long, deep trench make this technology impractical. Recovery wells, a technology demonstrated to be effective at the Site and retained for further evaluation, could achieve the same objective and would have lower capital costs.
Discharge	Off-site Discharge at a POTW	Off-site discharge involves piping or trucking extracted groundwater to a publicly owned treatment works (POTW). The discharge water must be either pretreated or contain levels of contaminants that can be treated by the particular POTW.	**Effectiveness:** Sewer use ordinances typically require pretreatment of water containing hazardous constituents. **Implementability/Cost:** The closest access to a POTW is likely to be on Plains Road, associated with the Luther Forest Housing Development. This technology would require construction of over a mile of sanitary sewer line to conduct the effluent to the location of the nearest POTW. Alternatively, on-site storage tanks and provision for trucking of effluent to the POTW would be required. **Comments:** ELIMINATED. The lack of a nearby sanitary sewer line and the potential pretreatment requirements make this technology impractical.
	On-site Discharge of Treated Groundwater	On-site discharge requires treatment of groundwater to applicable standards prior to discharge to the ground or surface water.	**Effectiveness:** Routing of treated water to the Site storm water drainageways, retention basins, sanitary system, a surface water location, or recharge (reinjection/infiltration) point would be effective as long as water quality is in compliance with Federal, State or local water discharge requirements. **Implementability/Cost:** Treated water could be easily discharged to any of the above referenced points. Recharge points (reinjection/infiltration) could be readily installed. Currently, treated water is being used as a water supply for the Site. **Comments:** RETAINED. The actual point and manner of discharge will be addressed as part of the detailed analysis of alternatives.
Containment	Extraction Wells	Groundwater recovery wells are pumped at a rate such that hydraulic gradients are reversed and off-site migration of groundwater is prevented.	**Effectiveness:** Hydraulic containment using recovery wells is a proven effective means of controlling the migration of groundwater contaminants in unconsolidated water bearing units. The water bearing unit underlying the MRFA Site can yield adequate production rates to reverse gradients, as demonstrated by the effect of the MRFA Site water supply wells on the groundwater contours. **Implementability/Cost:** Installation of recovery wells could be readily implemented. **Comments:** RETAINED.

Table 2-5
Groundwater: Remedial Technology Screening
Malta Rocket Fuel Area Site

General Response Action	Remedial Technology	Description	Screening
Containment	Subsurface Drains (Interceptor Trench)	A gravel-filled trench is placed on the downgradient edge of the impacted groundwater. The elevation of groundwater within the trench is lowered only enough to mitigate downgradient migration of VOCs.	**Effectiveness:** Although a trench is ordinarily an effective and simple means of controlling groundwater flow, it may not be effective at the MRFA Site because inhomogeneities within the relatively thick stratigraphic units could allow impacted groundwater to flow beneath the trench. The interceptor trench would have to be unusually deep and long to fully capture impacted groundwater. **Implementability/Cost:** Construction of an interceptor trench requires commonly available equipment and methods. To contain the wide-spread lateral extent of impacted groundwater, a long trench (3,000 to 4,000 feet) would be required at the leading edge of the plume. The relatively deep groundwater (17 to 53 feet below ground surface) would require a deep trench. Installation of a long deep trench would be costly. **Comments:** ELIMINATED. The cost and effort to install a long, deep trench make this technology impractical. Recovery wells, a technology demonstrated to be effective at the Site and retained for further evaluation, could achieve the same objective and would have lower capital costs.
	Vertical Groundwater Flow Barrier	A low permeability vertical barrier to groundwater flow is created using a cutoff wall, grout curtain or sheet piling.	**Effectiveness:** Groundwater flow barriers are used frequently with other gradient control technologies. If constructed properly, a cut-off wall, grout curtain or sheet pile could create an effective barrier to groundwater flow, potentially increasing the effectiveness of a groundwater recovery system and reducing the inflow of groundwater that is not impacted. A downgradient barrier, or one that completely encircles the VOC plume, would need to be long due to the wide-spread nature of the VOCs in groundwater. No localized source area has been identified to contain within vertical barriers. **Implementability/Cost:** Installation of a cut-off wall, grout curtain or sheet pile could be readily implemented at the Site although it is not practical due to the wide-spread nature of the impacted groundwater. A vertical cutoff wall would need to be keyed into a low permeability unit such as the lake clay and silt (approximately 80 to 100 feet below ground surface) underlying the lake silty sand. Such a long and deep barrier wall would have high construction costs. **Comments:** ELIMINATED. This technology is not practical for a site with wide-spread, low level concentrations of VOCs and deep confining layer.
Treatment	Aeration/ Stripping	Volatile and some semi-volatile compounds are removed from extracted groundwater by creating turbulence or mixing to expedite partitioning into air.	**Effectiveness:** Aeration/stripping has been proven effective for the removal of TCE and carbon tetrachloride from groundwater. **Implementability/Cost:** The on-site system could be used or modified to accommodate varying pumping rates. This is a common technology and could easily be implemented. Pretreatment of groundwater may be necessary to remove iron or suspended solids which can foul the aeration/stripping process. Air emissions sometimes require treatment but may not be necessary at the MRFA Site due to the low concentrations of VOCs in groundwater. **Comments:** RETAINED.
	Carbon Adsorption	This process is used to remove constituents by passing the flow over or through a medium such as granular activated carbon (GAC) which adsorbs the constituents.	**Effectiveness:** Adsorption by GAC is commonly applied to remove a wide range of organics, including TCE and carbon tetrachloride, from aqueous streams. It would be an effective technology for treatment of extracted groundwater or air containing these compounds. The GAC could become a hazardous waste as a result of its use and be subject to the regulatory restrictions associated with those wastes. **Implementability/Cost:** Adsorption equipment is readily available, compact, and could be used on-site. Pretreatment of groundwater may be necessary to remove suspended solids which can foul the GAC. Since the aeration/stripping technology is equally as effective as carbon adsorption, and an air stripping system already exists on the Site, air stripping would be more practical and cost effective than carbon adsorption. **Comments:** ELIMINATED. Air stripping is more practical for the MRFA site than carbon treatment because a system is already located on Site.

Table 2-5
Groundwater: Remedial Technology Screening
Malta Rocket Fuel Area Site

General Response Action	Remedial Technology	Description	Screening
Treatment	Off-site Treatment at POTW	Extracted water is discharged or transported to a local POTW for treatment.	**<u>Effectiveness:</u>** Sewer-use ordinances typically require pretreatment of water containing hazardous constituents. Therefore, the discharge water would likely require pretreatment prior to discharge to the POTW. **<u>Implementability/Cost:</u>** The closest access to a POTW is likely to be on Plains Road, associated with the Luther Forest Housing Development. This technology would require construction of over a mile of sanitary sewer line to conduct the effluent to the location of the nearest POTW. Alternatively, on-site storage tanks and provision for trucking of effluent to the POTW would be required. **<u>Comments:</u>** ELIMINATED. The lack of a nearby sanitary sewer line and the potential pretreatment requirements make this technology impractical.
	Off-Site Treatment at RCRA Facility	Extracted water is discharged or transported to a RCRA facility for treatment.	**<u>Effectiveness:</u>** A RCRA facility could effectively treat groundwater collected at the Site to levels below applicable standards. **<u>Implementability/Cost:</u>** No RCRA facility is located near the Site. The closest RCRA permitted facilities are located in northern New Jersey, western New York and Boston, MA. It would be impractical and costly to transport water via tanker truck to one of these facilities compared with on-site treatment. **<u>Comments:</u>** ELIMINATED. The lack of a nearby RCRA facility and the costs associated with transporting water over long distances makes this technology impractical.
	Air Sparging	Sparging wells are used to inject air below the water table, allowing VOCs to partition into the air and be extracted by a vapor extraction system.	**<u>Effectiveness:</u>** Air sparging has been used effectively at sites with VOCs in groundwater. Higher concentrations of VOCs partition more readily and are therefore recovered more efficiently than lower concentrations. The thickness of the water bearing unit and the depth to groundwater are amenable to air sparging in conjunction with vapor extraction. **<u>Implementability/Cost:</u>** This technology is not practical for low concentrations of VOCs over wide-spread areas. A large air sparging system would require many air sparging and vapor extraction points and a large source of compressed air. Construction of a subsurface air sparging/vapor extraction system would be complicated by the presence of buildings and other Site structures. Construction and installation of an air sparging/vapor extraction system would be more costly than groundwater recovery with only a minimal increase of VOC recovery. **<u>Comments:</u>** ELIMINATED. Due to the wide distribution of low levels of VOCs in the groundwater and the lack of an obvious source area, air sparging combined with vapor extraction would be only marginally effective, impractical to build, and costly.
	Bio-remediation	In situ biodegradation of VOCs in groundwater is enhanced by injecting VOC digesting bacteria and other supporting compounds into the area of the groundwater plume.	**<u>Effectiveness:</u>** Under appropriate conditions, certain bacteria degrade TCE and carbon tetrachloride to daughter compounds, such as dichloroethenes or dichloromethanes, that are more mobile and thus more amenable to certain types of groundwater remediation. The marginal increase in mobility of certain TCE and carbon tetrachloride daughter products that bioremediation might provide is not likely to provide significant gains in the efficiency of groundwater recovery technologies. **<u>Implementability/Cost:</u>** The low concentration of compounds resulting from the biodegradation of TCE and carbon tetrachloride suggests that appropriate conditions for biodegradation are not overly favorable at the Site. Implementation may require injection of carbon substrates such as acetone or methanol, with their own potentially negative environmental effects. Heating necessary to encourage bacterial growth could require significant energy costs. **<u>Comments:</u>** ELIMINATED. Conditions at the Site do not appear to be conducive to growth of TCE and carbon tetrachloride metabolizing bacteria.

Table 2-5
Groundwater: Remedial Technology Screening
Malta Rocket Fuel Area Site

General Response Action	Remedial Technology	Description	Screening
Treatment	Permeable Treatment Beds	Downgradient trenches are backfilled with activated carbon to remove contaminants from water.	**Effectiveness:** A treatment bed would have to be keyed into the lake silty clay to capture the VOCs in the overlying units. The bed would also have to be long to fully capture impacted groundwater. The VOC-containing carbon may require removal and disposal at a future date. **Implementability/Cost:** As described for an interceptor trench, to capture the wide-spread lateral extent of impacted groundwater using a permeable treatment bed, a long trench (3,000 to 4,000 feet) would be required at the leading edge of the plume. The thick lake sand and lake silty sand stratigraphic units (nearly 100 feet below ground surface) would require a deep trench. Installation of a long deep trench and future removal and disposal would be costly. **Comments:** ELIMINATED. The cost and effort to install a long, deep trench make this technology impractical.

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(1) Injection wells in association with extraction wells are assessed under On-site Discharge of Treated Water.

Table 2-6
Soil: Remedial Technology Screening
Malta Rocket Fuel Area Site

General Response Action	Technology	Description	Screening
No Action	Non-Technology Based	No action is taken to remove or control affected soil.	**Comments:** RETAINED. This technology is retained for comparison to other alternatives.
Institutional Controls	Access Restriction	Restrictions to future use of selected areas are specified in the property deed.	**Effectiveness:** A deed restriction could be an effective means of controlling access and minimizing exposure to affected soil. Restrictions could include use of the property or portions of the property for commercial/industrial purposes only, no future development of selected areas, or continued enforcement of the existing 1-mile restrictive easement prohibiting human habitation and restricting access to the site. **Implementability/Cost:** Deed restrictions could be readily implemented at a minimal cost. **Comments:** RETAINED.
Contain-ment	Capping	Soil exceeding cleanup goals is closed in place (covered) using native material, clay, asphalt, concrete, or a synthetic membrane.	**Effectiveness:** Caps composed of asphalt, concrete, clay, soil or a synthetic membrane are effective for isolating and preventing exposure to or contact with soil containing PCBs or mercury. Except for soil, these alternate cap compositions would promote runoff and reduce infiltration of precipitation, but the affected soil areas have not been identified as sources of constituents to groundwater. A cap would require long-term maintenance for continued effectiveness. A soil cover could be more readily breached. **Implementability/Cost:** The installation of a layer of soil, asphalt or concrete over areas of contaminated soil would be readily implementable. Capital and long-term maintenance costs.would be relatively low. The installation of clay and synthetic membrane would require the addition of an overlying protective layer. Capping in drainageways may require drainage rerouting. **Comments:** RETAINED (Soil, asphalt, or concrete caps).
	Surface Controls	Affected soil is graded and stabilized, and surface water flow is diverted around the affected area to minimize erosion and runoff.	**Effectiveness:** Diverting surface water flow and reducing the potential for soil erosion through the installation of stabilization fabrics such as erosion mats would effectively eliminate the potential for migration of soil in drainage ditches. Diversions may be necessary if surface water drainage ditches or retention basins are disrupted due to excavation or capping activities. **Implementability/Cost:** Surface control measures vary in complexity and cost, and each type of measure serves a different purpose. Construction or modification of surface controls could be readily implemented using commonly available equipment. Whether the surface control measures consist of surface water diversion, soil regrading, or soil stabilization, the costs are relatively low in comparison to other remedial technologies. **Comments:** RETAINED.

Table 2-6
Soil: Remedial Technology Screening
Malta Rocket Fuel Area Site

General Response Action	Technology	Description	Screening
Removal	Excavation	Affected soil/sediment is excavated, and excavated areas are backfilled with clean material.	**Effectiveness:** Excavation is a proven method for remediation of affected soils. This is an effective long-term technology because the source of potential threat to human health or the environment is permanently removed. **Implementability/Cost:** Excavation equipment is commonly available. Special concerns with implementability can arise if accessibility is limited, if removal of affected soil could jeopardize the stability of a nearby building foundation or structure, or if it is in an active traffic or operations area. Soil disposal costs vary with the types of compounds contained in the excavated material. **Comments:** RETAINED.
Disposal	On-site Disposal	Excavated material is disposed in a common on-site disposal area.	**Effectiveness:** Eligible soil from the small areas of affected soil could be consolidated into one location (such as area D-2) for closure. Covering the consolidated excavated material with asphalt, concrete or native soil material would effectively eliminate the potential for human exposure. Although asphalt, concrete and clayey native soils would promote runoff and restrict precipitation infiltration, these benefits are not factors as the PCBs and mercury in the affected soils do not appear to present a significant threat to Site groundwater quality. A cap to isolate the affected soil would require long-term maintenance for continued effectiveness. **Implementability/Cost:** Construction of an on-site consolidation area could be implemented with commonly available equipment at reasonable costs. Capital and long-term maintenance costs would be relatively low. **Comments:** RETAINED.
	Off-site Disposal	Excavated material is transported to an appropriate off-site permitted facility for final disposition.	**Effectiveness:** Treatment or disposal of soil at an appropriate permitted off-site facility would effectively reduce or minimize the toxicity, volume or mobility of the constituents. **Implementability/Cost:** Permitted disposal facilities are available to receive soil containing PCBs and mercury. Disposal costs vary based on the soil's characterization and classification. **Comments:** RETAINED.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

3.1 Development of Alternatives

In this section, the remedial technologies selected for further consideration are assembled into appropriate remedial alternatives that address the media and areas of concern, and achieve the remedial objectives. Because the objectives for remediation of soil and groundwater at this Site are independent and distinct (i.e., affected soil areas do not appear to be sources of constituents to groundwater), the remedial alternatives for each medium are developed separately. As required by the NCP, the "No Action" remedial alternative is included. Other non-technology-based alternatives such as institutional controls/deed restrictions are also considered.

3.1.1 Groundwater

The remedial alternatives for groundwater are as follows:

- **Alternative G1: No Action**

Under this alternative, no action would be taken. The contaminated groundwater would not be pumped and treated, and concentrations of constituents in groundwater would not be monitored. The concentrations of carbon tetrachloride, TCE and other VOCs in groundwater would be reduced through natural attenuation and degradation processes such as dilution, dispersion, adsorption and possibly biological and chemical degradation. Groundwater containing VOCs flows through the Test Station toward nearby ravines, particularly Ravines 1b, 2a, 2b, and 2c. The ravine springs would continue to serve as water bearing zone discharge points releasing groundwater from the subsurface to the surface/near surface water system where volatilization would occur.

- **Alternative G2a: Continue the Existing System (No Further Action)**

Under this alternative, groundwater extraction and treatment would continue to be performed by the current system to meet on-site water supply needs, and groundwater monitoring would continue as per the existing EWMS. As with Alternative G1, the concentrations of VOCs in groundwater would be reduced through natural attenuation and degradation processes as groundwater flows across the Test Station toward nearby ravines, which serve as discharge points for the water bearing zone.

The existing on-site water supply is based entirely on groundwater pumpage. Groundwater is pumped from two existing water supply wells simultaneously, on an on-demand basis, at an estimated collective pumping rate of less than 1,000 gpd (0.7gpm). An average pumping rate for the individual wells is assumed to be 400 gpd (0.3 gpm). Occasionally, one well is taken off line for pump maintenance, but at the relatively low pumping rates, the remaining well should provide ample yield to meet current site demands. The recovered groundwater is transported to the air stripping tower for removal of VOCs, to a stainless steel transfer tank, to a 100,000-gallon underground holding tank or reservoir, and then to the on-site potable water distribution system for consumption or other uses. The air stripper, an Oil Recovery System (ORS) Air Stripper Model 1109004, was installed in January 1987, and operates under a NYSDEC permit and with NYSDOH approval.

The EWMS is a network of strategically located surface and groundwater monitoring stations that was established in 1987 to monitor the quality of the groundwater and surface water between the Test Station and the Luther Forest Well Field. Sampling is conducted to identify any changes in groundwater quality. A routine re-evaluation of the EWMS was recently completed to confirm the effectiveness of the monitoring program with respect to the off-site water supply. Currently, the EWMS program consists of sampling seven monitoring well locations (DGC-3S, DGC-4S, 13S, M-27S, M-27D, M-33S, and M-33I) and three surface water locations (SW-A, SW-B, and SW-D). Groundwater and surface water samples from these locations are now collected semi-annually (May and October). All samples except 13S are analyzed for VOCs. Samples from 13S, M-27S, M27D and SW-B are analyzed for unfiltered total chromium and hexavalent chromium. Monitoring reports are submitted to the USEPA and NYSDEC.

- **Alternative G2b: Continue the Existing System with Institutional Controls (Restricted Use of Untreated Groundwater)**

Under this alternative, in addition to continued treatment and monitoring and natural attenuation as described above for Alternative G2a, deed restrictions would be implemented to supplement the restrictive easement that currently serves to control use of groundwater within one mile of the Site. The deed restriction would restrict the use of groundwater, as appropriate. No groundwater control or removal would be performed other than that associated with meeting on-site water supply needs. In addition, groundwater monitoring through the EWMS would be continued.

- **Alternative G3: Manage Plume by Maximizing the Existing System with Institutional Controls**

This alternative would involve increasing the withdrawal rate of the existing on-site groundwater extraction system. It incorporates the provisions of Alternative G2, except that the current on-site groundwater treatment system would be operated at the maximum capacity of the air stripper, which is approximately 25 gpm. To maximize capture of contaminants from the central portion of the plume, groundwater would be pumped solely from water supply well 1D, with 2D available for backup. The recovered groundwater would be treated using the existing on-site air stripping system to meet applicable drinking water standards. The treated water would continue to be used for the on-site water supply. In the event that excess water is generated, i.e., more water is pumped than is needed to meet on-site water supply needs, the excess water would be discharged on-site in accordance with applicable regulations and in a manner that enhances performance of the groundwater remediation. The EWMS would continue, but additional wells would be monitored for water levels to verify that the radius of the capture zone is sufficient. Deed restrictions would be implemented to supplement the restrictive easement that currently controls use of groundwater within one mile of the Site. Groundwater not captured by pumping would flush naturally to the ravines, and VOC concentrations would be reduced through natural attenuation and degradation processes.

- **Alternative G4a: Manage Plume by Upgrading the Existing System (Using 2 Existing Supply Wells and New Air Stripper) with Institutional Controls**

Alternative G4a would involve use of the existing water supply wells (1D and 2D) pumped at an estimated collective pumping rate of 75 gpm or approximately 38 gpm per well in an effort to recover the central portion of the groundwater plume, which is defined as the plume containing concentrations of individual VOCs greater than 50 ppb. The configuration of this plume is defined by the carbon tetrachloride plume containing concentrations greater than 50 ppb, which encompasses the 50 ppb plumes of all other site-related VOCs. The recovered groundwater would be treated using a new on-site air stripping system to handle the increased volume of groundwater. The treated groundwater would be used for on-site water supply. Any excess would be discharged on-site in accordance with applicable regulations and in a manner that enhances performance of the groundwater remediation. In addition, the EWMS would be continued, but additional wells would be monitored for water levels to verify that the radius of the capture zone is sufficient. Deed restrictions would be implemented to supplement the restrictive easement that currently controls use of groundwater within one mile of the Site. Groundwater not captured by pumping would flush naturally to the ravines, and VOC concentrations would be reduced through natural attenuation and degradation processes.

- **Alternative G4b: Manage Plume by Upgrading the Existing System (Using 4 Recovery Wells and New Air Stripper) with Institutional Controls**

Alternative G4b would involve installation of additional groundwater recovery wells at key locations to recover the central portion of the groundwater plume. The recovery wells would include the two existing water supply wells and two new recovery wells. The estimated collective pumping rate would be 140 gpm with the pumping rates at individual wells ranging from 20 to 40 gpm. Like Alternative G4a, the recovered groundwater would be treated using a new on-site air stripping system to handle the increased volume of groundwater. The treated groundwater would be used for on-site water supply. Any excess would be discharged on-site in accordance with applicable regulations and in a manner that enhances performance of the groundwater remediation. In addition, the EWMS would be continued, but additional wells would be monitored for water levels to verify that the radius of the capture zone is sufficient. Deed restrictions would be implemented to supplement the restrictive easement that currently controls use of groundwater within one mile of the Site. Groundwater not captured by pumping would flush naturally to the ravines, and VOC concentrations would be reduced through natural attenuation and degradation processes.

3.1.2 Soil

Based on the Site RA, only two areas of the Site contain constituents at such levels that warrant consideration of remediation. These areas are in the vicinity of Building 23P (37 cubic yards) and in a short section of the Muggett's Pond Drainage Ditch (3 cubic yards). The source of constituents at these areas is believed to stem from discontinued, past activities at the Site, and has been eliminated. The five remedial alternatives for this limited volume of soil are as follows:

- **Alternative S1: No Action**

Under this alternative, no action would be taken to contain, remove, or treat soil or to restrict use or access to the these areas. The soil at Building 23P and in Muggett's Pond Drainage Ditch intersection would be left in place. The existing fence around the perimeter of the Site would continue to restrict access to the Site, and the one-mile restrictive easement would continue to be enforced.

- **Alternative S2: Institutional Controls**

Under this alternative, deed restrictions such as prohibiting all property use except for some commercial/industrial use or prohibiting future development of selected areas would be implemented to minimize exposure to acceptable levels and to eliminate potential residential-setting exposure scenarios. These restrictions would be incorporated into the deed of the property owner. As with Alternative S1, the existing fence around the perimeter of the Site would continue to restrict access to the Site. The existing restrictive easement would also continue to be enforced.

- **Alternative S3: Capping/Surface Controls**

The purpose of this alternative is to prevent contact with contaminated surface soil, the extent of which would be refined, if necessary, during a pre-design study. Under this alternative, a compacted native soil, concrete or asphalt cap would be placed over the affected soil at Building 23P and in the Muggett's Pond Drainage Ditch intersection. Placement of a cap over existing soils in the drainage ditch would require altering the ditch alignment slightly to maintain flow capacity and prevent cap erosion. Flow would be diverted around the cap. Because the contaminated soil would be left on-site, a deed restriction, as described in Alternative S2 may also be required as part of this alternative.

- **Alternative S4: Excavation and Off-Site Disposal**

This alternative involves excavation of affected soil at Building 23P and in the Muggett's Pond Drainage Ditch intersection. The limits of the areas to be excavated would be refined, if necessary, during a pre-design study. Excavated areas would be backfilled with clean fill material, graded to blend with surrounding areas, and revegetated. The excavated soil would be transported to an appropriate off-site facility for final disposition.

- **Alternative S5: Excavation and On-Site Disposal**

Under this alternative, affected soil at Building 23P and in the Muggett's Pond Drainage Ditch intersection would be excavated, and the excavation area would be backfilled with clean fill material, graded to blend with surrounding areas, and revegetated similar to Alternative S4. The eligible excavated material from all excavated areas would be consolidated at one common on-site location for disposal. Considering the small volume of excavated soil anticipated, the thickness of the consolidated layer would be relatively thin. A cap of compacted native soil, concrete or asphalt would then be placed over the consolidated soil location. If necessary, surface water flow would be diverted around the capped area.

3.2 Screening of Alternatives

In this section, the remedial alternatives identified and described in Section 3.1 are screened to narrow the range of alternatives that will be carried forward for the detailed evaluation. Alternatives are screened on the basis of effectiveness, implementability (both technical and administrative), and cost, which are described below:

- **Effectiveness**: Each alternative is evaluated in terms of its protectiveness of human health and the environment through reduction in toxicity, mobility and volume of the hazardous wastes. Short-term effectiveness refers to the benefits derived during or immediately after implementation and considers the increased risks resulting from implementation of an alternative. Long-term effectiveness refers to the performance of a remedial measure and the certainty that this performance will be maintained.

- **Implementability**: Each alternative is evaluated with respect to its technical and administrative implementablilty. Technical implementability relates to the feasibility of constructing the remedial measures, taking into account the availability of equipment and materials, experienced contractors and the overall difficulty of construction. Long-term technical implementability considers the ability to reliably maintain and monitor the remedial system. Administrative implementability refers to: compliance with applicable rules, regulations, and statutes; the ability to obtain approvals; and the availability of treatment, storage, and disposal services and capacity.

- **Cost**: Each alternative is evaluated with respect to relative costs, since detailed cost estimates have not been performed. The costs include both capital, and operation and maintenance (O&M) costs.

The alternatives screening for groundwater and soil are discussed in sections below. Those alternatives that pass the screening are retained for the detailed analysis.

3.2.1 Groundwater Remedial Alternatives

The screening matrix for the groundwater remedial alternatives is presented in Table 3-1. One of the alternatives is eliminated. The remaining five alternatives are retained for the detailed analysis. These alternatives include No Action and four variations of pump and treat alternatives.

As required by the NCP and USEPA Guidance (1988), the No Action Alternative (G1) is retained for comparison to other alternatives. Under this alternative, the concentrations of VOCs in groundwater would be reduced through natural attenuation and degradation processes such as dilution, dispersion, adsorption, volatilization, and possibly biological and chemical degradation.

Alternative G2, Continue Existing System (No Further Action), would be protective of human health and the environment as long as the present industrial use of the Site continues, the existing water treatment system and EWMS are maintained, and the one-mile restrictive easement continues to be implemented. As with Alternative G1, the concentrations of VOCs in groundwater would be reduced through natural attenuation and degradation processes as groundwater flows through the Test Station toward nearby ravines, which serve as water bearing zone discharge points, and where VOCs are naturally removed through volatilization. This alternative has two options. Alternative G2a involves continuation of the existing system as it is, while Alternative G2b also includes a deed restriction to restrict use of groundwater, as necessary, from the unconsolidated water bearing units underlying the Site. Under both options, there would be continued groundwater extraction using existing supply wells, treatment using the existing air stripper, and monitoring through the EWMS. Both would be effective in preventing future ingestion of groundwater containing VOCs above drinking water standards. The potential future threat to off-site receptors would be monitored through the existing EWMS. However, without deed restrictions, the existing restrictive easement would control future use of the easement area, but there would be no formal mechanism to control the future use of groundwater underlying the Site. Deed restrictions could be readily implemented at a minimal cost. Therefore, Alternative G2b is retained for the detailed analysis, and Alternative G2a is eliminated.

Alternative G3, Manage Plume by Maximizing Existing System with Institutional Controls, incorporates the provisions of Alternative G2, except that the current on-site groundwater treatment system would be operated at its maximum capacity (approximately 25 gpm). This alternative is equally as protective as Alternative G2, but the plume would be more aggressively managed through steady groundwater pumpage, interception and removal of the central portion of the groundwater plume. Through steady pumping, the capture zone would be more stable and predictable and more readily monitored. It would not fluctuate as much as the capture zone developed by the demand-only pumpage of Alternative G2. Groundwater recovery is a proven effective means of controlling the migration of groundwater contaminants in unconsolidated water bearing units. The water bearing unit underlying the MRFA Site can yield adequate production rates to affect gradients, as demonstrated by the effect of the MRFA Site water supply wells on the groundwater contours. Groundwater recovery wells have proven effective in sandy unconsolidated aquifers such as present at the Site, and the existing on-site air stripper has effectively treated groundwater during its approximately 8 years of operation. Groundwater not captured by pumping would flush naturally to the ravines, and VOC concentrations would be reduced through natural attenuation and degradation processes. Therefore, this alternative is retained for the detailed analysis.

Alternative G4, Manage Plume by Upgrading Existing System with Institutional Controls, is similar to Alternative G3 except it incorporates upgrades to the groundwater treatment system. Alternative G4 has to two options. G4a involves continued use of the existing water supply wells to manage the central portion of the plume and upgrading the groundwater treatment system (air stripper) to handle the increased pumping rates. G4b involves adding additional extraction wells and pumping to aggressively manage the central portion of the plume. Installation of additional recovery wells could be readily implemented. The groundwater recovery rates would be lower for G4a than for G4b and fewer wells may be required. Therefore, the capital and short-term costs should be less. However, Alternative G4a would reduce the concentrations of VOCs in groundwater at a lower rate compared to Alternative G4b, and may have higher associated long-term operation and maintenance costs. The time required to achieve groundwater standards is dependent on factors including: geological heterogeneities; mixing of clean groundwater with groundwater containing VOCs; sorption and desorption of VOCs onto and off soils; leaching from potential remaining sources; and biological, chemical and physical phenomena that cause a reduction in the concentrations of VOCs. Installation of additional recovery wells could be readily implemented to optimize the recovery of groundwater containing VOCs above NYSDEC groundwater standards. Under both alternatives, groundwater not captured by pumping would flush naturally to the ravines, and VOC concentrations would be reduced through natural attenuation and degradation processes. Both of these alternatives are retained for further analysis.

3.2.2 Soil Remedial Alternatives

The screening of the soil remedial alternatives is presented in Table 3-2. Alternatives S1, S2, S3b, and S4 are retained for detailed analysis, while Alternatives S3a, S3c, and S5 are eliminated.

As required by the NCP and USEPA Guidance (1988), the No Action Alternative (S1) is retained for comparison to other alternatives.

Alternative S2, Institutional Controls, through deed restrictions, could be an effective means of minimizing exposure to affected soil. Restrictions could include maintaining the existing restrictive easements plus restricting use of the property to commercial/industrial use only, or prohibiting future development of selected areas (such as the contaminated areas around Building 23 P or the affected portion of Muggett's Pond Drainage Ditch). Deed restrictions could be readily implemented at a minimal cost. Therefore, this alternative is retained for the detailed analysis.

Alternative S3a, Containment With a Native Soil Cap, can be effective for isolation and for preventing exposure to soil containing constituents such as PCBs or mercury. The affected soil areas are not sources of constituents to groundwater. However, excessive infiltration of precipitation or ponding in the area could promote erosion, so soils would have to be graded to provide positive drainage. A soil cap would require seeding, with long-term maintenance and surface controls to minimize erosion for continued effectiveness. A soil cover could be breached by future activity at the Site, by erosion, or by other natural factors, thereby causing possible transport of and potential exposure to contaminated soils. Deed restrictions could be used to minimize the potential for breaching or damaging the soil cap. The installation of a soil cover over areas of contaminated soil posing a risk would be readily implementable, although it is not practical in certain areas, such as near buildings, where it would not be possible to substantially change the existing grade. Capital and long-term maintenance costs would be relatively low, and deed restrictions could be readily implemented at a minimal cost. However, the possibility of breaching of the cap is high compared to Alternatives S3b and S3c, and the increased grade elevation may pose a problem in the areas targeted for soil remediation. This alternative would be appropriate only in areas away from buildings and drainageway. Therefore, it is not retained for detailed analysis.

Alternative S3b, Containment With an Asphalt Cap, is effective for isolation and for preventing exposure to or contact with soil containing constituents such as PCBs or mercury. An asphalt cap would promote runoff and reduce infiltration of precipitation. The cap would require periodic maintenance over the long-term for continued effectiveness. Cold temperatures and frost action can cause asphalt to break down and crack over time, and therefore, resurfacing would be required, as necessary, to prevent loss of the asphalt cap as a barrier layer. Because the contaminated soil would be left on Site, a deed restriction, as described in Alternative S3a may also be required as part of this alternative. The installation of a layer of asphalt over areas of contaminated soil would be readily implementable. Asphalt can be easily laid in close areas as would be encountered around Building 23P. Addition of thin repair layers of asphalt can be tolerated adjacent to building structures. Capital and long-term maintenance costs would be relatively moderate. For areas adjacent to buildings and in drainage pathways, an asphalt cap provides a cost-effective reliable surface cover. Therefore, this alternative is retained for detailed analysis.

Alternative S3c, Containment With a Concrete Cap, is effective for isolation and for preventing exposure to soil containing constituents such as PCBs or mercury. A concrete cap would promote runoff and reduce infiltration of precipitation. A concrete cap would require long-term maintenance for continued effectiveness. As with asphalt, concrete is prone to weather and cracking during winter months and would need to be repaired as necessary. The installation of a concrete cap over areas of contaminated soil would be readily implementable. Areas around the buildings would need to be framed and the ground surface graded prior to placing the concrete. Capital and long-term maintenance costs would be relatively high. Because the contaminated soil would be left on site, a deed restriction, as described in Alternative S3a may also be required as part of this alternative. Because the concrete cap requires periodic costly O&M without benefit over other alternative surface covers, it is not retained for detailed analysis.

Alternative S4, Excavation and Off-Site Disposal, is a proven method for remediation of soils. This is an effective long-term technology because the source of potential threat to human health or the environment is permanently removed from the Site. Quantities requiring excavation appear to be small, and therefore, could be easily transported off-site. No restrictions would need to be implemented on land use with this alternative. Excavation equipment is commonly available and could easily remove the soils in the areas of concern around Building 23P and the Muggett's Pond Drainage Ditch. Since the depth of the contamination is assumed to be superficial adjacent to the buildings, the small volume of removal of affected soils would not jeopardize the structural integrity of the buildings. PCB-contaminated soil and mercury-contaminated soil would be readily handled separately due to waste disposal requirements. Soil disposal costs at landfills vary with the types of compounds contained in the excavated material. Permitted TSCA, RCRA and industrial waste landfills are available as disposal sites. TCLP analysis would be conducted. If site concentrations of mercury fail TCLP, they would require treatment prior to disposal. Soils containing PCB concentrations below 50 ppm do not require disposal at a TSCA landfill; however, it is possible they will not be accepted for disposal at solid waste landfills. Costs would be relatively reasonable for this permanent remedy. Therefore, this alternative is retained for detailed analysis.

Alternative S5, Excavation and On-Site Disposal is a proven method for remediation of affected soils. Based upon the concentrations of the contaminants in some of the samples analyzed, some of the soils would not be considered hazardous and could be excavated and placed in a suitable location on site. Eligible soil, such as PCB-contaminated soil from the Building 23P area could be consolidated into one location for closure. Covering the consolidated excavated material with asphalt, concrete or native soil material would effectively eliminate the potential for human exposure to affected soils. A cap to isolate the affected soil would require long-term maintenance for continued effectiveness. Land burial restrictions would result in the elimination of this alternative for consideration for certain mercury contaminated soils. Construction of an on-site consolidation area could be implemented with commonly available equipment at reasonable costs. Because contaminated soil would be left on site, a deed restriction, as described in Alternative S2a may also be required as part of this alternative. Capital and long-term maintenance costs would be moderate. Due to long-term O&M requirements, this alternative is not as cost-effective as Alternative S4, and therefore, it is not retained for detailed analysis.

3.3 Summary Discussion and Conclusions

The groundwater alternatives retained for the detailed analysis are listed below.

- Alternative G1: No Action
- Alternative G2b: Continue Existing System with Deed Restrictions
- Alternative G3: Manage Plume by Maximizing Existing System
- Alternative G4a: Manage Plume by Upgrading Existing System Using Existing Supply Wells and a New Treatment System

- Alternative G4b: Manage Plume by Upgrading Existing System Using Existing and/or New Wells and a New Treatment System

One groundwater alternative was not retained for the detailed analysis: Alternative G2a (Continue Existing System). Alternative G2a did not include the deed restrictions that are part of Alternative G2b. Without deed restrictions, the existing restrictive easement would control future use of the easement area, but there would be no formal mechanism to control the future use of groundwater underlying the Site. Deed restrictions could be readily implemented at a minimal cost. Since Alternative G2b is retained for the detailed analysis, Alternative G2a was not retained.

The soil alternatives retained for the detailed analysis are listed below.

- Alternative S1: No Action
- Alternative S2: Institutional Controls
- Alternative S3b: Capping/Surface Controls
- Alternative S4: Excavation and Off-Site Disposal

Three soil alternatives were not retained for the detailed analysis: Alternatives S3a (Clay or Native Soil Cap), and S3c (Concrete Cap), and S5 (Excavation and On-Site Disposal). The possibility of breaching a clay or native soil cap is high compared to Alternatives S3b and S3c, and the increased grade elevation may pose a problem in the areas targeted for soil remediation. It would have been appropriately retained in areas away from buildings and drainageways. The concrete cap is more susceptible to cracking, and therefore, requires more periodic costly O&M that the other capping/surface control alternatives. Of the three capping alternatives evaluated, Alternative S3b is considered most effective and implementable, and therefore, it is retained and Alternatives S3a and S3c are not retained. Alternative S5 is not retained, since its continuing O&M requirements would make other alternatives more cost-effective or preferable.

Table 3-1
Groundwater: Remedial Alternatives Screening
Malta Rocket Fuel Area Site

Remedial Alternative	Description	Screening
G1: No Action	No action is taken to remove, treat, control or monitor groundwater.	**Comments:** RETAINED. As required by the NCP and EPA Guidance (1988), this alternative is retained for comparison to other alternatives.
G2a: Continue Existing System (No Further Action)	Groundwater extraction and treatment for an on-site water supply would continue and groundwater monitoring would continue through the existing EWMS.	**Effectiveness:** This alternative would be protective of human health and the environment as long as the present commercial/industrial use of the Site continues. It would be effective in meeting the remedial action objectives, since there is no risk to receptors for existing and reasonable future groundwater land use scenarios, and since natural attenuation, degradation in the water bearing formation and discharge at the groundwater discharge points (ravine streams) will eventually effectively reduce the groundwater concentration to below groundwater standards. Drinking water standards would be attained through the ongoing on-site groundwater treatment program. Its effectiveness is readily monitored on-site through well water and treatment system sampling and off-site through the EWMS. It would require continued long-term commitment to the easement that currently restricts use of property within one mile of the Test Station. **Implementability/Cost:** This alternative is readily implementable with a high level of certainty as this alternative is currently in operation. It is reliable since monitoring controls are already in place. It would require no additional costs other than implementation of long-term O&M for the treatment system and additional groundwater monitoring. **Comments:** ELIMINATED. Without deed restrictions, the existing restrictive easement would control future use of the easement area, but there would be no current mechanism to prevent ingestion of groundwater containing VOCs above drinking water standards.
G2b: Continue Existing System, with Institutional Controls	Groundwater extraction and treatment for an on-site water supply would continue and groundwater monitoring would continue through the existing EWMS. Deed restrictions would be implemented.	**Effectiveness:** Same as G2a. In addition, a deed restriction that restricts use of groundwater, as appropriate, would be effective for preventing ingestion of groundwater containing VOCs above drinking water standards. For example, if additional water supply were to become necessary, the deed restriction would require on-site groundwater treatment or supply from an off-site source. Natural attenuation, degradation in the water bearing formation and natural volatilization at the groundwater discharge points (the ravines) will eventually reduce the groundwater concentration to below groundwater standards. **Implementability/Cost:** Deed restrictions could be readily implemented at a minimal cost. **Comments:** RETAINED.
G3: Manage Plume by Maximizing Existing System, with Institutional Controls	Same as G2b, except that existing wells would be pumped at the estimated capacity of the air stripper (25 gpm). Deed restrictions would be implemented.	**Effectiveness:** This alternative is equivalent to Alternative G2b, except that the current on-site groundwater treatment system would be operated at its maximum capacity (approximately 25 gpm). This alternative is equally as protective as Alternative G2b, but the VOC plume would be managed through steady groundwater pumpage in an effort to intercept and remove the central portion of the groundwater plume. Natural attenuation, degradation in the water bearing formation and natural volatilization at the groundwater discharge points (the ravines) will eventually reduce the groundwater concentration to below groundwater standards. Through steady pumping, the capture zone would be more stable and predictable and more readily monitored. It would not fluctuate as much as the cone of depression developed by the demand-only pumpage of Alternative G2. The effectiveness of pumping to intercept and remove VOCs in groundwater has already been demonstrated on-site by the hydraulic gradient reversals in the vicinity of existing on-site water supply wells as shown in RI report water level contour maps. **Implementability/Cost:** This alternative could be readily implemented because it makes use of the existing system. Existing wells would be used for pumping at higher rates. O&M costs would be similar to Alternative G2, although additional monitoring would be required to demonstrate the effect of pumping on the VOC plume. Construction of a discharge system would be necessary to route excess treatment system effluent to an appropriate discharge location. Costs would be higher than Alternative G2, without a significant increase in the level of protectiveness. **Comments:** RETAINED.

Table 3-1
Groundwater: Remedial Alternatives Screening
Malta Rocket Fuel Area Site

Remedial Alternative	Description	Screening
G4a: Manage Plume by Upgrading System (Using 2 Existing Supply Wells and New Air Stripper), with Institutional Controls	Same as G3, using the two existing water supply wells and a new air stripper with a larger capacity in an effort to manage the central portion of the plume. Deed restrictions would be implemented.	Effectiveness: This alternative is equally as protective as Alternative G3, but the VOC plume would be managed through steady groundwater pumpage of existing and additional wells, intercepting and removing the central portion of the groundwater plume. The effectiveness of pumping; reliability of the system and monitorability of performance would be the same as for Alternative G3. Implementability/Cost: Installation of additional recovery wells would be readily implementable. Water conditioning prior to treatment may be necessary. Higher total pumping rates would necessitate an upgrade to the existing treatment system, which could require construction of additional treatment system housing. Capital costs would be higher than for Alternative G3 because of additional well installation and treatment system upgrading. O&M costs would be similar to Alternative G3. Comments: RETAINED.
G4b: Manage Plume by Upgrading System (Using 4 Recovery Wells and New Air Stripper), with Institutional Controls	Same as G3, with four of groundwater extraction wells (which includes two existing supply wells and two new wells) placed and pumped to achieve the fastest groundwater cleanup rate. Deed restrictions would be implemented.	Effectiveness: Four recovery wells would be used (a combination of existing and new wells) and pumping would be optimized to aggressively manage the central portion of the plume. Groundwater recovery is a proven means of enhancing groundwater quality, but success is highly site-dependent. The volume of groundwater contaminants would be reduced at a greater rate than Alternative G4a. The larger capture zone than Alternative G4a may result in a greater reduction in contaminant mobility and possibly a reduction of VOC loading to groundwater discharge areas. Spring flows in nearby ravines may be decreased, thereby affecting the local surface water regime and habitats. Despite the greater volume and rate of pumpage, it is uncertain if ARARs could be achieved in a reasonable time frame. The time required to achieve groundwater standards is dependent on factors including: geological heterogeneities; mixing of clean groundwater with groundwater containing VOCs; sorption and desorption of VOCs onto and off soils; leaching from potential remaining sources; presence of undetected non-aqueous phase liquids, and biological, chemical and physical phenomena that cause a reduction in the concentrations of VOCs. Implementability/Cost: Installation of new recovery wells to optimize the recovery of groundwater containing VOCs above NYSDEC groundwater standards would encounter the same difficulties alluded to in Alternative G4a, with added complexity. The capital costs of this alternative will be even higher than Alternative G4a because of the greater number of new wells and the need for a larger treatment system. Long-term O&M costs may be less if groundwater standards can be achieved in a reasonable amount of time, but this is highly unpredictable. Comments: RETAINED.

Table 3-2
Soil: Preliminary Remedial Alternatives Screening
Malta Rocket Fuel Area Site

Remedial Alternative	Description	Screening
S1: No Action	No action is taken to remove or contain affected soil.	**Comments:** RETAINED. As required by the NCP and EPA Guidance (1988), this alternative is retained for comparison to other alternatives.
S2: Institutional Controls	Restrict future use of the site to commercial/ industrial use only or restrict future development of selected areas.	**Effectiveness:** A deed restriction could be an effective means of minimizing exposure to affected soil. Restrictions could include restricting use of the property to commercial/industrial use only, or prohibiting future development of selected areas (such as around Building 23P and the Muggett's Pond Drainage Ditch intersection. The existing restrictive easement would continue to be enforced). **Implementability/Cost:** Deed restrictions could be readily implemented at a minimal cost. **Comments:** RETAINED.
S3a: Containment with Native Soil Cap, and Institutional Controls	Soil exceeding cleanup goals is contained in place (covered) using native soil material Restrict future use of the Site to commercial/ industrial use only or restrict future development of selected areas.	**Effectiveness:** Caps composed of soil can be effective for isolation and for preventing exposure to soil containing constituents such as PCBs or mercury. The affected soil areas have not been identified as sources of constituents to groundwater; however, excessive infiltration of precipitation or ponding in the area could promote erosion. Soils would have to be graded to provide positive drainage. A soil cap would require seeding, with long-term maintenance and surface controls to minimize erosion for continued effectiveness. A soil cover could be breached by future activity at the site, by erosion, or by other natural factors, thereby causing possible transport of and potential exposure to contaminated soils. Deed restrictions could be used to minimize the potential for breaching or damaging the soil cap. **Implementability/Cost:** The installation of a soil cover over areas of contaminated soil would be readily implementable, although it is not practical in certain ares, such as near buildings, where it would not be possible to substantially change the existing grade. Capital and long-term maintenance costs would be relatively low. The installation of a soil cap would require the addition of an overlying protective layer of vegetation and surface control measures to assure erosion does not cause breaching of the cap and where high grade elevation does not pose a problem. Deed restrictions could be readily implemented at a minimal cost. **Comments:** ELIMINATED. The possibility of breaching of the cap is high compared to Alternatives S3b and S3c, and the increased grade elevation may pose a problem in the areas targeted for soil remediation. It would have been appropriately retained in areas away from buildings and drainageways.

Table 3-2
Soil: Preliminary Remedial Alternatives Screening
Malta Rocket Fuel Area Site

Remedial Alternative	Description	Screening
S3b: Containment with Asphalt Cap and Institutional Controls	Soil exceeding cleanup goals is contained in place (covered) using asphalt. Restrict future use of the Site to commercial/industrial use only or restrict future development of selected areas.	**Effectiveness:** Caps composed of asphalt are effective for isolation and for preventing exposure to or contact with soil containing constituents such as PCBs or mercury. An asphalt cap would promote runoff and reduce infiltration of precipitation. The cap would require periodic maintenance over the long-term for continued effectiveness. Cold temperatures and frost action can cause asphalt to break down and crack over time, and therefore, resurfacing would be required, as necessary, to prevent loss of the asphalt cap as a barrier layer. Because the contaminated soil would be left on site, a deed restriction, as described in Alternative S3a may also be required as part of this alternative. **Implementability/Cost:** The installation of a layer of asphalt over areas of contaminated soil would be readily implementable. Asphalt can be easily laid in close areas as would be encountered around Building 23P. Addition of thin repair layers of asphalt can be tolerated adjacent to building structures. Capital and long-term maintenance costs would be relatively moderate. Because the contaminated soil would be left on site, a deed restriction, as described in Alternative S3a may also be required as part of this alternative. **Comments:** RETAINED. For areas adjacent to buildings and in drainage pathways, asphalt cap provides a cost-effective reliable surface cover.
S3c: Containment with Concrete Cap and Institutional Controls	Soil exceeding cleanup goals is contained in place (covered) using concrete. Restrict future use of the Site to commercial/industrial use only or restrict future development of selected areas.	**Effectiveness:** Caps composed of concrete are effective for isolation and for preventing exposure to soil containing constituents such as PCBs or mercury. A concrete cap would promote runoff and reduce infiltration of precipitation. A concrete cap would require long-term maintenance for continued effectiveness. As with asphalt, concrete is prone to weather and cracking during winter months and would need to be repaired as necessary. **Implementability/Cost:** The installation of a concrete cap over areas of contaminated soil would be readily implementable. Areas around the buildings would need to be framed and the ground surface graded prior to placing the concrete. Capital and long-term maintenance costs would be relatively high. Because the contaminated soil would be left on site, a deed restriction, as described in Alternative S3a may also be required as part of this alternative. **Comments:** ELIMINATED. The concrete cap requires periodic costly O&M without benefit over other alternative surface covers.
S4: Excavation and Off-Site Disposal	Soil exceeding cleanup goals is excavated, and excavated areas are regraded or backfilled with clean material. Excavated soil is tested and sent off site for disposal.	**Effectiveness:** Excavation is a proven method for remediation of affected soils. This is an effective long-term technology because the source of potential threat to human health or the environment is permanently removed from the site. Quantities requiring remediation as defined in the RI appear to be small, and therefore, could be easily transported off-site. No deed restrictions would need to be implemented with this alternative. **Implementability/Cost:** Excavation equipment is commonly available and could easily remove the soils in the areas of concern around Building 23P. Since the depth of the contamination is superficial adjacent to the building, the small volume of removal of affected soils would not jeopardize the structural integrity of the buildings. PCB-contaminated soil from the Building 23P area and mercury-contaminated soil would be handled separately due to waste disposal requirements. Soil disposal costs at landfills vary with the types of compounds contained in the excavated material. Permitted TSCA, RCRA and industrial waste landfills are available as disposal sites. TCLP analysis would be conducted. Site concentrations of mercury may fail TCLP, and therefore require treatment prior to disposal. Soils containing PCB concentrations below 50 ppm do not require disposal at a TSCA landfill; however, it is possible they will not be accepted at solid waste landfill for disposal. Minimum bulk volume and transportation would constitute the disposal cost, which would be reasonable for this permanent remedy. Excavated areas would be backfilled, graded and revegetated. **Comments:** RETAINED.

Table 3-2
Soil: Preliminary Remedial Alternatives Screening
Malta Rocket Fuel Area Site

Remedial Alternative	Description	Screening
S5: Excavation and On-Site Disposal and Institutional Controls	Soil exceeding cleanup goals is excavated and consolidated in an on-site disposal area. Restrict future use of the Site to commercial/ industrial use only or restrict future development of the on site disposal area.	Effectiveness: Based upon the concentrations of the contaminants in some of the samples analyzed, some of the soils would not be considered hazardous and could be excavated and placed in a suitable location on site. Eligible soil, such as PCB-contaminated soil from the Building 23P area could be consolidated into one location for closure. Covering the consolidated excavated material with asphalt, concrete or native soil material would effectively eliminate the potential for human exposure to affected soils. A cap to isolate the affected soil would require long-term maintenance for continued effectiveness. Implementability/Cost: Construction of an on-site consolidation area could be implemented with commonly available equipment at reasonable costs. Because contaminated soil would be left on site, a deed restriction, as described in Alternative S2a may also be required as part of this alternative. Capital and long-term maintenance costs would be moderate. Excavated areas would be backfilled, graded and revegetated. Land burial restrictions would result in the elimination of this alternative for certain mercury contaminated soils. Comments: ELIMINATED. Due to continuing O&M requirements, on-site disposal is not cost effective or preferable to other disposal alternatives.

4.0 DETAILED ANALYSIS OF ALTERNATIVES

This section describes the evaluation criteria for the detailed analysis of the alternatives retained after the preliminary screening of alternatives. Section 4.1 identifies and describes the evaluation criteria. Sections 4.2 and 4.3 present the detailed analysis of the groundwater and soil remedial alternatives, respectively. In these sections, the remedial alternatives are described, and then systematically assessed, on an individual basis, relative to the evaluation criteria. In Sections 4.4 and 4.5, the alternatives are compared on the basis of these evaluation criteria. Section 4.6 identifies the recommended remedial alternatives for groundwater and soil.

4.1 Evaluation Criteria

USEPA guidance on selection of remedial actions (USEPA, 1988 and 1989) presents nine criteria to be used for evaluating remedial alternatives that have passed the preliminary screening process. These criteria are as follows:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility or volume through treatment
- Short-term effectiveness
- Implementability
- Costs (capital, annual operation and maintenance, present worth)
- State acceptance
- Community acceptance

There are three tiers to the above nine criteria. The first two are threshold factors, the next five are primary balancing factors, and the last two are modifying considerations. These three tiers are reflected in the detailed analysis. Descriptions of the criteria are provided below.

4.1.1 Overall Protection of Human Health and the Environment

This evaluation criterion is designed to determine whether a proposed remedial alternative is adequate with respect to protection of human health and the environment. The evaluation focuses on how each proposed alternative achieves protection over time, how Site risks are eliminated, reduced, or controlled, and whether any unacceptable short-term impacts would result from implementation of the alternative. The overall protection of human health and the environment evaluation draws on the assessments for long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

4.1.2 Compliance with ARARs

This evaluation criterion is used to assess compliance with chemical-specific, action-specific, and location-specific ARARs, and with other TBC criteria, advisories and guidance. ARARs for the MRFA Site are discussed in Section 1.5. Proposed remedial alternatives are analyzed to assess whether they achieve ARARs under Federal and State environmental laws, public health laws, and

State facility siting laws, or whether they may be subject to one of the six waivers allowed under CERCLA.

4.1.3 Long-Term Effectiveness and Permanence

This criterion addresses the long-term effectiveness and permanence of the remedial alternative with respect to the quantity of residual chemicals remaining at the Site after response goals have been met. The principal focus of this analysis is the adequacy and reliability of controls necessary to manage any untreated media and treatment residuals. Characteristics of the residual chemicals such as volume, toxicity, mobility, degree to which they remain hazardous, and tendency to bioaccumulate must also be examined. Specifically, these considerations are:

- Magnitude of residual risk,
- Adequacy of controls, and
- Reliability of controls.

4.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This criterion assesses the degree to which the remedial alternative utilizes recycling and/or treatment technologies that permanently decrease toxicity, mobility, or volume of the chemicals as their primary element. It also assesses the effectiveness of the treatment in addressing the predominant health and environmental threats presented by the Site. The specific factors considered under this evaluation criterion include:

- Treatment process the remedy would employ and the materials it would treat;

- Amount of contaminants that would be treated or destroyed;

- Degree of expected reduction in toxicity, mobility, or volume (expressed as a percentage of reduction or order of magnitude);

- Degree to which the treatment would be irreversible;

- Type and quantity of treatment residuals that would remain following treatment accounting for persistence, toxicity, mobility and the tendency to bioaccumulate; and

- Whether the alternative would satisfy the statutory preference for treatment as a primary element.

4.1.5 Short-Term Effectiveness

This evaluation criterion is used to assess short-term potential impacts associated with the construction and implementation phase of remediation. Alternatives are evaluated with regard to their effects on human health and the environment. These considerations include:

- Protection of the community during implementation of the proposed remedial action (i.e., dust, inhalation of volatile gases);

- Protection of workers during implementation;

- Environmental impacts that may result from the implementation of the remedial alternative and the reliability of mitigative measures to prevent or reduce these impacts; and

- Time until remedial response objectives are met, including the estimated time required to achieve protection.

4.1.6 Implementability

This criterion assesses the technical and administrative feasibility of implementing a remedial alternative and the availability of various services and materials that would be required during its implementation. Factors considered include the following.

- Technical feasibility: includes the difficulties and unknowns relating to construction and operation of a technology, the reliability of the technology (including problems resulting in schedule delays), the ease of performing additional remedial actions, and the ability to monitor the effectiveness of the remedy.

- Administrative feasibility: involves coordinating with governmental agencies to obtain necessary permits or approvals.

- Availability of services and materials: includes sufficiency of off-site treatment, storage and disposal capacity; access to necessary equipment, specialists and additional resources; potential for obtaining competitive bids especially for new and innovative technologies; and availability of state-of-the-art technologies.

4.1.7 Costs

This criterion assesses the costs associated with a remedial action. It can be divided into capital costs, annual operation and maintenance (O&M) costs, and net present worth costs. Capital costs consist of direct (construction) and indirect (non-construction and overhead) costs. Direct capital costs include:

- Construction and equipment costs: materials, labor, equipment required to install/perform a remedial action.

- Land and site-development costs: land purchase and associated expenses, site preparation of existing property.

- Building and service costs: process and non-process buildings, utility connections, and purchased services.

- Disposal costs: transporting and disposing of materials.

Indirect capital costs include:

- Engineering expenses: administration, design, construction, supervision, drafting, and treatability testing.
- Legal fees and license or permit costs: administrative and technical costs expended to obtain licenses and permits for installation and operation.
- Start up costs incurred during initiation of remedial action.
- Contingency allowances: costs resulting from unpredicted circumstances (i.e., adverse weather, strikes, etc.).

Annual O&M costs are post-construction costs expended to maintain and ensure the effectiveness of a remedial action. The following are annual O&M costs evaluated:

- Labor costs: wages, salaries, training, overhead, and fringe benefits for operational labor.
- Maintenance materials and maintenance labor costs: labor and parts, etc. necessary for routine maintenance of facilities and equipment.
- Auxiliary materials and utilities: chemicals and electricity needed for treatment plant operations, water and sewer services.
- Disposal of residue: disposal or treatment and disposal of residues such as sludges from treatment processes.
- Purchased services: sampling costs, laboratory fees, and professional fees as necessary.
- Administrative costs: costs associated with the administration of O&M that have not already been accounted for elsewhere.
- Insurance, taxes, and licensing costs: liability and sudden accidental insurance, real estate taxes on purchased land or rights-of-way, licensing fees for certain technologies, permit renewal and reporting costs.
- Replacement costs: maintenance of equipment or structures that wear out over time.
- Cost of periodic Site reviews if a remedial action leaves residual contamination.

Net present worth consists of capital and O&M costs calculated over the lifetime of the remedial action and expressed in present day value. The lifetime of the remedial action is considered to be a maximum of 30 years for costing purposes.

Any remedial action that leaves hazardous waste at a site may affect future land use, resulting in a loss of business activities, residential development, and taxes. This unquantified cost is considered for the alternatives that would leave hazardous wastes on site.

4.1.8 State and Community Acceptance

These criteria are modifying considerations and can only be evaluated in the FS to a limited extent at this time. Typically, these considerations are not taken into account until the Record of Decision (ROD) is prepared following the public comment period on the proposed plan and RI/FS report. State acceptance can be based on formal comments made by the State during previous phases of the RI/FS. Technical and administrative issues that the State may have concerning each alternative are typically identified and discussed, including features that the State supports, features that the State may have reservations about, and features that the State opposes. The evaluation of community acceptance is analogous to the evaluation made for State acceptance and generally is deferred until ROD preparation. Comments received from the public are assessed to determine aspects of each remedy that are supported or opposed. However, since formal comments from the State have not been received and a public comment period has not yet been held, the evaluation presented in the FS at this time is very general and somewhat speculative.

4.2 Groundwater Alternatives Analysis

This detailed analysis evaluates the groundwater alternatives that passed the preliminary screening in Section 3.0 relative to the nine evaluation criteria. It focuses on the relative performance of each alternative. The groundwater remedial alternatives evaluated in the detailed analysis are as follows:

- Alternative G1: No Action
- Alternative G2b: Continue the Existing System with Institutional Controls (Restricted Use of Untreated Groundwater)
- Alternative G3: Manage Plume by Maximizing the Existing System with Institutional Controls
- Alternative G4a: Manage Plume by Upgrading the Existing System (Using 2 Existing Supply Wells and New Air Stripper) with Institutional Controls
- Alternative G4b: Manage Plume by Upgrading the Existing System (Using 4 Recovery Wells and New Air Stripper) with Institutional Controls

4.2.1 Alternative G1 - No Action

4.2.1.1 Description

Groundwater is currently pumped from existing wells and treated by an air stripper for on-site use. Alternative G1 assumes that use of the existing treatment system and Site water supply would be discontinued. No actions would be taken to control, remove or monitor the groundwater plume (i.e., no groundwater pumping or treatment, no EWMS or well water monitoring, and no deed restrictions). The existing fence around the perimeter of the one-mile restrictive easement would continue to restrict access to the Site.

As described in Section 1.3.3, Contaminant Fate and Transport, Site groundwater flows across the Test Station toward nearby ravines, particularly Ravines 1b, 2a, 2b, and 2c. Ravine springs serve as water bearing zone discharge points releasing groundwater from the subsurface to the surface/near surface water system. VOCs are removed, i.e. stripped, naturally from the water through volatilization resulting from the pressure drops and turbulence that accompanies this process.

Under the No Action Alternative, the VOC concentrations in the groundwater would primarily be reduced through natural attenuation and degradation processes such as dilution, dispersion, adsorption and possibly biological and chemical degradation. Groundwater VOCs that reach the ravines are volatilized in the course of their flow at the ground surface. The observed reduction of carbon tetrachloride and TCE concentrations in well water and groundwater monitoring wells in comparison to historic levels, and the trace to non-detect levels of VOCs monitored in the downstream ravine streams, provide evidence that these natural phenomena are occurring at the Site.

4.2.1.2 Assessment

Overall Protectiveness of Human Health and the Environment

Under the No Action Alternative, there would be no action taken to prevent ingestion of groundwater containing VOCs above the current drinking water standards. Although the current usage of Site groundwater would be discontinued there would be no restriction on the use of the untreated water. Also, since EWMS monitoring would not be performed, the distribution, migration and natural reduction of VOC concentrations in groundwater and surface water would not be monitored. Therefore, there would be no long-term mechanism for documenting the nature and extent of the groundwater plume near the ravines, verifying that the downstream groundwater and surface water quality are not affected, and confirming that VOCs are not migrating toward the Luther Forest Well Field or the Cold Springs Well Field. Since no construction is proposed for the No Action Alternative, no associated short-term risks would be posed.

Compliance with ARARs

Chemical-specific ARARs: Attainment of groundwater standards across the Site would eventually occur under this alternative as a result of the natural flushing and gradual attenuation and degradation of the groundwater plume. The estimated time for the no action alternative to meet chemical-specific ARARs for groundwater across the Site as a result of natural flushing is estimated to be 110 years (see Table 4-1).

The analytical method used for estimating durations for remediation relies on assumptions that have a relatively high degree of uncertainty. These assumptions however, apply equally to all of the alternatives and therefore the method should be viewed as a useful tool for comparison. Specific Site conditions may result in a shorter or longer time frame for achieving the remedial objectives. Important parameters affecting the cleanup time include hydraulic conductivity, groundwater recharge, effective porosity and retardation coefficient.

Natural Flushing - In the absence of pumping-induced drawdown and active groundwater capture, groundwater in the water bearing zones underlying the Site would flow to the ravines. The VOCs in this groundwater would be passively remediated by natural attenuation processes, including volatilization in the ravines. The rate of flow to the ravines has been simulated and evaluated using a two-dimensional analytical groundwater model, TWODAN, described in Appendix D. Simulated groundwater flow pathlines are shown on Figure D-4 (Appendix D). Based on model simulations, the time required for natural flushing to remediate the groundwater plume is approximately 110 years. This estimates can be used as a basis for comparison with the various pumping alternatives addressed below. It should be recognized, however, that this model of natural flushing does not include a provision for processes that could affect the time to achieve ARARs such as dilution, dispersion, and chemical or biological degradation. The actual rate of natural attenuation, which could be longer or shorter than estimated, would not be evaluated because no monitoring would be performed.

Long-Term Effectiveness and Permanence

Residual risk: The No Action Alternative includes no provisions to prevent the ingestion of untreated groundwater, and therefore, poses potential long-term residual health risks.

Adequacy of controls: The adequacy of this alternative in reducing the concentrations within the groundwater plume through natural flushing would not be determined, since no monitoring is included in this alternative.

Reliability of controls: No controls would be implemented under this alternative.

Reduction of Toxicity, Mobility & Volume Through Treatment

No reduction in toxicity, mobility or volume would occur under the No Action Alternative other than through natural degradation and attenuation. The proximity of the groundwater discharge areas (ravine streams) to the Site help to confine the plume to a reasonably well-defined flow zone that terminates at the ravines where the residual VOCs are removed through a natural stripping process of volatilization.

Short-Term Effectiveness

Community, worker and environmental protection: Discontinuing of the existing on-site water supply would potentially disrupt Site operations. Development of an alternate off-site water supply would be necessary; the feasibility of an alternate supply was considered and eliminated (see Section 2.0). Since no construction activities are proposed for the No Action Alternative, no associated short-term risks would be created.

Implementability

No additional remedial activities are proposed for this alternative, and therefore, implementability does not apply.

Cost

There are no additional remedial costs directly associated with this alternative. There may be costs associated with losses due to the discontinuance or interruption of the treated water supply, but these are not quantified.

State Acceptance

Formal comments relative to technical and administrative issues would be addressed at the completion of the FS, prior to the signing of the ROD. It is anticipated that the State may not accept this alternative because it is not protective of human health and the environment and falls short of meeting remedial action objectives.

Community Acceptance

Community input on specific alternatives will be documented and addressed after a public comment period following agency review of the FS. Public comments will be addressed and agency responses incorporated into the ROD. The community may not accept this alternative because without the EWMS, protection of the nearby water supply wells would not be confirmed through monitoring.

4.2.2 Alternative G2b - Continue the Existing System with Institutional Controls (Restricted Use of Untreated Groundwater)

4.2.2.1 Description

The existing groundwater pumping and treatment system would continue to be used for the on-demand, on-site water supply. Groundwater monitoring would continue through the existing EWMS. Deed restrictions and continued maintenance of the one-mile restricted access easement would be used to prevent ingestion of untreated groundwater.

As described for the No Action Alternative, the concentrations of VOCs in groundwater would be reduced through natural attenuation and degradation processes such as dilution, dispersion, adsorption and possibly biological and chemical degradation. Dissolved VOCs that reach the ravines are volatilized in the course of their flow at the ground surface. The observed reduction of VOC concentrations in well water and groundwater monitoring wells in comparison to historic levels, and the trace to non-detect levels of VOCs monitored in the downstream ravine streams, provide evidence that these natural phenomena are occurring at the Site.

The existing groundwater extraction and treatment system is described in Section 1.2.8. Two water supply wells (1D and 2D) are located near and intercept groundwater from the central portion of the plume. The effectiveness of capture depends upon pumping rate and duration. Under existing water use and pumping requirements, the wells capture only a small portion of the plume, but this portion contains some of the highest concentrations of VOCs observed on-site. For the purpose of the detailed analysis, the average pumping rate of the individual water supply wells is assumed to be 0.3 gpm; the total system pumping rate would therefore be 0.6 gpm (see Table 4-1). The predicted capture zone developed by this pumping scenario is shown on Figure D-5 (Appendix D), which was developed using the two-dimensional groundwater flow model, TWODAN, as described in

Appendix D. The lobate shape of the VOC plume reported in the RI attests to the effectiveness of past pumping on attenuating groundwater VOCs. Past pumping rates have been substantially higher than present rates. Although it is possible that future rates may match or exceed historic on-site water consumption, Alternative G2b does not provide for any minimum pumping rate for groundwater remediation purposes. However, if operations at the MRFA site and/or the associated water use decline significantly, then the need for maintaining a minimum level of pumping will be reevaluated.

Each of the two wells is equipped with a submersible pump and the necessary piping to extract and convey groundwater to a single groundwater treatment (air stripper and holding tanks) system located mostly in Building 15. Two other supply wells on-site are not normally used.

The treatment system was constructed and operation was initiated in 1987. The system includes a 17-foot high, 1-foot diameter air stripper system, manufactured by ORS, Inc (Model 1109004). The air stripper is equipped with a 1 HP, 500 cubic feet per minute (cfm) blower. According to the manufacturer, this system has a capacity of effectively treating approximately 25 gallons per minute (gpm) based on the peak concentrations measured historically in the stripper influent samples collected and analyzed between 1990 and 1994.

Treated effluent from the air stripper discharges into a 450 gallon tank containing a 1/2 HP sump pump that conveys the treated water into a 100,000 gallon reservoir which supplies water to the underground water distribution system. The water is used for both domestic purposes and for fire protection at the Site, including the MTI and former GE/Exxon facilities. Samples of air stripper influent and effluent are collected quarterly and analyzed for volatile organic compounds to monitor the effectiveness of the system. The influent samples are collected from manually operated valves located in the lines just upstream of the air stripper. Effluent samples are collected from the 450 gallon holding tank. This tank is periodically flushed to remove sediment which settles out from the well water.

A description of the EWMS is provided in Section 1.2.7. The ongoing EWMS provides for the long-term monitoring of groundwater and surface water to verify and document that the MRFA Site groundwater plume is not migrating to the Luther Forest Well Field. Air stripper influent monitoring and EWMS monitoring would provide an indication of the reduction of VOC concentrations over time.

Deed restrictions and continued maintenance of the one-mile restricted access easement would prevent ingestion of untreated groundwater from the water bearing units in the vicinity of the Site by preventing installation of drinking water supply wells without an associated treatment system.

4.2.2.2 Assessment

Overall Protectiveness of Human Health and the Environment

Alternative G2b would be protective of human health and the environment, since future ingestion of untreated groundwater would be prevented through a combination of the on-site groundwater treatment, deed restrictions and the EWMS monitoring program. The one-mile restricted access easement would also limit or prevent residential or any other building development (and the potential for installation of drinking water wells) in the area surrounding the Site. Other than groundwater removal associated with Site water usage and the associated incidental capture of a portion of the plume, no active measures would be taken to manage the groundwater plume. It is anticipated, as described under Alternative G1, that natural attenuation and degradation would reduce groundwater concentrations to below drinking water standards over time, and volatilization of VOCs in ravine surface water would remove residual VOCs. Exposure to VOCs in groundwater before natural attenuation is complete would be controlled through the deed restrictions and easement, thus providing long-term protection to human health. No short-term risks would be posed, since there would be no construction associated with this alternative.

Compliance with ARARs

Chemical-specific ARARs: Attainment of groundwater standards across the Site would eventually occur as a result of the on-demand pumping plus, natural flushing, and gradual attenuation and degradation of VOCs as described for Alternative G1. The estimated time for Alternative G2b to meet chemical-specific ARARs for groundwater across the Site is estimated to be the same as for Alternative G1 (110 years - see Table 4-1), because the low pumping rate is anticipated to have a negligible effect on the reduction of groundwater VOC concentrations, relative to natural flushing.

Removal of groundwater VOCs would primarily be through passive remediation, i.e. natural attenuation in the subsurface and volatilization at the ravines. Unlike G1, however, Alternative G2b would provide, through the EWMS system and treatment system monitoring, a means of monitoring the reduction in groundwater VOC concentrations at the production wells and in groundwater and ravine springs hydraulically downgradient of the Site. Groundwater plume concentrations would be measured by the EWMS network, and through the water supply well influent sampling. Achieving ARARs at these measuring points would provide an indication that ARARs for groundwater have been met across the Site. Monitoring of surface water at the locations designated in the EWMS network would confirm that compliance with surface water ARARs is maintained.

Long-Term Effectiveness and Permanence

Residual risk: The existing groundwater treatment system has a proven record of effectively reducing concentrations of VOCs in recovered groundwater to below drinking water standards. Deed restrictions and the one-mile restricted access easement would prevent ingestion of untreated water. Although residual VOCs would remain, residual risks would be controlled and kept to acceptable levels.

Adequacy of controls: The groundwater plume would be remediated by natural flushing and attenuation including volatilization in the ravines. The EWMS would provide a long-term mechanism for determining if the MRFA Site groundwater plume is migrating toward the Luther Forest Well Field or Cold Springs Well Field. Treatment system monitoring would ensure that effluent meets drinking water quality standards. EWMS monitoring at M-27D and treatment system influent monitoring would provide an indication of the reduction of VOC concentrations over time.

Reliability of controls: EWMS and treatment system monitoring would be performed. During monitoring events, the wells and treatment system would be visually inspected and the results would be evaluated to determine if these long-term controls are operating reliably. Maintenance of the wells and treatment system would be performed, as appropriate, based on the recommendations set forth in the monitoring reports. Performance of these controls would continue until ARARs are achieved in Site groundwater, or otherwise waived.

Reduction of Toxicity, Mobility & Volume Through Treatment

On-demand pumping and natural attenuation and degradation of VOCs in the water bearing zone and at the ravine discharge points would contribute to the overall reduction of the toxicity, volume, and mobility of these compounds in groundwater. Continued pumping at the current low rates would contribute relatively little to enhance this reduction. Air stripping of recovered groundwater would eliminate risks of exposure to VOCs in the extracted groundwater. Air stripper emissions are expected to be within acceptable levels without treatment. An evaluation of air stripper emissions based on Air Guide-1 is provided in Appendix E.

Short-Term Effectiveness

Community, worker and environmental protection: This alternative proposes no activities other than continuing the operation and maintenance of the existing water supply and treatment system and implementation of deed restrictions. These activities would cause no short-term risks to the community, workers or the environment.

Time to implement: This alternative is already in effect as part of ongoing Site operations.

Implementability

Since this alternative makes use of an existing system that is currently in operation, it is considered readily implementable.

Cost

The costs associated with Alternative G2b have been estimated as shown on Table 4-3. A summary of these costs and a comparison with the other alternatives are provided on Table 4-2. The capital costs associated with this alternative are those related to the preparation of the deed restriction, as the wells and treatment system are already operational. Operation and maintenance of the existing system is expected to continue for remedial purposes until the remedial action objectives are achieved, which has been predicted to be in the range of 110 years. In reality, the system operation would continue as long as the on-site groundwater supply is needed. For comparison with other alternatives, 30 years of operation and maintenance have been assumed.

State Acceptance

Formal comments relative to technical and administrative issues will be addressed at the completion of the FS, prior to the signing of the ROD. Since this alternative would be protective of human health and the environment, it would likely be acceptable to the State.

Community Acceptance

Community input on specific alternatives will be documented and addressed after a public comment period and incorporated into the ROD. Since this alternative would meet the remedial action objectives, and with the EWMS in effect, this alternative should be acceptable to the community.

4.2.3 Alternative G3 - Manage Plume by Maximizing the Existing System with Institutional Controls

4.2.3.1 Description

Alternative G3 incorporates the provisions of Alternative G2b (use of existing system, EWMS monitoring, deed restrictions and continued maintenance of the one-mile restrictive easement), except that the current on-site groundwater treatment system would be operated at its maximum capacity. The two existing water supply wells, 1D and 2D, are capable of producing more water than current demand. A 25 gpm production rate has been assumed for G3 based on the capacity of the existing air stripper system. Based on peak influent concentrations for carbon tetrachloride (150 ppb) and TCE (80 ppb) measured between 1990 and 1994, the air stripper manufacturer estimates that the maximum flow rate that would continue to meet the 5 ppb effluent standard for either compound, is approximately 25 gpm for the existing system.

A preliminary evaluation of various pumping rates at wells 1D and 2D was performed to determine how the groundwater plume would be managed through steady groundwater pumping at 25 gpm. The results of this evaluation indicated that pumping well 1D at 25 gpm would have the most impact on the central portion of the plume. For the purposes of the detailed analysis, it is assumed that 1D will be pumped at 25 gpm and 2D will be reserved for backup (see Table 4-1). It is also assumed that excess water would be reinjected (at 25 gpm) through an injection well located approximately 700 feet northwest of well 1D. The use of injection wells for reinjection of groundwater was selected to simplify the evaluation of various pumping scenerios. Other reinjection methods such as infiltration trenches or retention basins would be considered during design. The predicted capture zone developed by this pumping scenario is shown on Figure D-6 (Appendix D), which was developed using the two-dimensional groundwater flow model, TWODAN, as described in Appendix D. Through steady pumping, a significant portion of the central portion of the plume would be removed and treated. The capture zone for this alternative would not fluctuate as much as the capture zone developed by the demand-only pumpage of Alternatives G1 and G2b. Groundwater not captured by pumping would flush naturally to the ravines.

To evaluate the performance of the increased pumping rate on reducing concentrations of VOCs in groundwater, monitoring is necessary. For the purpose of the FS, it is assumed that performance monitoring of the pump and treat system would consist of periodic water level monitoring, EWMS and treatment system influent monitoring, and periodic rounds of water quality monitoring (assumed to be approximately every 5 years for cost estimating purposes) at selected wells.

Use of the air stripper system at or near its maximum capacity would require additional operation and maintenance considerations. Turbidity may increase and cause a build up of sediments in the air stripper packing material or in the 450 gallon holding tank. The packing material would need to be monitored and eventually cleaned or replaced and the 450 gallon tank would likely need to be flushed more frequently than in the past. The potential increase in emissions from the air stripper resulting from the increase in pumping rate was evaluated, and it is predicted that no air treatment would be required. The emission calculations are provided in Appendix E.

Since pumpage would be greater than Site water usage, locations for treatment system discharge were evaluated. The discharge locations considered were: 1) Muggett's Pond via the Muggett's Pond Drainage Ditch; 2) the lagoon located at the MTI site; 3) Ravine 2a (the closest ravine to the treatment system); and upgradient reinjection/recharge. The following is a description of the evaluation of these discharge options.

1. Use of Muggett's Pond would have advantages and disadvantages. No new construction would be required since treated water would flow over existing surface ditches to Muggett's Pond. However, the existing drainage ditches may require cleaning to accommodate increased flow rates. Also, if the remedy selected for soil involves leaving impacted drainage ditch soil in place (i.e., use of a low permeability cap) construction of a new drainage ditch may be required. Discharging treated water to Muggett's Pond would recharge groundwater at an upgradient location which would contribute to aquifer flushing and reduce the stress on the formation due to pumping. With long-term use of Muggett's Pond as a discharge infiltration point sedimentation is likely to occur. According to the RA, under current and future land use scenarios, the compounds detected above the MRFA Criteria in the Muggett's Pond sediments are not considered a risk to human health or the environment. However, if dredging became necessary for the continued functioning of the Pond as a discharge point, final disposition of the sediments could become an issue because of the presence of these compounds. Due to this uncertainty, Muggett's Pond is not further considered as a discharge point for treated groundwater.

2. The lagoon at MTI was also eliminated from further consideration upon determining that the overflow structure for this lagoon was designed for approximately 5 gpm of flow which would be exceeded by the 25 gpm discharge rate from the treatment system.

3. Construction of a discharge structure at the head of Ravine 2a appears to be a viable option in terms of constructibility. This option is not complicated by the presence of impacted media. Discharge directly to the stream would help offset the depletion of stream recharge caused by groundwater pumping. However, converting the ravine stream from intermittent to continuous could have an impact on the stream ecosystem. The discharge system could be designed to handle the specific treatment system flow rate. Effluent would be tested to ensure that NYSDEC surface water discharge standards (specified under NYCRR Parts 700-703) are met. These standards are likely to be more stringent than those for upgradient infiltration for certain parameters. For the purpose of the FS, it is assumed that the treated water would be conveyed from Building 15, through approximately 1,000 feet of 8-inch HDPE pipe to a rip-rap outfall at Ravine 2a. A pre-design study to evaluate the appropriate final location and sizing of the system is included in the cost estimate.

4. Reinjection of treated groundwater is also considered a viable discharge option. This option is not complicated by the presence of impacted media. Use of suitably located upgradient injection wells, a surface infiltration trench or bed, or a retention basin could induce a higher gradient toward the pumping wells and therefore produce a benefit in both the greater rate of flushing and percentage capture. For the purpose of the FS, it is assumed that discharge would be conveyed from Building 15, through approximately 1,500 feet of 8-inch HDPE pipe to two groundwater injection wells. Other reinjection methods would be considered during remedial design.

To comply with discharge standards specified in NYCRR Parts 700-703, in addition to the current quarterly influent and effluent sampling at the treatment system, samples would be required of the effluent just prior to discharge. The samples would be analyzed for VOCs plus other specified discharge criteria and a report would be submitted to the state. For the purpose of the FS, it is assumed that no treatment of groundwater other than air stripping would be necessary prior to discharge.

4.2.3.2 Assessment

Overall Protectiveness of Human Health and the Environment

Alternative G3 would be no more protective than Alternative G2b. Future ingestion of untreated groundwater would be prevented through on-site groundwater treatment, deed restrictions, continued maintenance of the one-mile restrictive easement and EWMS and performance monitoring. Although a great deal of uncertainty is associated with estimated remediation duration, relative to Alternative G2b, this alternative may achieve groundwater standards in a slightly shorter time period.

Compliance with ARARs

Chemical-specific ARARs: Attainment of groundwater standards across the Site would eventually occur as a result of active pumping combined with natural flushing, and gradual attenuation and degradation of the VOC plume as described for Alternative G1. The predicted capture zone for Alternative G3, developed using TWODAN simulations (see Appendix D), is shown on Figure D-6 (Appendix D). Impacted water, not intercepted by wells 1D and 2D, would reach standards through natural flushing, and attenuation and degradation of VOCs. The estimated time to achieve ARARs across the Site as a result of active pumping and natural flushing is 90 years based on TWODAN simulations (see Appendix D). This duration is only 20 years less than the duration estimated for Alternatives G1 and G2b (see Table 4-1).

Location-specific ARARs: If excess treated groundwater is discharged at Ravine 2a, the construction of an outfall structure would require substantive complicance with the U.S. Army Corps of Engineers Nationwide Permit Program (33 CFR 330) under the Clean Water Act, Section 404(b)(1). The US Fish and Wildlife Service would be notified by the Corps of Engineers under the Nationwide Permit Program regarding any potential impact on the ravine stream by the proposed discharge. If excess treated groundwater is reinjected via site wells, substantive compliance with the Nationwide Permit Program would not be required.

Action-specific ARARs: If excess treated groundwater is discharged at Ravine 2a, pre-discharge monitoring would be required to comply with the substantive requirements of the NYS Pollution Discharge Elimination System (SPDES) Standards for Storm Water Runoff, Surface Water, and Groundwater Discharges (6 NYCRR 750-757). If excess treated groundwater is reinjected via Site wells, the activities must also comply with the substantive requirements of the EPA Underground Injection Control (UIC) permit program (40 CFR Part 144). The UIC program requires that the injection activities be conducted in a manner that will not cause a violation of any primary drinking water standard in groundwater. It is likely that effluent standards applicable to discharge to Ravine 2a would be more stringent than for reinjection wells due to the consideration of protection to aquatic life. Variances to the effluent standards may be permitted if protection of human health and the environment can be demonstrated.

Long-Term Effectiveness and Permanence

Residual risk: As with Alternative G2b, the existing groundwater treatment system has a proven record of effectively reducing concentrations of VOCs in recovered groundwater to below drinking water standards. Deed restrictions and the one-mile restrictive easement would prevent ingestion of untreated water. The increased pumping rate compared to G2b would provide the added benefit of achieving groundwater standards in a shorter time period.

Adequacy of controls: The groundwater plume would be remediated through active pumping and natural flushing. The EWMS would provide a long-term mechanism for determining if the MRFA Site groundwater plume is migrating toward the Luther Forest Well Field and the Cold Spring Well Field. Treatment system performance monitoring would ensure that effluent meets drinking water quality and discharge standards. EWMS monitoring at M-27D, performance monitoring and treatment system influent monitoring would provide a basis for evaluating groundwater quality enhancements.

Reliability of controls: EWMS, treatment system and discharge monitoring would be performed periodically. During monitoring events, the wells and treatment system would be visually inspected and the results would be evaluated to determine if these long-term controls are operating reliably. Maintenance of the wells and treatment system would be performed based on recommendations within the monitoring reports.

Reduction of Toxicity, Mobility & Volume Through Treatment

This alternative would be the same as Alternative G2b, except the increase in pumping rate would provide additional control of the mobility of VOCs in groundwater and further contribute to reducing the volume and toxicity of contaminated groundwater. Natural attenuation and degradation of the VOCs in the water bearing zone and at the ravine discharge points would contribute to the overall reduction of the toxicity, volume, and mobility of VOCs in groundwater. Air stripping of recovered groundwater would eliminate risks of exposure to VOCs in the extracted groundwater. Air stripper emissions are expected to be within acceptable levels without treatment. An evaluation of air stripper emissions is provided in Appendix E.

Short-Term Effectiveness

Increasing the pumping rate of the existing Site production wells, continuing the operation and maintenance of the existing water treatment system, and implementation of deed restrictions would pose no short-term risks to the community or Site workers. Treated water would be discharged in accordance with applicable regulations.

Time to implement: If approval relative to substantive compliance with any permit progam is required (i.e., wetlands, SPDES and/or UIC program), time for obtaining the approval(s) must be allowed. The time to rehabilitate existing wells, construct a discharge system and otherwise prepare the existing system for operation at a higher pumping rate would be approximately one to two months after contractor mobilization to the Site.

Implementability

Ability to construct and operate: This alternative makes use of an existing system that is currently operating under its original design capacity. There would be no need to install new wells or a new treatment system. Rehabilitating the existing wells and construction of a groundwater discharge system are routine activities considered to be readily implementable.

Reliability: The existing system has been operated successfully since 1987 and is expected to continue operating reliably with proper operation, maintenance and monitoring.

Ease of undertaking additional actions: This alternative would not complicate or prevent additional action on-site as it would not cause any major changes to the Site.

Ability to monitor: Performance monitoring, as previously described, would be used to evaluate the effectiveness of the remedy.

Availability of material and services: There are no aspects of this alternative that would require specialty services. There are numerous contractors that could rehabilitate the wells or construct the discharge system.

Cost

The costs associated with Alternative G3 - Manage Plume by Maximizing Existing System have been estimated as shown on Table 4-4. A summary of these costs and a comparison with the other alternatives are provided on Table 4-2. Operation and maintenance of the system is expected to continue until ARARs are achieved, which has been predicted to be approximately 90 years. For comparison with other alternatives, 30 years of operation and maintenance has been assumed.

State Acceptance

Formal comments relative to technical and administrative issues will be addressed at the completion of the FS, prior to the signing of the ROD. The added protection provided by aggressive active plume management and the enhanced cleanup time would likely be acceptable to the State.

Community Acceptance

Community input on specific alternatives will be documented and addressed after a public comment period and incorporated into the ROD. The added protection provided by aggressive active plume management would likely be acceptable to the community.

4.2.4 Alternative G4a - Manage Plume by Upgrading the Existing System (Using 2 Existing Supply Wells and New Air Stripper) with Institutional Controls

4.2.4.1 Description

This alternative incorporates the provisions of Alternative G3 (use of existing system, EWMS monitoring, deed restrictions and continued maintenance of the one-mile restrictive easement), but pumping would not be limited to the capacity of the existing air stripper. TWODAN was used to estimate the maximum sustained pumping rate of the existing production wells 1D and 2D. This rate is highly dependent upon site specific conditions including hydraulic conductivity which was estimated based on available data. Any necessary, confirmation of the assumptions used to estimate pumping rates is deferred to the design stage. For the purpose of this detailed analysis, the estimated combined pumping rate for wells 1D and 2D is 75 gpm (see Table 4-1). The pumping rate for each individual well is approximately 38 gpm. The discharge of treated groundwater would be through a discharge structure constructed at the head of Ravine 2a or through reinjection wells. The assumptions for the groundwater model simulation and cost estimate included two injection wells located near the southwest corner of the Site, each with a flow rate of approximately 38 gpm (see Figure D-7, Appendix D). As discussed under Alternative G3, other reinjection methods such as infiltration trenches or retention basins would be considered during design.

Figure D-7 (Appendix D) illustrates the lateral extent of the capture zone predicted using TWODAN for wells 1D and 2D pumped at combined pumping rate of 75 gpm. An upgrade to the existing groundwater treatment system would be required to handle this pumping rate. The existing air stripper tower would be replaced by a larger diameter tower. The performance monitoring and O&M considerations discussed for Alternative G3 would also apply to G4a. The potential increase in emissions from the air stripper resulting from the increase in pumping rate was evaluated and it is predicted that no air treatment would be required. The emission calculations are provided in Appendix E.

4.2.4.2 Assessment

Overall Protectiveness of Human Health and the Environment

This alternative would be no more protective than Alternative G2b. Future ingestion of untreated groundwater would be prevented through on-site groundwater treatment, the deed restriction, continued maintenance of the one-mile restricted access easement and EWMS and performance monitoring. Although a great deal of uncertainty is associated with the estimate of the duration to remediate, relative to Alternative G3, this alternative would achieve groundwater standards in a shorter time period due to its higher pumping rate.

If excess water is discharged to Ravine 2a at a rate of approximately 75 gpm, the potential effect on the ravine habitat would need to be evaluated. Reinjection of excess water would reduce the potential impacts associated with discharge to the ravine and may also mitigate the potential reduction of groundwater flow to the ravines that may be caused by continuous pumping of the water supply wells.

Compliance with ARARs

Chemical-specific ARARs: Attainment of groundwater standards across the Site would eventually occur as a result of active pumping combined with natural flushing, and gradual attenuation and degradation of VOCs as described for Alternative G1. The predicted capture zone for Alternative G4a, estimated based on TWODAN simulations (see Appendix D), is shown on Figure D-7 (Appendix D). The relative proportion of impacted groundwater not intercepted by wells 1D and 2D would be smaller than for alternatives G1, G2b or G3. This groundwater would discharge at the ravines and would reach standards through natural attenuation and degradation of VOCs. The estimated time to achieve ARARs across the Site as a result of active pumping and natural flushing is 80 years based on TWODAN simulations (see Appendix D). This duration is only 30 years less than the 110 year duration estimated for Alternatives G1 and G2b (see Table 4-1).

Location-specific ARARs: If excess treated groundwater is discharged at Ravine 2a, the construction of an outfall structure would require substantive complicance with the U.S. Army Corps of Engineers Nationwide Permit Program (33 CFR 330) under the Clean Water Act, Section 404(b)(1). The US Fish and Wildlife Service would be notified by the Corps of Engineers under the Nationwide Permit Program regarding any potential impact on the ravine stream by the proposed discharge. If excess treated groundwater is reinjected via site wells, substantive compliance with the Nationwide Permit program would not be required.

Action-specific ARARs: If excess treated groundwater is discharged at Ravine 2a, pre-discharge monitoring would be required to comply with the substantive requirements of the NYS Pollution Discharge Elimination System (SPDES) Standards for Storm Water Runoff, Surface Water, and Groundwater Discharges (6 NYCRR 750-757). If excess treated groundwater is reinjected via Site wells, the activities must also comply with the substantive requirements of the EPA Underground Injection Control (UIC) permit program (40 CFR Part 144). The UIC program requires that the injection activities be conducted in a manner that will not cause a violation of any primary drinking water standard in groundwater. It is likely that effluent standards required for discharge to Ravine 2a would be more stringent than for reinjection wells due to the consideration of protection to aquatic life. Variances to the effluent standards may be permitted if protection to human health and the environment can be demonstrated.

Long-Term Effectiveness and Permanence

Residual risk: As with Alternative G2b, the existing groundwater treatment system has a proven record of effectively reducing concentrations of VOCs in recovered groundwater to below drinking water standards. Deed restrictions and the one-mile restrictive easement would prevent ingestion of untreated water as related to future use of the Site and the surrounding areas. The increased pumping rate would provide the added benefit of achieving groundwater standards in a shorter time period.

Adequacy of controls: Unlike Alternative G3, a substantial portion of the central portion of the plume would be captured by the existing wells. Similar to G3, the portions of the plume outside the central portion would be flushed to the ravines. The EWMS would provide a long-term mechanism for determining if the MRFA Site groundwater plume is migrating toward the Luther Forest Well Field and the Cold Springs Well Field. Treatment system performance monitoring would ensure that effluent meets drinking water quality and discharge standards. EWMS monitoring at M-27D, performance monitoring and treatment system influent monitoring would provide a basis for evaluating groundwater quality enhancements.

Reliability of controls: This would be the same as for Alternative G3. EWMS, treatment system and discharge monitoring would be performed periodically. During monitoring events, the wells and treatment system would be visually inspected and the results would be evaluated to determine if these long-term controls are operating reliably. Maintenance of the wells and treatment system would be performed based on the recommendations set forth in the monitoring reports.

Reduction of Toxicity, Mobility & Volume Through Treatment

This alternative would be the same as for Alternative G2b, except the increase in pumping rate would provide additional control of the mobility of VOCs in groundwater and further contribute to reducing the volume and toxicity of contaminated groundwater. Natural attenuation and degradation of the VOCs in the water bearing zone and at the ravine discharge points would contribute to the overall reduction of the toxicity, volume, and mobility of the contaminants in groundwater. Air stripping of recovered groundwater would eliminate the risk of exposure to VOCs in the extracted groundwater. Air stripper emissions are expected to be within acceptable levels without treatment. An evaluation of air stripper emissions is provided in Appendix E.

Short-Term Effectiveness

Community protection: There would be no significant risks or adverse impacts to the community during implementation of this alternative. It is anticipated that air emissions associated with the air stripper would be within acceptable levels.

Worker protection: Disassembling the existing air stripper tower and installing a new tower would not pose a substantial risk to the workers as they would likely be conducting this work wearing any necessary personal protective equipment (PPE).

Environmental protection: Implementation of Alternative G4a would pose no adverse impacts to the environment except that higher pumping rates may affect (reduce) groundwater discharge to the ravine streams which may affect the local habitat. Reinjection of treated groundwater may serve to minimize this potential impact. Alternately, if excess treated water were discharged directly to the ravine, the increase in stream flow may also affect the local habitats. Treated water would be discharged in accordance with applicable regulations.

Time to implement: If approval relative to substantive compliance with any permit progam is required (i.e., wetlands, SPDES and/or UIC program), time for obtaining the approval(s) must be allowed. The time required to install and test recovery wells, mobilize a treatment system and prepare the system for operation would be approximately four to six months after contractor mobilization to the Site.

Implementability

Ability to construct and operate: Rehabilitating the existing wells and construction of a treated groundwater discharge system (such as injection wells or outfall structure) are common activities and are considered readily implementable. The upgrade to the treatment system would require disassembly of the existing system and construction of the new system. Operation and maintenance of the new system would be similar to the existing system. Successful implementation would require close coordination with and cooperation of Wright Malta.

Reliability: The existing system has been operated successfully since 1987 and is expected to continue operating reliably with proper operation, maintenance and monitoring.

Ease of undertaking additional actions: This alternative would not complicate or prevent additional action on-site as it would not cause any major changes to the Site.

Ability to monitor: The EWMS plus performance monitoring would be used to evaluate the effectiveness of the remedy.

Availability of material and services: There are no aspects of this alternative that would require specialty services. There are numerous contractors that could install wells and construct the treatment and discharge system.

Cost

The costs associated with Alternative G4a, have been estimated as shown on Table 4-5. A summary of these costs and a comparison with the other alternatives are provided on Table 4-2. Operation and maintenance of the existing system is expected to continue until ARARs are achieved, which has been predicted to be approximately 80 years for this alternative. For comparison with other alternatives, 30 years of operation and maintenance has been assumed.

State Acceptance

Formal comments relative to technical and administrative issues will be addressed at the completion of the FS, prior to the signing of the ROD. The added protection provided by aggressive active plume management and the enhanced cleanup time would likely be acceptable to the State.

Community Acceptance

Community input on specific alternatives will be documented and addressed after a public comment period and incorporated into the ROD. The added protection provided by aggressive active plume management would likely be acceptable to the community.

4.2.5 Alternative G4b - Manage Plume by Upgrading the Existing System (Using 4 Recovery Wells and New Air Stripper) with Institutional Controls

4.2.5.1 Description

This alternative is essentially the same as Alternative G4a, except a combination of the two existing and two new wells would be configured and pumped to aggressively manage the central portion of the plume with the objective of minimizing the time required to achieve ARARs. TWODAN was used to predict the number of new wells and well locations to be used in addition to existing production wells 1D and 2D. Figure D-8 (Appendix D) shows the location of the two additional extraction wells and the capture zone predicted using TWODAN. These four wells would generally be pumped at their maximum combined sustained rate of140 gpm to remove the central portion of the plume at the fastest rate (see Table 4-1). It is assumed that well 1D would be pumped at 37 gpm, well 2D and the west recovery well at 40 gpm, and the east recovery well at 23 gpm. Also, for the purpose of the detailed analysis, it is assumed that three injection wells would be located west of the Site with flow rates of 40 gpm and one injection well would be located 400 feet west of well 1D with a flow rate of 19 gpm (see Figure D-8). Discharge of excess treated water to Ravine 2a would also be evaluated.

An upgrade to the existing groundwater treatment system would be required to handle the total 140 gpm pumping rate estimated for this alternative. The existing air stripper tower could be replaced by a larger diameter tower or a low profile air stripper. A system of this capacity would require a larger blower than the existing 1 HP blower and may require construction of a temporary shelter due to the limited space within Building 15. The performance and O&M considerations discussed for Alternative G3 would also apply for this alternative. The potential increase in emissions from the air stripper resulting from the increase in pumping rate was evaluated and it is predicted that no air treatment would be required. The emission calculations are provided in Appendix E.

4.2.5.2 Assessment

Overall Protectiveness of Human Health and the Environment

This alternative would be no more protective than Alternative G2b. Future ingestion of untreated groundwater would be prevented through on-site groundwater treatment, the deed restriction, continued maintenance of the one-mile restrictive easement and EWMS and performance monitoring. Although a great deal of uncertainty is associated with the actual cleanup time this alternative would achieve groundwater standards in a shorter time period than Alternatives G3 and G4a due to the higher pumping rates.If excess water is discharged to Ravine 2a at a rate of approximately 140 gpm, the potential effect on habitat would need to be evaluated. Reinjection of excess water would reduce the potential impacts associated with discharge to the ravine and may also mitigate the potential reduction of groundwater flow to the ravines that may be caused by continuous pumping of the water supply wells.

Compliance with ARARs

Chemical-specific ARARs: Attainment of groundwater standards across the Site would eventually occur as a result of active pumping combined with natural flushing, and gradual attenuation and degradation of VOCs as described for Alternative G1. The predicted capture zone for Alternative G4b, estimated based on TWODAN simulations (see Appendix D), is shown on Figure D-8 (Appendix D). The addition of suitably located new wells would enhance the capture of the central portion of the plume relative to the previous alternatives and reduce the time to achieve groundwater standards. Based on TWODAN (see Appendix D), the time required to achieve groundwater standards across the Site under Alternative G4b is estimated to be 60 years. Compared with the 110 year time frame estimated to achieve ARARs through natural flushing (Alternatives G1 and G2b), this alternative reduces the remediation duration (see Table 4-1).

Location-specific ARARs: If excess treated groundwater is discharged at Ravine 2a, the construction of an outfall structure would require substantive complicance with the U.S. Army Corps of Engineers Nationwide Permit Program (33 CFR 330) under the Clean Water Act, Section 404(b)(1). The US Fish and Wildlife Service would be notified by the Corps of Engineers under the Nationwide Permit Program regarding any potential impact on the ravine stream by the proposed discharge. If excess treated groundwater is reinjected via site wells, substantive compliance with the Nationwide Permit program would not be required.

Action-specific ARARs: If excess treated groundwater is discharged at Ravine 2a, pre-discharge monitoring would be required to comply with the substantive requirements of the NYS Pollution Discharge Elimination System (SPDES) Standards for Storm Water Runoff, Surface Water, and Groundwater Discharges (6 NYCRR 750-757). If excess treated groundwater is reinjected via Site wells, the activities must also comply with the substantive requirements of the EPA Underground Injection Control (UIC) permit program (40 CFR Part 144). The UIC program requires that the injection activities be conducted in a manner that will not cause a violation of any primary drinking water standard in groundwater. It is likely that effluent standards required for discharge to Ravine 2a would be more stringent than for reinjection wells due to the consideration of protection to aquatic life. Variances to the effluent standards may be permitted if protection to human health and the environment can be demonstrated.

Long-Term Effectiveness and Permanence

Residual risk: As with Alternative G2b, the existing groundwater treatment system has a proven record of effectively reducing concentrations of carbon tetrachloride, TCE and other VOCs in recovered groundwater to below drinking water standards. Deed restrictions and the one-mile restrictive easement would prevent ingestion of untreated water as related to future use of the Site and the surrounding areas. The increased pumping rate would provide the added benefit of achieving groundwater standards in a shorter time period.

Adequacy of controls: Alternative G4b endeavors to obtain 100 percent capture of the central portion of the plume through optimum well placement. Modelling simulations indicate that this would also result in active capture of approximately 50 percent of the portion of the plume outside of the central portion; the remainder to be remediated passively through natural flushing and attenuation. The EWMS would provide a long-term mechanism for determining if the MRFA Site groundwater plume is migrating toward the Luther Forest Well Field and the Cold Springs Well Field. Treatment system monitoring would ensure that effluent meets drinking water quality and discharge standards. EWMS monitoring at M-27D, performance monitoring and treatment system influent monitoring would provide a basis for evaluating groundwater quality enhancements.

Reliability of controls: This would be the same as for Alternative G3. EWMS, treatment system and discharge monitoring would be performed periodically. During monitoring events, the wells and treatment system would be visually inspected and the results would be evaluated to determine if these long-term controls are operating reliably. Maintenance of the wells and treatment system would be performed based on the recommendations included in the monitoring reports.

Short-Term Effectiveness

Community protection: There would be no significant risks or adverse impacts to the community during implementation of this alternative. It is anticipated that air emissions associated with the air stripper would be within acceptable levels.

Worker protection: Disassembling the existing air stripper tower and installing a new tower would not pose a substantial risk to the workers as they would likely be wearing personal protective equipment (PPE) as necessary, during the implementation of this alternative.

Environmental protection: Implementation of Alternative G4b would pose no adverse impacts to the environment except that higher pumping rates may affect (reduce) groundwater discharge to the ravine streams which may affect the local habitat. Reinjection of treated groundwater may serve to minimize this potential impact. Alternatively, if excess treated water were discharged directly to Ravine 2a, the increase in stream flow may also affect local habitat. Treated water would be discharged in accordance with applicable regulations.

Time to implement: The time required to install and test recovery wells, mobilize a treatment system and prepare the system for operation would be approximately four to six months after contractor mobilization to the Site.

Implementability

Ability to construct and operate: New extraction wells, injection wells, or an outfall structure could be readily installed and tested. The upgrade to the treatment system would require disassembly of the existing system and construction of a new higher capacity system. Operation and maintenance of the new system would be similar to existing system. Successful implementation would require close coordination with and cooperation of Wright Malta.

Reliability: The existing system has been operated successfully since 1987. Based on this success rate the new system is expected to operate reliably with proper operation, maintenance and monitoring.

Ease of undertaking additional actions: This alternative would not complicate or prevent additional action on-site as it would not cause any major changes to the Site.

Ability to monitor: The EWMS plus additional groundwater quality and level monitoring would be used to evaluate the effectiveness of the remedy.

Availability of material and services: There are no aspects of this alternative that would require specialty services. There are numerous contractors that could install wells and construct the treatment and discharge system.

Cost

The costs associated with Alternative G4b have been estimated as shown on Table 4-6. A summary of these costs and a comparison with the other alternatives are provided on Table 4-2. Operation and maintenance of the existing system is expected to continue until ARARs are achieved, which has been predicted to be approximately 60 years. For comparison with other alternatives, 30 years of operation and maintenance has been assumed.

State Acceptance

Formal comments relative to technical and administrative issues will be addressed at the completion of the FS, prior to the signing of the ROD. The added protection provided by aggressive active plume management and the enhanced cleanup time would likely be acceptable to the State.

Community Acceptance

Community input on specific alternatives will be documented and addressed after a public comment period and incorporated into the ROD. The added protection provided by aggressive active plume management would likely be acceptable to the community.

4.3 Soil Alternatives Analysis

This detailed analysis evaluates the soil alternatives that passed the initial alternatives screening in Section 3.0 relative to the nine evaluation criteria. It focuses upon the relative performance of each alternative. The soil remedial alternatives that are evaluated in the detailed analysis are as follows:

- Alternative S1: No Action
- Alternative S2: Institutional Controls
- Alternative S3b: Capping/Surface Controls (Asphalt)
- Alternative S4: Excavation and Off-Site Disposal

4.3.1 Alternative S1 - No Action

4.3.1.1 Description

The No Action Alternative (Alternative S1) is at one end of the range of source remediation alternatives for surface soil at the Site. Under this alternative, no action would be taken to contain, remove, or treat soil or to further restrict use or access to the Site. The soil at Building 23P and in the Muggett's Pond Drainage Ditch intersection would be left in place. The existing fence around the perimeter of the Site and the one-mile restrictive easement would continue to restrict access to the Site.

4.3.1.2 Assessment

Overall Protection of Human Health and the Environment

The two affected surface soil areas lie within the Test Station, which is enclosed by a perimeter boundary fence and largely surrounded by a restrictive easement area. The risk of direct contact with contaminated soil is mainly by Site personnel, utility workers and construction workers. Thus, the Site has restricted entry and minimal occupation. This alternative would not reduce existing on-site risks. Although access to the Site is currently controlled and limited by way of the one-mile easement and the perimeter fence, under the No Action Alternative, there is no guarantee that these controls would be maintained. Should the land usage be changed or the Site be developed, the human health and/or ecological risks would be increased.

Off-site migration of PCBs and lead (Building 23P) and mercury (Muggett's Pond Drainage Ditch intersection) is unlikely to occur. These constituents are considered to be relatively immobile and are not associated with constituents found in groundwater. The risk associated with the potential migration of these constituents is expected to be negligible.

Compliance with ARARs

TSCA, which may be an ARAR, governs the cleanup standards for PCB spills. The policy establishes requirements for PCB levels at 25 ppm for restricted access areas and 10 ppm for unrestricted access areas. PCB concentrations at Building 23P are below the cleanup standard under TSCA for restricted access industrial areas.

There are no promulgated federal and State ARARs for mercury and lead in soil. TBC chemical-specific site cleanup guidelines (SCGs) (NYSDEC TAGM 4046) and site-specific cleanup values exist for these constituents. The TBCs are 0.1 ppm for mercury and site background (23.8 ppm) for lead (see Table 1-9). Site-specific cleanup levels for mercury and lead are 2 ppm and 1,000 ppm, respectfully. Neither the guidelines nor the cleanup levels would be met under the No Action Alternative, since no removal/treatment of PCB- and lead-impacted soil at Building 23P nor soil containing mercury in the Muggett's Pond Drainage Ditch intersection is proposed under this alternative.

Long-Term Effectiveness and Permanence

Residual risk: The long-term risk of exposure for this alternative is moderately high since future Site usage and access is not controlled under the No Action Alternative.

Adequacy of controls: Long-term human health or ecological risks due to exposure to affected soils would not be reduced.

Reliability of controls: No controls would be implemented for this alternative.

Reduction of Toxicity, Mobility, and Volume Through Treatment

The No Action Alternative would not reduce the toxicity, mobility or volume of the COCs in the soil at Building 23P and Muggett's Pond Drainage Ditch intersection. Since treatment is not part of this alternative, irreversibility does not apply.

Short-Term Effectiveness

Community, worker and environmental protection: Since no action would be taken to disturb the contaminated soil under this alternative, implementation would not pose any short-term risks to workers, the community, or the environment as a result of construction activities.

Implementability

No construction or operation would be required to implement the No Action Alternative. No treatment would be performed, and therefore, no permits or approvals are necessary. The No Action Alternative does not complicate or prevent any future remedial actions from being implemented at the Site.

Cost

There are no costs directly associated with this alternative.

State Acceptance

Formal comments relative to technical and administrative issues would be addressed at the completion of the FS, prior to signing the ROD. The State may not accept this alternative since it is not protective of human health and the environment and does not achieve site-specific cleanup goals.

Community Acceptance

Community input on specific alternatives would be documented and addressed after a public comment period and incorporated into the ROD. This alternative may not achieve community acceptance because soils with elevated concentrations of PCBs, lead, and mercury that may pose unacceptable potential risks to human health or the environment would remain on-site.

4.3.2 Alternative S2 - Institutional Controls

4.3.2.1 Description

Alternative S2, Institutional Controls, involves implementation of deed restrictions such as restricting property use in affected areas to commercial/industrial use or prohibiting future development of selected areas to minimize potential exposure to acceptable levels and eliminate potential residential-setting exposure scenarios. The deed restrictions, which would prohibit future development/excavation around Building 23P and the Muggett's Pond Drainage Ditch intersection, would be incorporated into the property deed for the Site. The existing Test Station perimeter boundary fence would continue to limit direct access to the Test Station where Building 23P and Muggett's Pond Drainage Ditch intersection are located, and the existing restrictive easement would continue to be enforced.

4.3.2.2 Assessment

Overall Protection of Human Health and the Environment

The affected soil areas lie within the Test Station's perimeter boundary fence. The Test Station has restricted entry and minimal occupation. The risk of direct contact with contaminated soil is mainly by Site personnel, utility workers and construction workers. Access to the Site is currently controlled and limited, but deed restrictions would help guarantee that these controls would be maintained. Deed restrictions would restrict land use around Building 23P and the Muggett's Pond Drainage Ditch intersection and prohibit any future development involving soil excavation in and around these areas. In this way, future risks to human health and the environment would be reduced.

Off-site migration of PCBs and lead (Building 23P) and mercury (Muggett's Pond Drainage Ditch intersection) is unlikely to occur. These constituents are considered to be relatively immobile and are not associated with constituents found in groundwater. The risk associated with the potential migration of these constituents is expected to be negligible.

Compliance with ARARs

Compliance with ARARs would be the same as Alternative S1. TSCA, which may be an ARAR, governs the cleanup standards for PCB spills. The policy establishes requirements for PCB levels at 25 ppm for restricted access areas and 10 ppm for unrestricted access areas. PCB concentrations at Building 23P are below the cleanup standard under TSCA for restricted access industrial areas. There are no promulgated federal and State ARARs for mercury and lead in soil. TBC chemical-specific site cleanup guidelines (SCGs) (NYSDEC TAGM 4046) and site-specific cleanup levels exist for these constituents. The TBCs are 0.1 ppm for mercury and site background (23.8 ppm) for lead (see Table 1-9). Site-specific cleanup levels for mercury and lead are 2 ppm and 1,000 ppm, respectfully. Neither the guidelines, nor the cleanup levels would be met under this alternative, since no removal/treatment of PCB- and lead- impacted soil at Building 23P nor soil containing mercury in the Muggett's Pond Drainage Ditch intersection is proposed under this alternative.

Long-Term Effectiveness and Permanence

Residual risk: This alternative would reduce, but not eliminate, potential risks due to exposure to contaminated soil by limiting future use of contaminated areas.

Adequacy of controls: Long-term risks due to exposure to affected soils would be reduced if deed restrictions made the Site inaccessible to many potential receptors. Any restrictions set forth in the property deed would govern any proposed change in the usage of the Site.

Reliability of controls: No controls, other than deed restrictions, would be implemented for this alternative. Deed restrictions are considered reliable.

Reduction of Toxicity, Mobility and Volume Through Treatment

The reduction in toxicity, mobility and volume through treatment would be the same as Alternative S1. The Institutional Controls Alternative would not reduce the toxicity, mobility or volume of the COCs in the soil at Building 23P and the Muggett's Pond Drainage Ditch intersection. Since treatment is not part of this alternative, irreversibility does not apply.

Short-Term Effectiveness

Community, worker and environmental protection: This alternative would be the same as Alternative S1. Since no action would be taken that would disturb the contaminated soil under this alternative, implementation would not pose any short-term risks to workers, the community or the environment as a result of construction activities.

Implementability

There are no technical components to this alternative. Deed restrictions and the existing one-mile restrictive easement are reliable means of controlling property usage. This alternative would not complicate or hinder other remedial actions. Implementation of deed restrictions would require legal assistance and coordination with Saratoga County officials.

Cost

A summary of the costs associated with Alternative S2, Institutional Controls, and a comparison with the costs associated with other alternatives is provided on Table 4-7. Detailed costs for Alternative S2 have been estimated as shown on Table 4-8. The capital costs associated with this alternative are those related to the preparation of the deed restriction. There are no associated operation and maintenance costs.

State Acceptance

Formal comments relative to technical and administrative issues would be addressed at the completion of the FS, prior to signing the ROD. The State may not accept this alternative since it does not achieve site-specific cleanup goals, nor isolate contaminated soils to reduce exposure potential.

Community Acceptance

Community input on specific alternatives would be documented and addressed after a public comment period and incorporated into the ROD. This alternative may achieve community acceptance based on the institutional controls selected.

4.3.3 Alternative S3b - Capping/Surface Controls (Asphalt)

4.3.3.1 Description

Under this alternative, an asphalt cap would be placed over the affected soil at Building 23P and in the Muggett's Pond Drainage Ditch intersection. Affected areas would be delineated and the surface prepared with a thin layer of subbase material, after which an asphalt layer would be placed and rolled. A hard surface cap is durable and would effectively isolate PCB-containing soil around Building 23P and mercury-containing soil in the Muggett's Pond Drainage Ditch intersection. Placement of an asphalt cap over existing soils in the drainage ditch would require altering the ditch alignment slightly to maintain flow capacity and prevent cap erosion. Drainage considerations for diverting flow around the cap would be addressed as the areas are covered with asphalt. This alternative includes long-term operation and maintenance to ensure cap integrity is preserved. Because this alternative relies on isolation rather than removal of affected soils, cap demarcation and deed restrictions would be required to prevent any future damage to the cap.

4.3.3.2 Assessment

Overall Protection of Human Health and the Environment

Capping would effectively isolate contaminated soils and prevent exposure to affected on-site soils. An asphalt cap is an effective infiltration barrier, and although the COCs are in themselves relatively immobile, the cap would reduce risk of leaching of the constituents to groundwater. Capping would prevent uptake of constituents in vegetation and/or exposure to soil, thereby reducing risks to higher order receptors in the food chain.

Compliance with ARARs

Chemical-specific ARARs: There are no promulgated federal and State ARARs for mercury and lead in soil. TBC chemical-specific site cleanup guidelines (SCGs) (NYSDEC TAGM 4046) and site-specific cleanup levels exist for these constituents. The TBCs are 0.1 ppm for mercury and site background (23.8 ppm) for lead (see Table 1-9). Site-specific cleanup levels for mercury and lead are 2 ppm and 1,000 ppm, respectfully. The cleanup levels and TBC guidelines would not be met under this alternative, since no removal/treatment of PCB- and lead-impacted soil at Building 23P nor soil containing mercury in the Muggett's Pond Drainage Ditch intersection is proposed under this alternative.

Action-specific ARARs: TSCA, which may be an ARAR, governs the cleanup standards for PCB spills. The policy establishes requirements for PCB levels at 25 ppm for restricted access industrial areas and 10 ppm for unrestricted access industrial areas. PCB concentrations at Building 23P are below the cleanup standard under TSCA for restricted access industrial areas.

Long-Term Effectiveness and Permanence

Residual risk: The long-term risk of exposure for this alternative is relatively low. The affected soils would be adequately contained and isolated in place below the cap. Assuming proper functioning of the cap, the risks to potential future receptors due to direct dermal contact or incidental ingestion of contaminated soils is mitigated effectively. Migration of PCBs below the cap would be negligible since infiltration of precipitation is prevented by the asphalt cap and drainage controls would aid to prevent erosion around the cap. In the Muggett's Pond Drainage Ditch intersection, subsurface migration of mercury is prevented by the physical boundary of the concrete drainageway.

As the affected soils are not treated, a failure or breach of the cap would result in the reoccurrence of health-based or ecological risks. Appropriate land use restrictions would be implemented to assure that the cap is not breached.

Adequacy of controls: An asphalt cap should, in all probability, achieve its performance requirement of preventing direct contact to future potential receptors. Implementation of and compliance with land use restrictions and long-term maintenance obligations would aid in preserving cap integrity (permanence) and limiting exposure. Long-term maintenance activities, including annual visual inspection of the cap, and crack and surface repair, as necessary, would ensure cap integrity.

Reliability of controls: With proper construction and long-term maintenance the asphalt cap would provide a highly reliable isolation barrier to potential future receptors. Deed restrictions would limit access to the area, and therefore, aid in preventing accidental damage to the cap. It is anticipated that with proper maintenance, the cap should last indefinitely.

Reduction of Toxicity, Mobility and Volume Through Treatment

As the affected soils are not treated, there is no reduction in the toxicity, or volume of affected soil at the Site. The asphalt cap would, however, somewhat reduce the mobility of constituents from soil.

Short-Term Effectiveness

Community, worker and environmental protection: Since actions would be taken not to disturb the affected soils, but leave them in place and cover them with an asphalt layer, implementation would pose minimal risks to workers, the community and the environment. Air monitoring for PCBs and use of personal protective equipment would mitigate risk to workers during construction.

Implementability

An asphalt cap could be constructed with little or no difficulty using readily available material and equipment. Successful implementation would require close coordination with and cooperation of Wright Malta. On-site implementation of this alternative would be accomplished in approximately one week (or less), and achieve the remedial action objectives. Implementation of deed restrictions would require coordination with Saratoga County.

Cost

The costs associated with Alternative S3b have been estimated as shown on Table 4-9. A summary of these costs and a comparison with the costs associated with other alternatives is provided on Table 4-7.

State Acceptance

Formal comments relative to technical and administrative issues would be addressed at the completion of the FS, prior to signing the ROD. The State has previously accepted reliable cover systems as a means to isolate constituents from exposure pathways. Since the Site contaminants are not a threat to groundwater, and the cap provides an isolation barrier to the environment, Alternative S3b should be acceptable to the State, along with a specified maintenance obligation and deed restrictions.

Community Acceptance

Community input on specific alternatives would be documented and addressed after a public comment period and incorporated into the ROD. This alternative would likely achieve community acceptance based upon it meeting the remedial objectives.

4.3.4 Alternative S4 - Excavation and Off-Site Disposal

4.3.4.1 Description

This alternative involves excavation and off-site disposal of surface soils containing PCBs and lead adjacent to Building 23P, and surface soil containing mercury within the confines of the Muggett's Pond Drainage Ditch near the intersection.

At the Building 23P area, surface soil would be removed to a depth of approximately one foot, backfilled with clean fill material, graded to blend with surrounding areas, and revegetated. Any soil below one-foot that exceeds 25 ppm would also be excavated. Volumes of soil to be excavated are discussed in Section 2.3 and in Appendix C. The final volume of soil to be removed would be based upon confirmatory sampling done at the base and perimeter of the excavations. Before transport off-site, the soil materials would be analyzed as necessary (PCB/TCLP) for acceptance at an industrial landfill or a TSCA and RCRA-approved facility.

At the Muggett's Pond Drainage Ditch intersection, mercury-containing soils would be excavated from the drainageway, which is concrete-lined. Volumes of excavated soil were estimated in Section 2.0. Before transport off-site, the soil materials would be analyzed as necessary (i.e., TCLP) for acceptance at either an industrial landfill or a RCRA-approved facility. If necessary, a pretreatment/stabilization process would immobilize the mercury compounds within the soil prior to land burial in a lined disposal cell.

4.3.4.2 Assessment

Overall Protection of Human Health and the Environment

The combined components of this alternative would provide a high level of protection to human health and the environment, not only in the vicinity of the Site but also in general. Potential risks resulting from exposure to mercury-containing (Muggett's Pond Drainage Ditch intersection) and PCB and lead-containing soils (Building 23P) would be eliminated under this alternative. The soils would be excavated, transported off-site, treated (if necessary), and disposed in an appropriate permitted waste facility. Cleanup objectives for PCBs, mercury and lead would be met since the PCB, lead and mercury-containing soils at the two locations would be permanently removed from the Site. After removal from the Site, PCB contaminated soils would be disposed of in a secure landfill, subject to regular monitoring and maintenance requirements.

Compliance with ARARs

Chemical Specific ARARs: There are no promulgated Federal and State ARARs for mercury and lead in soil. TBC chemical-specific site cleanup guidelines (SCGs) (NYSDEC TAGM 4046) and site-specific cleanup values exist for these constituents. The TBCs are 0.1 ppm for mercury and site background (23.8 ppm) for lead (see Table 1-9). Site-specific cleanup values for mercury and lead are 2 ppm and 1,000 ppm, respectfully. Under this alternative, mercury and lead affected soils containing concentration above site-specific cleanup guidelines would be excavated and removed off-site. This alternative would not meet the generic and more conservative TBC values that are appropriate for residential settings, but would meet the site-specific cleanup goals that are appropriate for the industrial setting of the Site. Soil containing lead and mercury at concentrations between the TBCs and the site-specific cleanup levels would remain on site at Building 23P and in the Muggett's Pond Drainage Ditch intersection, respectively.

TSCA, which governs the cleanup standards for PCB spills, establishes requirements for PCB levels at 25 ppm for restricted access areas and 10 ppm for unrestricted access areas (see Appendix C). Under this alternative, the soil ARAR under TSCA would be met since PCB affected surface soil at Building 23P would be excavated and hauled off-site for land burial.

Action-specific ARARs: TBCs and ARARs to be considered with the implementation of this alternative include RCRA, OSHA and the New York State hazardous waste regulations. Excavation of PCB or mercury-containing soils is subject to OSHA health and safety standards. Transportation of contaminated materials to a TSDF is subject to various RCRA regulations for transport and monitoring. Treated (stabilized) mercury affected soils must pass a TCLP in accordance with RCRA prior to landfilling.

Long-Term Effectiveness and Permanence

Residual risk: The surface soil around Building 23P would be removed until concentrations of PCBs are below 10 ppm. Surface soils with mercury concentrations in excess of 2 ppm at the Muggett's Pond Drainage Ditch intersection would be removed down to the physical limit of the concrete drainageway. The risks to potential future receptors due to direct dermal contact or incidental ingestion of contaminated soils is mitigated effectively by removal of the affected soil. Disposal of affected soils in an off-site industrial, RCRA or TSCA-approved landfill effectively isolates the constituents from potential receptors, and also greatly reduces contaminant mobility, especially in the case of mercury, which would be stabilized before land burial.

Adequacy of controls: Off-site, industrial, RCRA and TSCA-permitted landfill facilities should, in all probability, achieve its performance requirement of preventing direct contact to any receptors. There would be no long-term management or deed restrictions placed on the MRFA Site in regard to this alternative for soils, since risks to human health and the environment would be sufficiently mitigated and all contaminated soil would have been removed.

Reliability of controls: No on-site controls would be required because the contamination would be removed. It is anticipated that the off-site disposal facility could function properly for an indefinite period of time, assuming proper maintenance.

Reduction of Toxicity, Mobility and Volume Through Treatment

The exact means of treatment would depend on constituent concentrations and waste disposal facility requirements. PCB contaminated materials accepted for disposal in an industrial landfill are landburied. Mercury contaminated soils may be immobilized by stabilization and encapsulation. Through excavation, the volume and toxicity of contaminants on site are reduced.

The toxicity of the materials being excavated and removed is not reduced, except in the case of mercury which may be stabilized within the soil matrix. Reduction in contaminant mobility is achieved by encapsulation of the material within a controlled landfill environment. Since all contaminated soil above the risk-based action cleanup levels are removed, the volume of constituents remaining on site is reduced.

Short-Term Effectiveness

There would be minimal impact to the community during the implementation of this alternative, since the Site is isolated, access is limited, and quantities to be moved off site are of relatively small. Fugitive dust would be controlled using engineering measures. Traffic increases due to transportation of soil would not be significant as the volume of soil is small. It is estimated that no more that three truckloads of soil would be removed from the Site over a period of one week.

Workers involved with the soil excavation, transport and disposal activities could be exposed to the risks associated with dermal contact with contaminated soil and inhalation of soil dust particulates. Risks would be mitigated by properly outfitting workers with appropriate personnel protection equipment, following proper industrial hygiene procedures, using controlled excavations, and monitoring air quality during soil excavation activities. All work associated safety practices would be outlined in a Health and Safety Plan, including a description of the control measures that would be implemented at the Site. The Health and Safety Plan would be reviewed by USEPA and the State.

Short-term adverse environmental impacts due to excavation and removal would be minimal due to the small volumes of soil involved. They may be mitigated by the proper use of erosion control devices, including diversion ditches and hay bales.

It is anticipated, once the contractor is mobilized to the Site, that excavation, confirmatory sampling, transport and backfilling activities would be completed within a one week time frame.

Implementability

All components of Alternative S4 utilize relatively common construction equipment and materials. Soil excavation and removal utilizes routine construction procedures. No permits are anticipated to be required. However, the Malta PPs may need to obtain a hazardous waste generator USEPA Identification number. Soil shipments considered hazardous must be manifested and transported by a permitted hazardous waste transporter. Successful implementation would require close coordination with and cooperation of Wright Malta.

All aspects of this alternative would be highly reliable in achieving the remedial action objectives as it involves proven technologies and all components of Alternative S4 utilize common construction materials and procedures, and routine sampling procedures and analyses. All equipment and materials are available locally and have been demonstrated sufficiently for the purpose for which they are intended. Due to the small volume required to be landfilled and the nature of the constituents and waste, at least three nearby facilities have been identified as potentially capable of receiving such waste. This alternative would not complicate or hinder other remedial actions.

Cost

The costs associated with Alternative S4 have been estimated as shown on Table 4-10. A summary of these costs and a comparison with the costs associated with other alternatives is provided on Table 4-7.

State Acceptance

Formal comments relative to technical and administrative issues would be addressed at the completion of the FS, prior to signing the ROD. Since this remedial alternative would meet State-approved site-specific cleanup goals and the remedial action objectives, it would likely be acceptable to the State.

Community Acceptance

Community input on specific alternatives would be documented and addressed after a public comment period and incorporated into the ROD. Since surface soil contamination in Building 23P and the Muggett's Pond Drainage Ditch intersection above specified cleanup levels would be removed from the Site, this alternative would likely be acceptable to the community.

4.4 Comparison of Groundwater Alternatives

This analysis provides a comparative assessment of the groundwater alternatives to evaluate the relative performance of each in relation to the specific evaluation criteria. The results of the individual analyses (Section 4.2) are used to determine which alternative best satisfies the evaluation criteria. The purpose is to identify the advantages and disadvantages of each alternative relative to one another so that the key tradeoffs that must be balanced can be identified.

Consistent with the 1988 USEPA guidance for conducting an RI/FS under CERCLA, the overall protection of human health and the environment is a threshold criterion that an alternative must meet to be selected as a proposed remedy. Compliance with ARARs is also a threshold criterion, unless a waiver is involved. The five primary balancing criteria include long-term effectiveness and permanence; reduction of toxicity, mobility, or volume of waste; short-term effectiveness; implementability; and present worth of capital and operating costs. Modifying criteria consisting of State and community acceptance will be evaluated following comment on the RI/FS report and the proposed plan, and will be addressed once a final decision is made and the ROD is prepared.

The comparative analysis focuses mainly on those aspects of the alternatives that are unique for each. A summary of each of the criteria for each of the groundwater alternatives carried through the detailed analysis is provided on Table 4-11. This summary can be used to quickly compare the alternatives and facilitate selection of an appropriate remedy for groundwater at the MRFA site.

4.4.1 Overall Protection of Human Health and the Environment

This criterion is used to evaluate how well each of the alternatives protects human health and the environment, and as such, how each alternative is consistent with the Remedial Action Objectives for groundwater.

Alternative G1, the No Action Alternative, is the least protective of human health and the environment as it does not prevent ingestion of untreated groundwater and it provides no means of monitoring the distribution or migration of VOCs in groundwater. Alternatives G2b, G3, G4a and G4b are equally as protective of human health, since future ingestion of untreated groundwater would be prevented through on-site groundwater treatment, deed restrictions and EWMS monitoring. The one-mile restrictive easement would also limit or prevent development (and the potential for installation of private drinking water wells) in the vicinity of the Site.

Alternatives G2b, G3, G4a and G4b would be protective of the environment. For each alternative, some of the VOCs in groundwater would be removed through pumping and treating the groundwater, while the remainder would be removed through natural attenuation and degradation processes as the groundwater flows under the Test Station and discharges to the nearby ravines. At the ravines, the low concentrations of VOCs would be removed naturally through volatilization. Groundwater restoration would take from 60 to 110 years, with Alternative G4b taking the shortest amount of time, Alternative G2b taking the longest, and Alternatives G4a and G3 being intermediate. However, Alternative G2b would be more protective of the ravine environment than Alternatives G3, G4a and G4b because there would be no potential impacts to the ravine streams due to the long-term pumping of large volumes of groundwater and the discharging of large volumes of treated water, which are associated with Alternatives G3, G4a and G4b.

With the exception of Alternative G1, all of these alternatives (Alternatives G2b, G3, G4a and G4b) would be protective of human health and the environment and would meet the Remedial Action Objectives.

4.4.2 Compliance with ARARs

This criterion is used to assess how successful an alternative is in attaining action-, location- and chemical-specific ARARs and as such, is consistent with the Remedial Action Objectives for groundwater.

Chemical specific ARARs: It is anticipated that given adequate time, each of the alternatives would meet chemical-specific ARARs. Alternatives G1/G2b and G4b represent the ends of the spectrum in terms of time to achieve ARARs across the Site. Under Alternative G1, the time to achieve ARARs (estimated to be 110 years) is dependent entirely on natural attenuation and degradation of VOC concentrations. These natural processes would include dilution, dispersion, adsorption, and other physical, chemical and biological phenomena occurring in the water bearing unit and volatilization occurring at the ravine stream groundwater discharge points. Under Alternative G2b, the time to achieve ARARs (estimated to be 110 years) would result from active removal of groundwater as well as natural attenuation and degradation of VOC concentrations. The time to achieve ARARs would decrease with each of the Alternatives G3 (90 years), G4a (80 years) and G4b (60 years).

Location-specific ARARs: No location-specific ARARs are applicable to Alternatives G1 and G2b because no discharge of excess treated water is associated with these alternatives. If, under Alternatives G3, G4a and G4b, excess treated groundwater is discharged at Ravine 2a, the construction of an outfall structure at the head of a ravine stream would require substantive compliance with the Nationwide Program under the Clean Water Act. If excess treated groundwater is reinjected via site wells, substantive compliance with this Program would not be required.

Action-specific ARARs: No action-specific ARARs are applicable to Alternatives G1 and G2b because no discharge of excess treated water is associated with these alternatives. If, under Alternatives G3, G4a and G4b, excess treated groundwater is discharged at Ravine 2a, SPDES requirements would need to be met. If excess treated groundwater is reinjected via Site wells, substantive compliance with the UIC Program may be required in addition to compliance with SPDES permit requirements. It is likely that effluent standards required for discharge to Ravine 2a would be more stringent than for reinjection wells due to the consideration of protection to aquatic life. Variances to the effluent standards may be permitted if protection of human health and the environment can be demonstrated.

4.4.3 Long-Term Effectiveness and Permanence

This criterion is used to evaluate the residual long-term risks posed by the site and the long-term adequacy and reliability of controls.

Alternative G1, the No Action Alternative, is neither effective nor permanent because it would not prevent ingestion of impacted groundwater and it provides no mechanism for monitoring reduction of carbon tetrachloride, TCE or other VOCs over time. The remaining alternatives G2b, G3, G4a and G4b are equal with respect to long-term effectiveness and permanence, since each prevents ingestion of untreated groundwater and each includes provisions for monitoring the reduction of carbon tetrachloride, TCE and other VOCs over time.

4.4.4 Reduction of Toxicity, Mobility & Volume Through Treatment

This criterion is used to evaluate how well the alternative satisfies the regulatory preference towards treatment. The USEPA prefers a remedy that eliminates significant site threats through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of the total volume of contaminated media.

Alternatives G1 and G2b would reduce the toxicity, mobility or volume of the VOCs in groundwater through natural attenuation and degradation and through demand-only pumping of Site production wells (Alternative G2b only). Alternatives G3, G4a and G4b would reduce the mobility and volume of a significant portion of the groundwater containing carbon tetrachloride, TCE and other VOCs through pumping and on-site treatment..

4.4.5 Short-Term Effectiveness

This criterion is used to evaluate how effective an alternative is in mitigating immediate site hazards, and to determine whether implementation of the remedial action would result in risks to the community, workers or the environment.

Alternatives G1, G2b and G3 do not pose any short-term risks related to upgrading of the treatment system, since they include either no activities or use of an existing system. Alternatives G4a and G4b are equivalent for this criterion because they both include disassembly of the existing treatment system which could pose short-term risks associated with potential direct contact with packing material. These minor risks could be easily controlled with proper construction, and health and safety practices.

The time required to implement any of these alternatives is no greater than 4 to 6 months after contractor mobilization to the Site.

4.4.6 Implementability

This criterion is used to evaluate the ease with which an alternative can be constructed, operated, monitored, maintained, or upgraded, if necessary.

Alternatives G1 would not require any construction, operation or monitoring, therefore implementability does not apply. Alternatives G2b, G3 and G4a would make use of the existing wells, while Alternatives G2b and G3 would make use of the existing treatment system, thus making these alternatives easily implemented. Installation of new recovery wells (G4b), upgrading of the treatment system (G4a and G4b), and construction of a discharge system (G3, G4a and G4b) would require no specialty equipment or contractors and could be implemented using common construction practices.

4.4.7 Costs

This criterion is used to evaluate all costs and cost uncertainties associated with implementing and maintaining the remedial alternatives.

Table 4-1 is a summary of the costs for each of the groundwater alternatives. The increase in effectiveness (in terms of duration to remediate) provided by increased pumping rate is not supported by the relative increase in cost (i.e., Alternative G4b remediates the Site groundwater in half the time compared to Alternative G2b, but the present worth cost of Alternative G4b is five times greater than that of Alternative G2b.

4.4.8 State Acceptance

Formal comments relative to technical and administrative issues will be addressed at the completion of the FS, prior to the signing of the ROD.

The State is not likely to accept Alternative G1, the No Action Alternative because it is not protective of human health and the environment. The remaining alternatives would likely be acceptable because they would prevent ingestion of untreated groundwater and would therefore be protective of human health and the environment.

4.4.9 Community Acceptance

Community input on specific alternatives will be documented and addressed after a public comment period, and will be incorporated into the ROD.

The community may not accept Alternative G1, the No Action Alternative, because without the EWMS, protection of the nearby water supply wells would not be monitored. As described for State acceptance, the remaining alternatives would likely be acceptable because they would prevent ingestion of untreated groundwater.

4.5 Comparison of Soil Alternatives

This analysis provides a comparative assessment of the soil alternatives to evaluate the relative performance of each in relation to the specific evaluation criteria. The results of the individual analyses (Section 4.3) are used in this evaluation to determine which alternative best satisfies the evaluation criteria. The purpose is to identify the advantages and disadvantages of each alternative relative to one another so that the key tradeoffs that must be balanced can be identified.

The comparative analysis focuses mainly on those aspects of the alternatives that are unique for each. A summary of each of the criteria for each of the soil alternatives carried through the detailed analysis is provided on Table 4-12. This summary can be used to quickly compare the alternatives and facilitate selection of an appropriate remedy for affected soils at the MRFA Site.

4.5.1 Overall Protection of Human Health and the Environment

For all alternatives, the perimeter fence and restrictive easement provide some measure of protection of human health and the environment by limiting access to Building 23P and the Muggett's Pond Drainage Ditch intersection. Of the four remedial alternatives evaluated, Alternative S1, the No Action Alternative, is the least protective of human health and the environment as it does not prevent exposure or further reduce potential risks to human heath and the environment due to soil at Building 23P and Muggett's Pond Drainage Ditch intersection containing elevated levels of PCBs, lead, and/or mercury. Alternative S2 is marginally better than Alternative S1 in that it would serve to lower the potential for future risks to human health by limiting land use at areas around Building 23P and the Muggett's Pond Drainage Ditch intersection. However, like Alternative S1, Alternative S2 would not reduce existing risks on site. Alternative S3b would effectively isolate contaminated soils and greatly limit the potential for exposure. For this alternative, overall protection of human health and the environment is high compared to Alternatives S1 and S2. Under Alternative S4, potential risks resulting from exposure to mercury-contaminated soil (Muggett's Pond Drainage Ditch intersection), and PCB and lead-contaminated soils (Building 23P) would be eliminated. The soils would be excavated, transported off-site, treated (if necessary), and disposed in an appropriate permitted waste facility. Site-specific cleanup objectives for PCBs, mercury and lead would be met in the areas excavated.

4.5.2 Compliance with ARARs

Compliance with ARARs is similar for all alternatives. PCB concentrations at Building 23P are below the TSCA cleanup standard for PCBs (25 ppm) in restricted access areas, and no chemical-specific ARARs exist for mercury or lead in soil.

To be considered (TBC) and site-specific cleanup values exist for mercury and lead. The TBCs are 0.1 ppm and site background and the site-specific values are 2 ppm and 1000 ppm, respectively, for mercury and lead. Alternatives S1, S2, and S3 would not meet either set of values, as no soils would be excavated and removed from the Site. Alternative S4 would not meet the generic and more conservative TBC values that are appropriate for residential settings, but would meet the site-specific cleanup goals that are appropriate for the industrial setting of the Site. Action-specific ARARs for transport, handling and disposal of specific ARARs for transport, handling and disposal of affected Site soils would be met for Alternative S4.

4.5.3 Long-Term Effectiveness and Permanence

Alternative S1 is neither effective nor permanent since the residual long-term risks due to exposure to contaminated soils at the Building 23P and Muggett's Pond Drainage Ditch intersection would not be reduced. With Alternative S2, long-term risks due to exposure to contaminated soils would be reduced, but not eliminated. Alternative S3b is more effective in reducing long term residual risks since contaminated soils would be isolated. However, because this alternative relies on isolation rather than removal of contaminated soil, cap demarcation and maintenance would be required to ensure its integrity (permanence). Under Alternative S4, long-term residual risks due to exposure to contaminated soils would be eliminated. Disposal of the contaminated soils in a permitted off-site facility effectively and permanently removes the contaminants from potential receptors.

4.5.4 Reduction of Toxicity, Mobility and Volume Through Treatment

Since neither Alternatives S1 nor S2 involve any type of treatment for affected soils around Building 23P or for the soils in the Muggett's Pond Drainage Ditch intersection, these alternatives would not reduce the toxicity, mobility or volume of affected soils. Alternative S3b involves the installation of an asphalt cap over the affected soil regions of both the area around building 23P and the Muggett's Pond Drainage Ditch intersection. With this alternative, a reduction in contaminant mobility, primarily by wind and water erosion, would be greatly reduced. As the contaminated materials are not treated or removed, there is no reduction in the toxicity or volume of the contamination. Alternative S4 provides the greatest reduction in toxicity, mobility and volume of Site contaminants by removal of affected soils to a secure landfill facility. Reduction in mobility of contaminants would be achieved by encapsulation in a secure landfill. Toxicity of mercury affected soils is reduced through pre-treatment stabilization prior to land burial and since all affected soils are removed, the volume of contaminants left on Site is greatly reduced.

4.5.5 Short-Term Effectiveness

No short-term impacts to human health or the environment would result from Alternatives S1 and S2 since no construction, treatment, removal or transport of affected soils would take place. Under Alternative S3b, impacts to the community would be minimal since the Site is isolated and no materials would be transported off-site. Since actions would be taken not to disturb the affected soils while installing an asphalt cap, implementation would pose minimal risks to workers. This alternative could be implemented in a short period of time and due to the small areas involved, pose only minor risk to the environment. Alternative S4 also poses only minimal risk to the community, since off-site transport of affected soils would be limited to a few truckloads. Properly fitting workers with personal protective equipment during excavation, transport and disposal mitigate exposure risks, and since the areas affected are small, and implementation time is short, the environmental impacts would be similar to Alternative S3b.

4.5.6 Implementability

Alternatives S1 and S2 are readily implementable since no construction or Site activities are part of these alternatives. Both Alternatives S3b and S4 could be implemented with little or no difficulty using readily available materials, equipment, and construction practices.

4.5.7 Cost

Table 4-7 provides a summary of the costs for each of the soil alternatives.

4.5.8 State Acceptance

The NYSDEC may not accept Alternative S1, No Action, since it is not protective of human health and the environment and does not achieve site-specific cleanup goals. Similarly, it may not accept Alternative S2, since this alternative also does not achieve site-specific cleanup goals nor does it isolate contaminated soils to reduce exposure potential. The State has previously accepted reliable cover systems, such as provided by Alternative S3b, as a means to isolate contaminants from exposure pathways. Since the Site contaminants are not a threat to groundwater and the cap provides an isolation barrier to the environment, it should be acceptable to the State, along with an outlined maintenance obligation and deed restrictions. Alternative S4 would likely be acceptable to the State since it would achieve site-specific cleanup goals and the remedial action objectives.

4.5.9 Community Acceptance

Alternative S1, No Action, may not achieve community acceptance because soils posing unacceptable potential risks to human health and the environment would remain accessible on site. Alternative S2 may achieve community acceptance based on the institutional controls selected. Alternative S3b would likely achieve community acceptance since it would meet the remedial objectives. Similarly, Alternative S4 would likely be acceptable to the community, since contaminated surface soil at Building 23P and Muggett's Pond Drainage Ditch intersection above specified cleanup levels would be removed from the Site.

4.6 Recommended Alternatives

4.6.1 Groundwater

The recommended remedial alternative for groundwater is Alternative G2b, Continue Existing System with Institutional Controls. This recommendation is based on the RI findings, the conclusions in the RA, and the evaluation conducted in this FS.

The RI Report identified the nature and extent of contamination at the site. The contaminated groundwater occurs in a well-defined flow zone originating at the Malta Test Station and approaching or discharging at the nearby ravines where the VOCs are naturally stripped through volatilization processes. The RI further indicates that compared to historic levels, concentrations of VOCs in groundwater are decreasing. The analytical data collected during the RI indicates that the source area of concern that appears to have contributed the majority of constituents to the groundwater in the past (Area D-1) may be depleted and no longer contributing constituents to groundwater. The local hydrogeologic conditions, including the presence of low permeability Lake Albany clay and silt underlying the Site and laterally discontinuous water bearing zones, prevent hydraulic connection between the water bearing material beneath the Site and the public water supply aquifers located approximately one mile from the Site. Finally, the ongoing EWMS provides an effective mechanism for the long-term monitoring of groundwater and surface water to verify and document that the MRFA Site groundwater plume is not migrating to the well field aquifers.

The RA concluded that exposure to treated groundwater does not present an unacceptable risk to human health under current and reasonable future land use scenarios. However, the RA also indicates that exposure to untreated groundwater would result in an unacceptable risk to human health.

Based on the RA conclusions, the FS identifies appropriate groundwater remedial action objectives, screens a range of groundwater remedial technologies and alternatives, and evaluates the alternatives that passed the screening process. The evaluation conducted confirms that Alternative G2b would be effective in achieving the remedial action objectives. It would be equally as protective of human health as the more aggressive pump and treat alternatives evaluated (Alternatives G3, G4a and G4b), since ingestion of groundwater with VOCs above current federal drinking water standards and/or New York State groundwater standards would be prevented through the current on-site groundwater treatment and EWMS monitoring systems, and additional deed restrictions. The one-mile restrictive easement would also limit or prevent development (i.e., the potential for installation of private drinking water wells) in the area surrounding the Site. The deed restriction would restrict, as appropriate, future use of groundwater in and immediately adjacent to the affected portion of the site.

Attainment of groundwater standards (ARARs) across the Site would eventually occur as a result of natural flushing. The concentrations of VOCs in groundwater would be reduced through natural attenuation and degradation processes (such as dilution, dispersion, adsorption and possibly biological and chemical degradation) as groundwater flows through the Test Station toward nearby ravines. VOCs would be further removed at the ravines, which serve as discharge points for the water bearing zone, through volatilization. The effectiveness of these natural processes will continue to be adequately monitored through the EWMS. The duration of remediation (i.e., the time to achieve ARARs) was evaluated with groundwater modeling and found to be approximately 110 years.

Alternative G2b is equal to other more aggressive pump and treat alternatives (Alternatives G3, G4a and G4b) with respect to long-term effectiveness and permanence, since each prevents ingestion of untreated groundwater and each includes provisions for monitoring the reduction of VOCs in groundwater over time. The effectiveness of the existing treatment system has been demonstrated. Under existing water use and pumping requirements, the wells capture only a small portion of the plume, but this portion contains some of the highest concentrations of VOCs observed on-site. The lobate shape of the VOC plume reported in the RI attests to the effectiveness of past on-demand pumping in attenuating groundwater VOCs. The pumping rate is less now than it was in the past, but natural attenuation and degradation are providing an effective remediation system. As noted previously, the ongoing EWMS provides an effective mechanism for the long-term monitoring of groundwater and surface water to verify and document that the MRFA Site groundwater plume is terminating in the upper reaches of the ravines and is not migrating to the well field aquifer.

Alternative G2b would reduce the toxicity, mobility and volume of VOCs in groundwater largely through natural attenuation and degradation, and to a more limited extent, through on-demand pumping and treating water from Site production wells. Alternative G2b would not pose any short-term risks, since it involves use of an existing system, and there would be no associated construction impacts. It is easily implemented since it makes use of the existing water supply wells and treatment system, and the existing EWMS.

Present value costs (5% discount rate) to implement this alternative for thirty years are estimated at $269,900, significantly lower than the more aggressive pump and treat alternatives. Therefore, this alternative is cost-effective relative to other alternatives.

Formal State or community input relative to technical and administrative issues will be addressed at the completion of the FS and/or following a public comment period, prior to the signing of the ROD. Alternative G2b should be acceptable to both the State and the community because it would achieve the remedial action objectives and prevent ingestion of untreated groundwater.

In conclusion, Alternative G2b is equally as protective of human health and the environment as the more aggressive pump and treat alternatives, and like those alternatives, Alternative G2b would achieve ARARs, provide long-term effectiveness and permanence, and reduce the toxicity, mobility and volume of VOCs in groundwater. Although the time to achieve ARARs would be longer than with the more aggressive alternatives, Alternative G2b would not pose any short-term risks, is easily implemented, and it is significantly more cost-effective than the more aggressive pump and treat alternatives. Therefore, selection of Alternative G2b is recommended.

4.6.2 Soil

The recommended remedial alternative for soil is Alternative S4, Excavation and Off-site Disposal. This recommendation is based on the RI findings, the conclusions in the RA, and the evaluation conducted in this FS.

Based on the RI and RA results, remediation of surface soil at two specific locations is warranted. The RI indicated that the Building 23P area contains elevated concentration of PCBs. In the RA, the risks associated with exposure to soils were evaluated both excluding the Building 23P samples and including the Building 23P samples. The Malta PPs and USEPA agreed that remediation of surface soil in this area would be appropriate. Similarly, remediation of surface soil at the Muggett's Pond Drainage Ditch intersection, which had elevated concentrations of mercury, was also assumed in the RA, since mercury is known to biomagnify in terrestrial food chains. After assuming remediation of the surface soil at both of these areas, the RA found that remaining site soils do not pose an unacceptable risk to human health or the environment for present and future exposure scenarios.

Based on the RA conclusions, the FS identifies appropriate soil remedial action objectives, screens a range of soil remedial technologies and alternatives, and evaluates the alternatives that passed the screening process. The evaluation conducted confirms that Alternative S4 would be effective in achieving the remedial action objectives.

Under Alternative S4, potential risks resulting from exposure to mercury-contaminated soil (Muggett's Pond Drainage Ditch intersection) and PCB-contaminated soils (Building 23P) would be eliminated. The soils would be excavated, transported off-site, treated (if necessary), and disposed in an appropriate permitted waste facility. Site-specific cleanup goals for PCBs and mercury would be met in the areas excavated. Therefore, Alternative S4 is protective of human health and the environment.

PCB concentrations at Building 23P are below the cleanup standard under TSCA for restricted access industrial areas (25 ppm). Chemical-specific promulgated federal or State ARARs for other soil constituents of concern (mercury and lead) do not exist. Under Alternative S4, PCB- and/or mercury-containing soils at the Building 23P area and the Muggett's Pond Drainage Ditch intersection would be excavated and removed from the Site, and therefore, the soil cleanup levels for these areas would be met. Action-specific ARARs for transport, handling and disposal of affected Site soils would be met for Alternative S4.

Alternative S4 reduces toxicity, mobility and volume of Site contaminants by removal of affected soils from Building 23P and the Muggett's Pond Drainage Ditch intersection to a secure landfill facility. Reduction in mobility of contaminants would be achieved by encapsulation in a secure landfill. Toxicity of mercury affected soils is reduced through pre-treatment stabilization prior to land burial. Since the affected soils from Building 23P and the Muggett's Pond Drainage Ditch intersection would be removed from the Site, the volume of contaminants left on Site would be greatly reduced.

Alternative S4 would also pose only minimal short term risk to the community, since off-site transport of affected soils would be limited to a few truckloads. Properly fitting workers with personal protective equipment during excavation, transport and disposal would mitigate exposure risks, and since the areas affected are small and the implementation time is short, the environmental impacts would be minimal. This alternative could be implemented with little or no difficulty using readily available materials, equipment, and construction practices.

Costs (5% discount rate) to implement this alternative are estimated at $25,100, lower than Alternative S3b ($42,400). Therefore, this alternative is more cost-effective.

Formal State or community input relative to technical and administrative issues will be addressed at the completion of the FS and/or following a public comment period, prior to the signing of the ROD. Alternative S4 would likely be acceptable to the State since it would achieve site-specific cleanup goals and the remedial action objectives.

In conclusion, Alternative S4 is protective of human health and the environment and it would achieve ARARs, provide long-term effectiveness and permanence, and reduce the toxicity, mobility and volume of PCBs and mercury in soil. Alternative S4 would result in only minimal short-term risk to the community, it would be easily implemented, and it is cost-effective. Therefore, selection of Alternative S4 is recommended.

TABLE 4-1

Summary
Groundwater Remedial Alternatives Durations (1)
Malta Rocket Fuel Area Site

Groundwater Remedial Alternative		No. of Recovery Wells Pumped	System Pumping Rate		Duration to Remediate (3)
G1	No Action (Natural Flushing)	0	0	gpm	110 yrs
G2b:	Continue Existing System System	2	0.6	gpm	110 yrs
G3:	Maximize Existing System (2)	1	25	gpm	90 yrs
G4a:	Upgrade Treatment System (2)	2	75	gpm	80 yrs
G4b:	Upgrade Wells and Treatment System (2)	4	140	gpm	60 yrs

Notes:

(1) Remediation times are estimates based on the assumption of advective contaminant flow and the model input parameters listed below. These times are intended to provide a relative comparison of the remedial alternatives evaluated. Actual clean-up times may be longer or shorter than those listed.

(2) Includes recharge of recovered and treated groundwater.

(3) Time for groundwater to reach ARARs as a result of natural flushing and active pumping, where applicable.

Groundwater Model Input Parameters:

I (infiltration recharge) = 12 in/yr
K (hydraulic conductivity) = 10 ft/day
R (retardation factor) = 2
n (effective porosity) = 0.2

TABLE 4-2
Summary of Estimated Costs for Groundwater Alternatives
Malta Rocket Fuel Area Site

	Alternative G1	Alternative G2b	Alternative G3	Alternative G4a	Alternative G4b
	No Action	Continue Existing System*	Maximize Existing System*	Upgrade Treatment System*	Upgrade Wells and Treat. System*
Capital Costs:	-	$7,000	$247,200	$348,700	$649,600
Annual O&M Costs:	-	$17,100	$46,200	$47,600	$51,800
Present Worth Costs:					
3% discount rate		$342,900	$1,154,700	$1,283,700	$1,667,100
5% discount rate		$269,900	$957,400	$1,080,400	$1,445,900
8% discount rate	-	$199,500	$767,300	$884,600	$1,232,800

Note:

* Includes deed restrictions.

1. There are no costs directly associated with Alternative G1 (No Action).
2. Present worth costs are calculated based on 30 years of operation and maintenance.
3. Costs associated with any necessary predesign studies are not included.

TABLE 4-3
Cost Estimate
ALTERNATIVE G2b: Continue Existing System with Institutional Controls

	Item	Quant.	Unit Cost	Unit	Cost	Refer. (See App. F)
	Direct Capital Costs:					
1	Deed Restriction		$5,000	ls	$5,000	A-1.1
	Total Direct Costs				$5,000	
	Indirect Capital Costs:					
1	Engineering (20% of total direct costs)				$1,000	A-1.2
2	Contingency (20% of total direct costs)				$1,000	A-1.5
	Total Indirect Costs				$2,000	
	TOTAL CAPITAL COSTS				$7,000	
	Annual O & M Costs:					
1	EWMS sampling and analysis		$12,500	ls	$12,500	B-1.1
2	Treatment system O&M		$3,200	ls	$3,200	B-2.1
3	Well maintenance	2	$700	well	$1,400	B-3.1
	Total Annual O&M Costs				$17,100	
	Present Worth Costs:					
1	Present Worth of Annual O&M Costs (5% discount rate, 30 years)				$262,900	B-5.1
2	Total Capital Costs				$7,000	
	TOTAL PRESENT WORTH				$269,900	

The above table represents the estimated costs associated with continuing current (as needed) pumping of wells 1D and 2D for on-site water supply, and maintenance of the existing air stripper water treatment system.
ls = lump sum

TABLE 4-4
Cost Estimate
ALTERNATIVE G3: Manage Plume by Maximizing Existing System (with Institutional Controls)

	Item	Quant.	Unit Cost	Unit	Cost	Refer.
	Direct Capital Costs:					
1	Deed Restriction		$5,000	ls	$5,000	A-1.1
2	Eval. & Rehabilitate prod. wells 1D and 2D	2	$7,000	well	$14,000	A-2.1
3	Rehabilitate treatment system		$5,000	ls	$5,000	A-3.1
4	Treatment system start-up		$30,000	ls	$30,000	A-3.2
5	Discharge piping to reinjection points*	1,500	$21	lf	$31,500	A-4.1
6	Install 2 reinjection wells*	2	$15,000	well	$30,000	A-4.2
7	Baseline monitoring		$55,000	ls	$55,000	A-5.1
	Total Direct Costs				$170,500	
	Indirect Capital Costs:					
1	Engineering (25% of total direct costs)				$42,600	A-1.2
2	Contingency (20% of total direct costs)				$34,100	A-1.5
	Total Indirect Costs				$76,700	
	TOTAL CAPITAL COSTS				$247,200	
	Annual O & M Costs:					
1	EWMS sampling and analysis		$12,500	ls	$12,500	B-1.1
2	Treatment system O&M		$24,100	ls	$24,100	B-2.2
3	Well maintenance (4 wells total)	4	$700	well	$2,800	B-3.1
4	Performance monitoring		$6,800	ls	$6,800	B-1.2
	Total Annual O&M Costs				$46,200	
	Present Worth Costs:					
1	Present Worth of Annual O&M Costs (5% discount rate, 30 years)				$710,200	B-5.1
2	Total Capital Costs				$247,200	
	TOTAL PRESENT WORTH				$957,400	

The above table represents the estimated costs associated with maximizing the exisiting extraction wells and air stripper system (manufacturer recommended capacity is 25 gpm). Treated water would be reinjected* into wells located to the west of Site. Costs do not include predesign studies that may be necessary.

* Reinjection wells are assumed for the purposes of the cost estimate. Actual recharge system may consist of infiltration trenches or another appropriate technology.

ls = lump sum; lf = lineal feet

TABLE 4-5
Cost Estimate
ALTERNATIVE G4a: Manage Plume by Upgrading Existing System (Using 2 Existing Supply Wells and New Air Stripper) with Institutional Controls

	Item	Quant.	Unit Cost	Unit	Cost	Refer. (See App. F)
	Direct Capital Costs:					
1	Deed Restriction		$5,000	ls	$5,000	A-1.1
2	Eval. & Rehabilitate prod. wells 1D and 2D	2	$7,000	well	$14,000	A-2.1
3	Upgrade treatment system		$45,000	ls	$45,000	A-3.1
4	Treatment system start-up		$30,000	ls	$30,000	A-3.2
5	Discharge piping to reinjection points*	1,500	$21	lf	$31,500	A-4.1
6	Install 4 reinjection wells*	4	$15,000	well	$60,000	A-4.2
7	Baseline monitoring		$55,000	ls	$55,000	A-5.1
	Total Direct Costs				$240,500	
	Indirect Capital Costs:					
1	Engineering (25% of total direct costs)				$60,100	A-1.2
2	Contingency (20% of total direct costs)				$48,100	A-1.5
	Total Indirect Costs				$108,200	
	TOTAL CAPITAL COSTS				$348,700	
	Annual O & M Costs:					
1	EWMS sampling and analysis		$12,500	ls	$12,500	B-1.1
2	Treatment system O&M		$24,100	ls	$24,100	B-2.2
3	Well maintenance (6 wells total)	6	$700	well	$4,200	B-3.1
4	Perfomance monitoring		$6,800	ls	$6,800	B-1.2
	Total Annual O&M Costs				$47,600	
	Present Worth Costs:					
1	Present Worth of Annual O&M Costs (5% discount rate, 30 years)				$731,700	B-5.1
2	Total Capital Costs				$348,700	
	TOTAL PRESENT WORTH				$1,080,400	

The above table represents the estimated costs associated with upgrading the air stripper system to a 100 gpm capacity, 2 ft diameter packed tower. Treated water would be reinjected* into wells located to the west of the Site. Costs do not include predesign studies that may be necessary.

* Reinjection wells are assumed for the purposes of the cost estimate. Actual recharge system may consist of infiltration trenches or another appropriate technology.

ls = lump sum; lf = lineal feet

TABLE 4-6
Cost Estimate
ALTERNATIVE G4b: Manage Plume by Upgrading the Existing System (Using 4 Recovery Wells and New Air Stripper) with Institutional Controls

	Item	Quant.	Unit Cost	Unit	Cost	Refer. (See App. F)
	Direct Capital Costs:					
1	Deed Restriction		$5,000	ls	$5,000	A-1.1
2	Eval. & Rehabilitate prod. wells 1D and 2D	2	$7,000	well	$14,000	A-2.1
3	Add 2 new recovery wells	2	$15,000	each	$30,000	A-2.3
4	Pump, controls & apert. per well	4	$4,000	each	$16,000	A-2.4
5	Discharge piping from wells to treat. sys.	2,000	$15	lf	$30,000	A-2.4
6	Perform step-rate pump test in 2 new wells	2	$4,000	well	$8,000	A-2.2
7	Upgrade treatment system		$50,000	ls	$50,000	A-3.1
8	Treatment system start-up		$30,000	ls	$30,000	A-3.2
9	Discharge piping to reinjection points*	6,000	$15	lf	$90,000	A-4.1
10	Install 8 reinjection wells*	8	$15,000	well	$120,000	A-4.2
11	Baseline monitoring		$55,000	ls	$55,000	A-5.1
	Total Direct Costs				$448,000	
	Indirect Capital Costs:					
1	Engineering (25% of total direct costs)				$112,000	A-1.2
2	Contingency (20% of total direct costs)				$89,600	A-1.5
	Total Indirect Costs				$201,600	
	TOTAL CAPITAL COSTS				$649,600	
	O & M Costs:					
1	EWMS sampling and analysis		$12,500	ls	$12,500	B-1.1
2	Treatment system O&M		$24,100	ls	$24,100	B-2.2
3	Well maintenance (12 wells total)	12	$700	well	$8,400	B-3.1
4	Perfomance monitoring		$6,800	ls	$6,800	B-1.2
	Total Annual O&M Costs				$51,800	
	Present Worth Costs:					
1	Present Worth of Annual O&M Costs (5% discount rate, 30 years)				$796,300	B-5.1
2	Total Capital Costs				$649,600	
	TOTAL PRESENT WORTH				$1,445,900	

The above table represents the estimated costs associated with installing two additional extraction wells and upgrading the air stripper water treatment system to a 200 gpm capacity, 3 ft diameter packed tower. Treated water would be reinjected*. Costs do not include predesign studies that may be necessary.

* Reinjection wells are assumed for the purposes of the cost estimate. Actual recharge system may consist of infiltration trenches or another appropriate technology.

ls = lump sum; lf = lineal feet

TABLE 4-7
Summary of Estimated Costs for Soil Alternatives
Malta Rocket Fuel Area Site

	Alternative S1	Alternative S2	Alternative S3b	Alternative S4
	No Action	Institut. Controls	Asphalt Cap/ Surface Controls	Excavation and Off-Site Disposal
Capital Costs:	-	$16,800	$27,000	$25,100
Annual O&M Costs:	-	$0	$1,000	$0
Present Worth Costs:		$16,800		$25,100
3% discount rate	-		$46,600	
5% discount rate	-		$42,400	
8% discount rate	-		$38,258	

Notes:

1. There are no costs directly associated with Alternative S1 (No Action). There may be unquantifiable costs associated with losses due to deed restrictions.
2. Present worth costs were calculated based on 30 years of operation.

TABLE 4-8
Cost Estimate
ALTERNATIVE S2: Institutional Controls

	Item	Quant.	Unit Cost	Unit	Cost	Refer. (See App. F)
	Direct Capital Costs:					
1	Deed Restrictions		$12,000	ls	$12,000	A-1.1
	Total Direct Costs				$12,000	
	Indirect Capital Costs:					
1	Engineering (20% of total direct costs)				$2,400	A-1.2
2	Contingency (20% of total direct costs)				$2,400	A-1.5
	Total Indirect Costs				$4,800	
	TOTAL CAPITAL COSTS				$16,800	
	TOTAL PRESENT WORTH				$16,800	

The above cost table represents those costs associated with legal fees, surveys, and consultant fees for setting up deed restrictions for that portion of the site affected by soil associated contamination.

ls = lump sum

TABLE 4-9
Cost Estimate
ALTERNATIVE S3b: Installation of an Asphalt Cap/ Surface Controls

	Item	Quant.	Unit Cost	Unit	Cost	Refer. (See App. F)
	Direct Capital Costs:					
1	Deed Restrictions		$12,000	ls	$12,000	A-1.1
2	Mobilization/Demobilization		$500	ls	$500	A-1.3
3	Bituminous Asphalt Cap (1" sub., 3 " surface)	200	$6	sf	$1,200	A-5.1x
4	Health and Safety		$500	ls	$500	A-1.4
	Total Direct Costs				$14,200	
	Indirect Capital Costs:					
1	Engineering (lump sum)				$10,000	A-1.2
2	Contingency (20% of total direct costs)				$2,800	
	Total Indirect Costs				$12,800	
	TOTAL CAPITAL COSTS				$27,000	
	Annual O & M Costs:					
1	Cap Repair and Maintanence		$1,000	ls	$1,000	B-4.1
	Total Annual O&M Costs				$1,000	
	Present Worth Costs:					
1	Present Worth of Annual O&M Costs (5% discount rate, 30 years)				$15,400	B-5.1
2	Total Capital Costs				$27,000	
	TOTAL PRESENT WORTH				$42,400	

The above table represents costs associated with asphalting areas of PCB contamination around Building 23P and mercury-affected areas in the MPDD intersection.
Capping will be constructed to allow for drainage in the affected areas.

MPDD = Muggett's Pond Drainage Ditch
ls = lump sum; sf = square foot

TABLE 4-10
Cost Estimate
ALTERNATIVE S4: Excavation and Off-Site Disposal

	Item	Quant.	Unit Cost	Unit	Cost	Refer. (See App. F)
	Direct Capital Costs:					
1	Mobilization/Demobilization		$700	ls	$700	A-1.3
2	Construct soil staging areas		$1,000	ls	$1,000	A-6.1
3	Excavation and handling of PCB contaminated soils (Bldg. 23P)	5	$60	cy	$300	A-6.2
4	Confirmatory soil sampling					
	a) total PCBs (EPA Method 8080)	4	$150	sample	$600	A-6.3
5	Transport of Bldg. 23 P waste (6.5 tons / 20 ton truck)	1	$1,100	20 ton truck	$1,100	A-6.4
6	Disposal of Bldg. 23P waste (6.5 tons @ $300/ton)	6.5	$300	ton	$1,950	
7	Hand excavation and handling of mercury contaminated soils, MPDD intersection	3.0	$150	cy	$450	A-6.2
8	Confirmatory soil sampling					
	a) metal - mercury (SW8 7470)	15	$35	sample	$525	A-6.3
9	Transport and disposal of MPDD inter. waste (est.4 tons soil, 20 ton min. charge for T&D)	1	$4,800	20 ton truck load	$4,800	A-6.4
10	Backfill excavated areas (Bldg. 23P)					
	(clean compacted fill, on-site source)	5	$35	cy	$175	A-6.5
11	Health and safety facilities (decon)		$1,000	ls	$1,000	A-1.4
	Total Direct Costs				$12,600	
	Indirect Capital Costs:					
1	Engineering (lump sum)				$10,000	A-1.2
2	Contingency (20% of total direct costs)				$2,500	A-1.5
	Total Indirect Costs				$12,500	
	TOTAL CAPITAL COSTS				$25,100	
	TOTAL PRESENT WORTH				$25,100	

The above cost table represents costs associated with the excavation of PCB affected soils around Building 23P and mercury affected areas in the MPDD intersection.

Transportation and disposal costs of all waste soils are based upon burial at Model City, NY. , a RCRA and TSCA-approved landfill.

MPDD intersection soil removal costs are based upon concrete drainway being intact and confirmatory testing of residuals on the base of the drainway being below regulatory levels.

MPDD = Muggett's Pond Drainage Ditch

ls = lump sum; cy = cubic yard

Table 4-11
Comparative Analysis of Groundwater Remedial Alternatives
Malta Rocket Fuel Area Site

	Alternative G1 No Action	Alternative G2b Continue Existing System	Alternative G3 Manage Plume by Maximizing Existing System	Alternative G4a Manage Plume by Upgrading Existing System (New Air Stripper)	Alternative G4b Manage Plume by Upgrading Existing System (2 New Recovery Wells, New Air Stripper)
Overall Protectiveness of Human Health and the Environment	No means of monitoring the distribution or migration of VOCs in groundwater. Therefore, the reduction of potential long-term risks, resulting from natural degradation and attenuation of VOCs, could not be monitored.	Ingestion of untreated groundwater would be prevented through deed restrictions, one-mile restrictive easement, EWMS monitoring and treatment system monitoring.	Same as G2.	Same as G2.	Same as G2.
Compliance with ARARs	Attainment of NYSDEC groundwater standards across the Site would occur on the order of 110 years as a result of natural dilution, dispersion and degradation of VOCs over time. This alternative would provide no means of monitoring reduction in VOC levels.	Attainment of NYSDEC groundwater standards across the Site would occur on the order of 110 years as a result of continued pumping and natural dilution, dispersion and degradation of VOCs over time.	By maximizing the existing system, attainment of standards would be achieved through increased pumping (25 gpm) and natural dilution, dispersion and degradation of VOCs over time. Groundwater is estimated to reach standards across the Site in approximately 90 years.	By upgrading the treatment system, attainment of standards would be achieved through increased pumping (75 gpm) and natural dilution, dispersion and degradation of VOCs over time. Groundwater is estimated to reach standards across the Site in approximately 80 years.	By installing two wells and upgrading the treatment system, attainment of standards would be achieved through increased pumping (140 gpm) and natural dilution, dispersion and degradation of VOCs over time. Groundwater is estimated to reach standards across the Site in approximately 60 years.

Table 4-11
Comparative Analysis of Groundwater Remedial Alternatives
Malta Rocket Fuel Area Site

	Alternative Gl No Action	Alternative G2b Continue Existing System	Alternative G3 Manage Plume by Maximizing Existing System	Alternative G4a Manage Plume by Upgrading Existing System (New Air Stripper)	Alternative G4b Manage Plume by Upgrading Existing System (2 New Recovery Wells, New Air Stripper)
Long-term Effectiveness and Permanence	Without monitoring, this alternative provides no means for evaluating long-term effectiveness or permanence.	The decrease of VOC concentrations over time observed at the production wells indicates that natural flushing of the water bearing zone would improve groundwater quality. EWMS and treatment system influent monitoring would ensure long-term protection to potential off-site receptors and provide a basis for evaluating groundwater quality enhancements. Deed restrictions would prevent ingestion of untreated water.	Same as G2 with the added benefit that performance monitoring would allow better evaluation of the reduction of VOC concentrations in groundwater.	Same as G3.	Same as G3.
Reduction of Toxicity, Mobility & Volume Through Treatment	No reduction in toxicity, mobility or volume other than through natural degradation and attenuation.	Continued pumping and natural degradation and attenuation would contribute to the reduction of the toxicity, volume, and mobility of the VOCs in groundwater.	Same as G2, except the increase in pumping rate would better control the mobility of VOCs in groundwater and contribute to reducing the volume and toxicity of contaminated groundwater in a shorter time period.	Same as G3, only the control and the rate of reduction would be increased.	Same as G4a.
Short-term Effectiveness	Discontinuing pumping from the Site water supply wells would impact site operations. Alternate water supplies would have to be developed. Since no activities are proposed, no associated short-term risks would be created.	This alternative would cause no short-term risks.	Same as G2.	Same as G2.	Same as G2.

Table 4-11
Comparative Analysis of Groundwater Remedial Alternatives
Malta Rocket Fuel Area Site

	Alternative G1 No Action	Alternative G2b Continue Existing System	Alternative G3 Manage Plume by Maximizing Existing System	Alternative G4a Manage Plume by Upgrading Existing System (New Air Stripper)	Alternative G4b Manage Plume by Upgrading Existing System (2 New Recovery Wells, New Air Stripper)
Implementability	This alternative could not be readily implemented unless operations on the Site were discontinued. Otherwise water supply would be required from an off-site source.	This alternative is readily implementable.	Same as G2.	This alternative would require construction of a new air stripping system to accommodate higher pumping rates. The required equipment is readily available.	Same as G4a.
Cost	Costs relative to loss of operation or accessing an off-site water supply have not been calculated but would be sizable.	Capital: $7,000 Annual O&M: $17,100 Present Worth: $269,900 (based on a 5% discount rate over 30 years)	Capital: $247,200 Annual O&M: $46,200 Present Worth: $957,400 (based on a 5% discount rate over 30 years)	Capital: $348,700 Annual O&M: $47,600 Present Worth: $1,080,400 (based on a 5% discount rate over 30 years)	Capital: $649,600 Annual O&M: $51,800 Present Worth: $1,445,900 (based on a 5% discount rate over 30 years)
State Acceptance	The NYSDEC may not accept this alternative because without the EWMS, protection of human health and the reduction of VOC concentrations (to eventually meet ARARs) could not be adequately monitored.	Since this alternative would be protective of human health , it would likely be acceptable to the State.	The added protection provided by aggressive active plume management and the enhanced cleanup time would likely be acceptable to the State.	Same as G3.	Same as G3.
Community Acceptance	This alternative may not achieve community acceptance. Without the EWMS, protection of the nearby water supply wells would not be adequately monitored.	Since this alternative would meet the remedial action objectives, it would likely be acceptable to the community.	The added protection provided by aggressive active plume management would likely be acceptable to the community.	Same as G3.	Same as G3.

Table 4-12
Comparative Analysis of Soil Remedial Alternatives
Malta Rocket Fuel Area Site

	Alternative S1 No Action	Alternative S2 Institutional Controls	Alternative S3b Asphalt Capping/Surface Controls	Alternative S4 Excavation and Off-Site Disposal
Overall Protectiveness of Human Health and the Environment	Access within the one-mile restrictive easement is limited. Access is also currently restricted by fencing around the test station perimeter. Access by site workers and wildlife to Building 23P and Muggett's Pond Drainage Ditch intersection is unrestricted. There is no significant reduction in potential risks to human health and the environment with this alternative. Site specific cleanup objectives would not be met, as no removal or treatment of contaminated soil is proposed.	This alternative would not reduce existing risks on Site. It would serve to lower the potential for future risks to human health by limiting land use at areas around Building 23P and the Muggett's Pond Drainage Ditch intersection.	This alternative would effectively isolate contaminated soils and greatly limit the potential for exposure. Overall protection of human health and the environment is high compared to Alternatives S1 and S2.	Potential risks resulting from exposure to mercury -contaminated (Muggett's Pond Drainage Ditch intersection) and PCB and lead-contaminated soils (Building 23P) would be eliminated under this alternative. The soils would be excavated, transported off-site, treated (if necessary), and disposed in an appropriate permitted waste facility. Site specific cleanup objectives for PCBs and mercury would be met. This alternative provides the highest level of overall long-term protection to human health and the environment.
Compliance with ARARs	PCB concentrations at Building 23P are below cleanup standards under TSCA for unrestricted or restricted access industrial areas. Chemical-specific ARARs for other soil constituents of concern (mercury and lead) do not exist.	Same as S1.	Same as S1.	Same as S1.
Long Term Effectiveness and Permanence	Long-term risks due to exposure to contaminated soils at the Building 23P area and Muggett's Pond Drainage Ditch intersection would not be reduced.	Long-term risks due to exposure to contaminated soils at the Building 23P area and Muggett's Pond Drainage Ditch intersection would be reduced, but not eliminated.	Because this alternative relies on isolation rather than removal of contaminated soil, cap demarcation and maintenance would be required to ensure its integrity, as well as restriction of future land use.	Long-term risks due to exposure to contaminated soils would be eliminated with this alternative. Disposal of the contaminated soils in a permitted off-site facility effectively removes the contaminants from potential receptors.

Table 4-12
Comparative Analysis of Soil Remedial Alternatives
Malta Rocket Fuel Area Site

	Alternative S1 No Action	Alternative S2 Institutional Controls	Alternative S3b Asphalt Capping/Surface Controls	Alternative S4 Excavation and Off-Site Disposal
Reduction of Toxicity, Mobility & Volume Through Treatment	This alternative would not reduce the toxicity, mobility or volume of contaminated soils.	Same as S1.	A reduction in contaminant mobility (primarily by wind and water erosion) would be achieved by installation of an asphalt cap. There would be no reduction in the toxicity or volume of the contaminants.	The exact means of treatment would depend on contaminant concentrations and waste disposal facility requirements. PCB contaminated materials accepted for disposal in an industrial landfill are landburied. Mercury contaminated soils may be immobilized by stabilization and encapsulation. Through excavation, the volume and toxicity of contaminants on site are reduced.
Short Term Effectiveness	Since no action would be taken to control or remediate the areas of soil contamination under this alternative, no short term impacts to human health and the environment would result. Remedial action objectives would not be achieved.	Deed restrictions for land use would pose no short term impacts.	Impacts to the community would be minimal, since the site is isolated. Air monitoring for PCBs and use of personal protective equipment would mitigate risk during construction activities. This alternative could be implemented in a short period of time due to the small areas involved and would pose only minor potential risk to the environment, which could be controlled (e.g., precipitation runoff controls).	Impacts to the community would be minimal, since the site is isolated and quantities to be moved off-site are of small volume. Properly fitting workers with personal protective equipment and monitoring air quality during soil excavation, transport and disposal mitigate exposure risks. Environmental impacts due to excavation would be negligible due to small areas of concern.
Implementability	Since no construction or operation is required, this alternative is readily implementable.	This alternative is readily implementable with concurrence of the landowners.	This alternative could be constructed with little or no difficulty using readily available material and equipment. Providing that the cap is periodically inspected and repaired, it provides a high degree of reliability.	This alternative could be implemented with little or no difficulty. The technologies proposed for this alternative are all demonstrated and commercially available.

Table 4-12
Comparative Analysis of Soil Remedial Alternatives
Malta Rocket Fuel Area Site

	Alternative S1 No Action	Alternative S2 Institutional Controls	Alternative S3b Asphalt Capping/Surface Controls	Alternative S4 Excavation and Off-Site Disposal
Cost	There is no cost associated with this alternative.	Minimal cost is expected with this alternative. Costs: Capital: $16,800 Annual O&M: $0 Present Worth: $16,800	The capital cost for implementation of this alternative is moderate. Long-term maintenance costs for inspections and cap repair are expected to be moderately low. Costs: Capital: $27,000 Annual O&M: $1,000 Present Worth: $42,400 (Based on a 5% discount rate over 30 years)	The capital cost for excavation and disposal is similar to Alternative S3b. This alternative should, over the long-term, prove more cost-effective with the added benefits of no long-term maintenance, no deed restrictions, no surface controls, and elimination of the source. Costs: Capital: $25,100 Annual O&M: $0 Present Worth: $25,100
State Acceptance	The NYSDEC may not accept this alternative since it is not protective of human health and does not achieve site specific cleanup goals.	The NYSDEC may not accept this alternative since it does not achieve site specific cleanup goals nor isolate contaminated soils to reduce exposure potential.	The NYSDEC has accepted reliable cover systems as a means to isolate contaminants from exposure pathways. Since the site contaminants are not a threat to groundwater, and the cap provides an isolation barrier to the environment, it should be acceptable to NYSDEC, along with an outlined maintenance obligation and deed restrictions.	Since this remedial alternative would meet State-approved site-specific cleanup goals and the remedial action objectives, it should be acceptable to the NYSDEC.
Community Acceptance	This alternative may not achieve community acceptance because soils posing unacceptable potential risks to human health would remain accessible on-site.	This alternative may achieve community acceptance based on the institutional controls selected.	This alternative would likely achieve community acceptance based upon it meeting the remedial objectives.	Since all contamination above specified cleanup levels would be removed from the site, this alternative would likely be acceptable to the community.

5.0 CONCEPTUAL DESIGN

Conceptual designs for the recommended remedies for groundwater and soil have been developed and are described in the following sections. The groundwater and soil remedies would be implemented independently, and therefore, are not combined into one conceptual design. The recommended groundwater remedy is essentially in operation now; therefore, rather than discuss a conceptual design, the existing system is described.

5.1 Groundwater

Alternative G2b, Continue the Existing System with Institutional Controls (Restricted Use of Untreated Groundwater), is the Malta PPs' recommended remedy for groundwater. Under this alternative, the existing groundwater pumping and treatment system would continue to be used for the on-demand, on-site water supply. Groundwater monitoring would continue through the existing EWMS. Deed restrictions and continued maintenance of the one-mile restrictive easement would be used to prevent ingestion of untreated groundwater.

Concentrations of VOCs in groundwater would be reduced through on-demand pumping of the existing water supply system, natural attenuation, and degradation processes such as dilution, dispersion, adsorption and biological and chemical degradation. Groundwater VOCs that reach the ravines would be volatilized once exposed to open air.

The existing groundwater extraction and treatment system consists of two water supply wells (1D and 2D), located near the central portion of the plume. Each of the two wells is equipped with a submersible pump and the necessary piping to extract and convey groundwater to a single groundwater treatment system (air stripper and holding tanks) located mostly in Building 15. The treatment system (constructed in 1987) includes a 17 ft high, 1 ft diameter air stripper system, manufactured by ORS, Inc (Model 1109004). The air stripper is equipped with a 1 HP, 500 cubic feet per minute (cfm) blower. According to the manufacturer, this system has a capacity of effectively treating approximately 25 gallons per minute (gpm) based on the air stripper efficiencies calculated using peak concentrations measured historically in the stripper influent samples collected and analyzed between 1990 and 1994. Alternative G2b does not require any minimum pumping rate. However, if operations at the MRFA site and/or the associated water use decline significantly, then the need for maintaining a minimum level of pumping will be reevaluated.

Treated effluent from the air stripper discharges into a 450 gallon tank containing a 1/2 HP pump that conveys the treated water into a 100,000 gallon reservoir that supplies water to the underground water distribution system. The water is used for both domestic purposes and for fire protection at the Site, including the MTI and former GE/Exxon facilities. Samples of air stripper influent and effluent are collected quarterly and analyzed for volatile organic compounds to monitor the effectiveness of the system. The influent samples are collected from manually operated valves located in the lines that feed to the air stripper. Effluent samples are collected from the 450 gallon holding tank. This tank is periodically flushed to remove sediment that settles out from the well water. No air stripper air emissions sampling or treatment is required.

Periodic evaluation and maintenance of the production wells, air stripper and other treatment system components would be necessary to maintain efficient system operation. Maintenance activities could include well rehabilitation, replacing of air stripper packing material and/or repair or replacement of system components, as necessary.

The EWMS program consists of sampling seven monitoring well locations (DGC-3S, DGC-4S, 13S, M-27S, M-27-D, M-33S, and M-33I) and three surface water locations (SW-A, SW-B, and SW-D). Groundwater and surface water samples from these locations are now collected semi-annually (May and October). All samples except 13S are analyzed for VOCs. Samples from 13S, 27S, M-27D, and SW-B are analyzed for unfiltered total chromium and hexavalent chromium. Monitoring reports are submitted to the USEPA and NYSDEC. The ongoing EWMS provides for the long-term monitoring of groundwater and surface water to verify and document that the MRFA Site groundwater plume is not migrating to the Luther Forest Well Field or the Cold Springs Well Field. Air stripper influent monitoring and EWMS monitoring would provide an indication of the reduction of VOC concentrations over time.

Additional deed restrictions and continued maintenance of the one-mile restrictive easement would prevent ingestion of untreated groundwater from the water bearing units in the vicinity of the Site. The one-mile restrictive easement would also limit or prevent development (i.e., the potential for installation of private drinking water wells) in the area surrounding the Site. The deed restriction would restrict future use of groundwater, as appropriate.

5.2 Soil

Alternative S4, Excavation and Off-Site Disposal, is the Malta PPs' recommended remedy for soil. This alternative involves excavation and off-site disposal of surface soils containing unacceptable concentration of PCBs and lead adjacent to Building 23P, and surface soil containing unacceptable concentrations of mercury within the confines of the Muggett's Pond Drainage Ditch near the intersection.

At the Building 23P area, surface soil would be removed to a depth of approximately one foot, backfilled with clean fill material, graded to blend with surrounding areas, and revegetated. Any soil below one-foot that exceeds 25 ppm of PCBs would also be excavated. Volumes of excavated soil were estimated at 35 to 40 cubic yards in Section 2.0. The final volume of soil to be removed would be based upon confirmatory sampling done at the base and perimeter of the excavations. Before transport off-site, the soil materials would be analyzed, as necessary, for acceptance at an industrial landfill or a TSCA and RCRA-approved facility.

At the Muggett's Pond Drainage Ditch intersection, mercury-containing soils would be excavated from the drainageway, which is concrete-lined. Volumes of excavated soil were estimated at 3 cubic yards in Section 2.0. Before transport off-site, the soil materials would be analyzed, as necessary, for acceptance at either an industrial landfill or a RCRA-approved facility. If necessary, a pretreatment/stabilization process would immobilize the mercury compounds within the soil prior to land burial in a lined disposal cell.

6.0 REFERENCES

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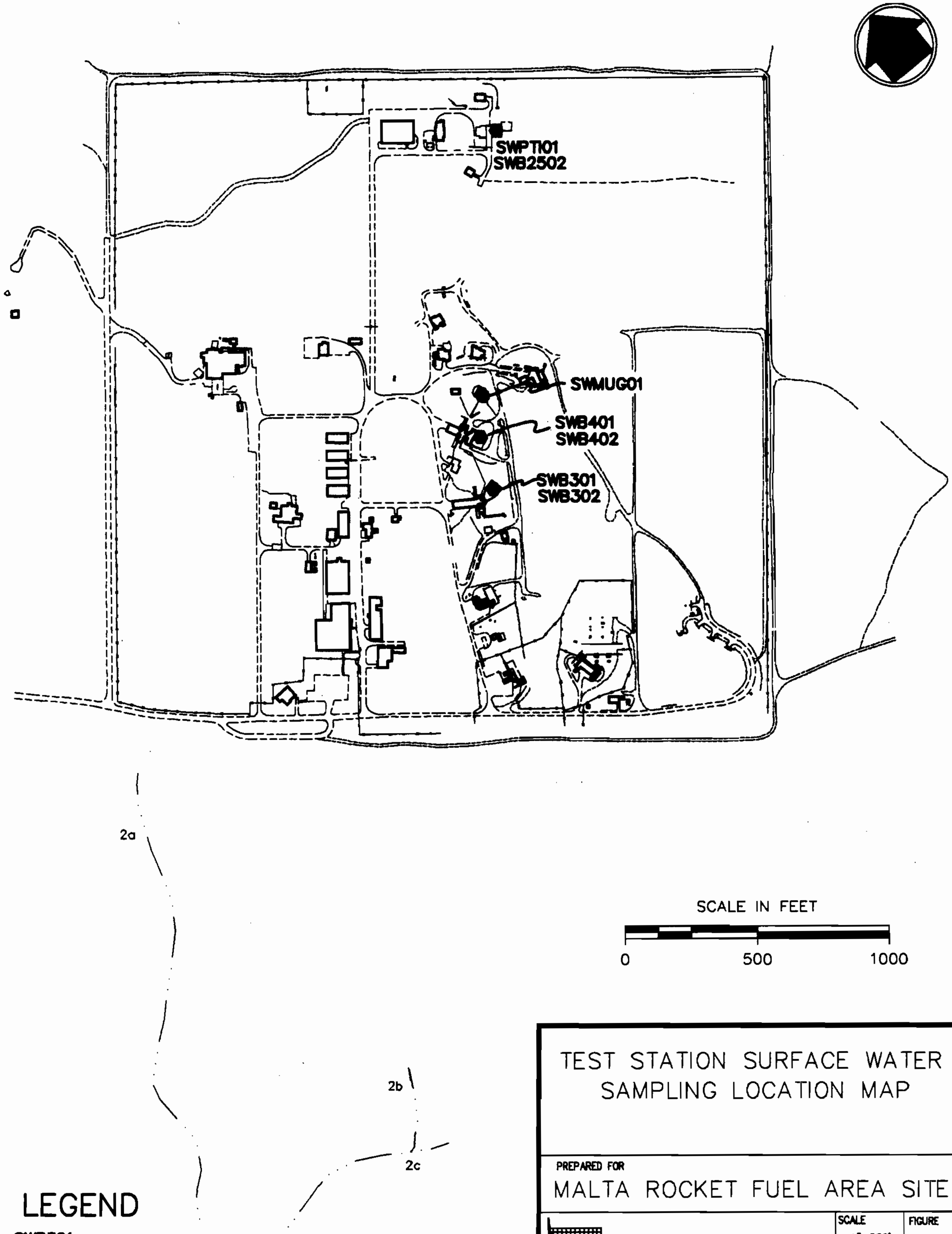
APPENDIX A

RI Sample Location Maps



LEGEND

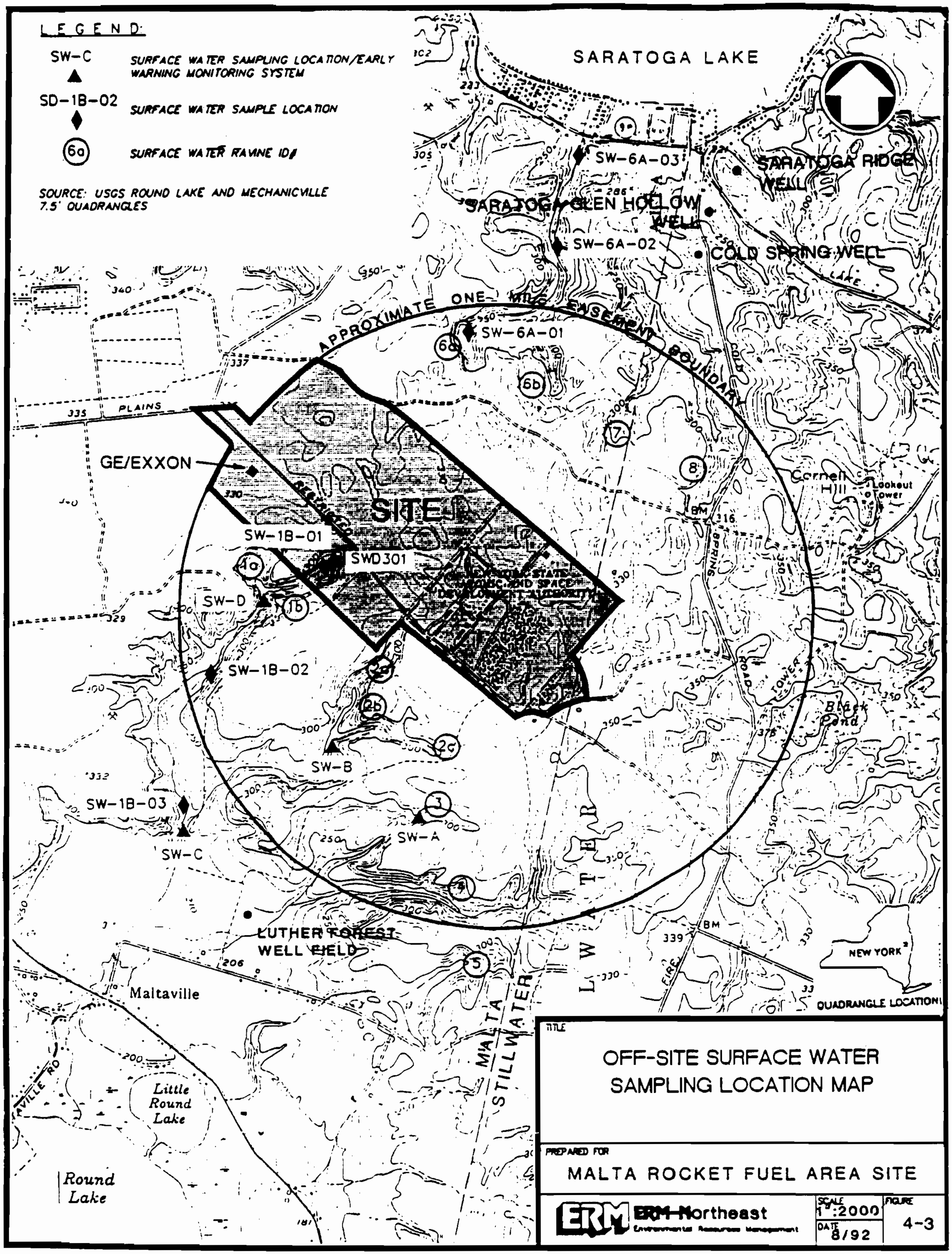
SWB301 ● *SURFACE WATER SAMPLING LOCATION & ID#*

TEST STATION SURFACE WATER
SAMPLING LOCATION MAP

PREPARED FOR
MALTA ROCKET FUEL AREA SITE

ERM
ERM-Northeast

SCALE 1"=500'
DATE 04/94
FIGURE 4-2



TITLE

OFF-SITE SURFACE WATER SAMPLING LOCATION MAP

PREPARED FOR

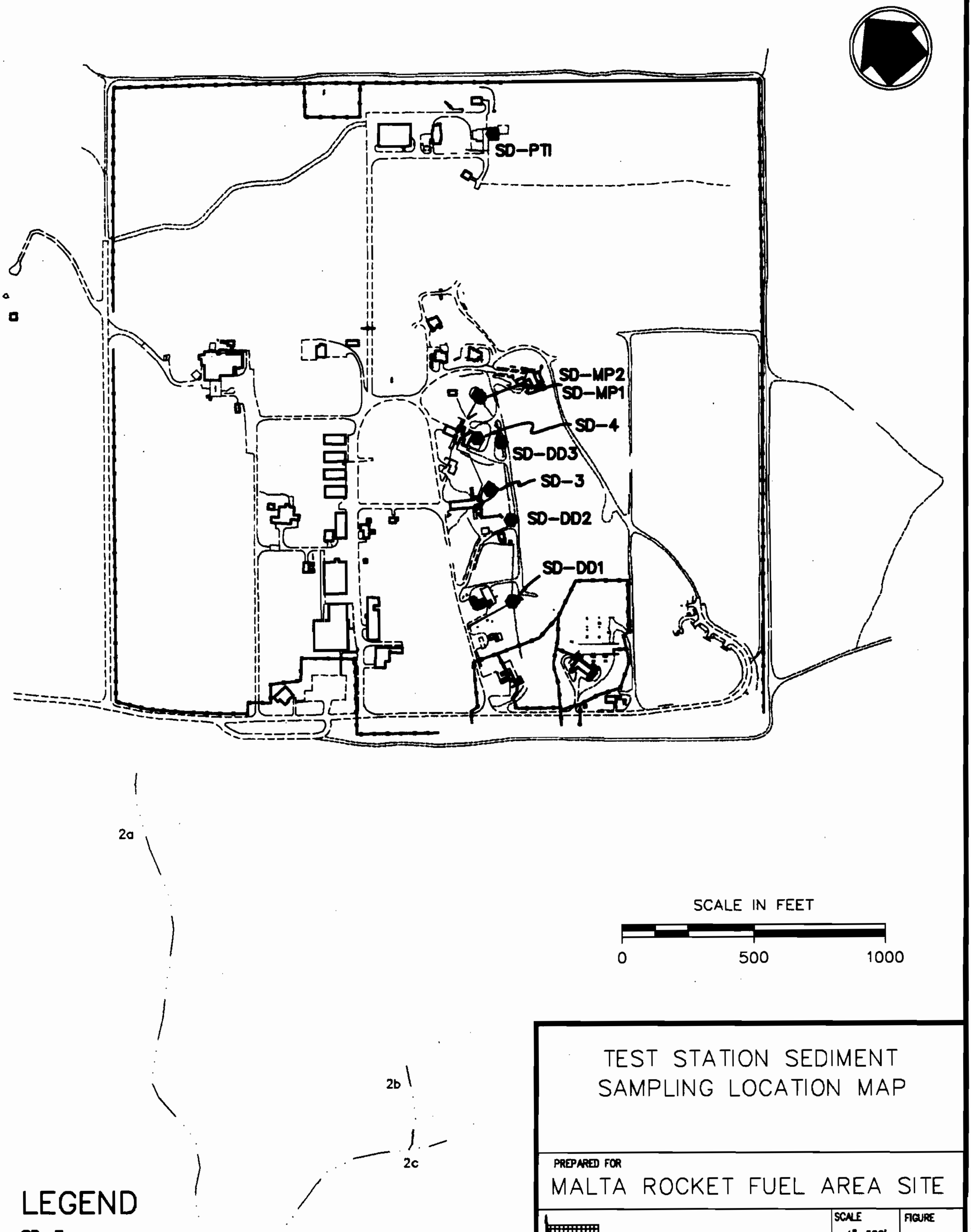
MALTA ROCKET FUEL AREA SITE

ERM-Northeast
Environmental Resources Management

SCALE 1":2000

DATE 8/92

FIGURE 4-3



LEGEND

SD-3 ● *SEDIMENT SAMPLING LOCATION & ID#*

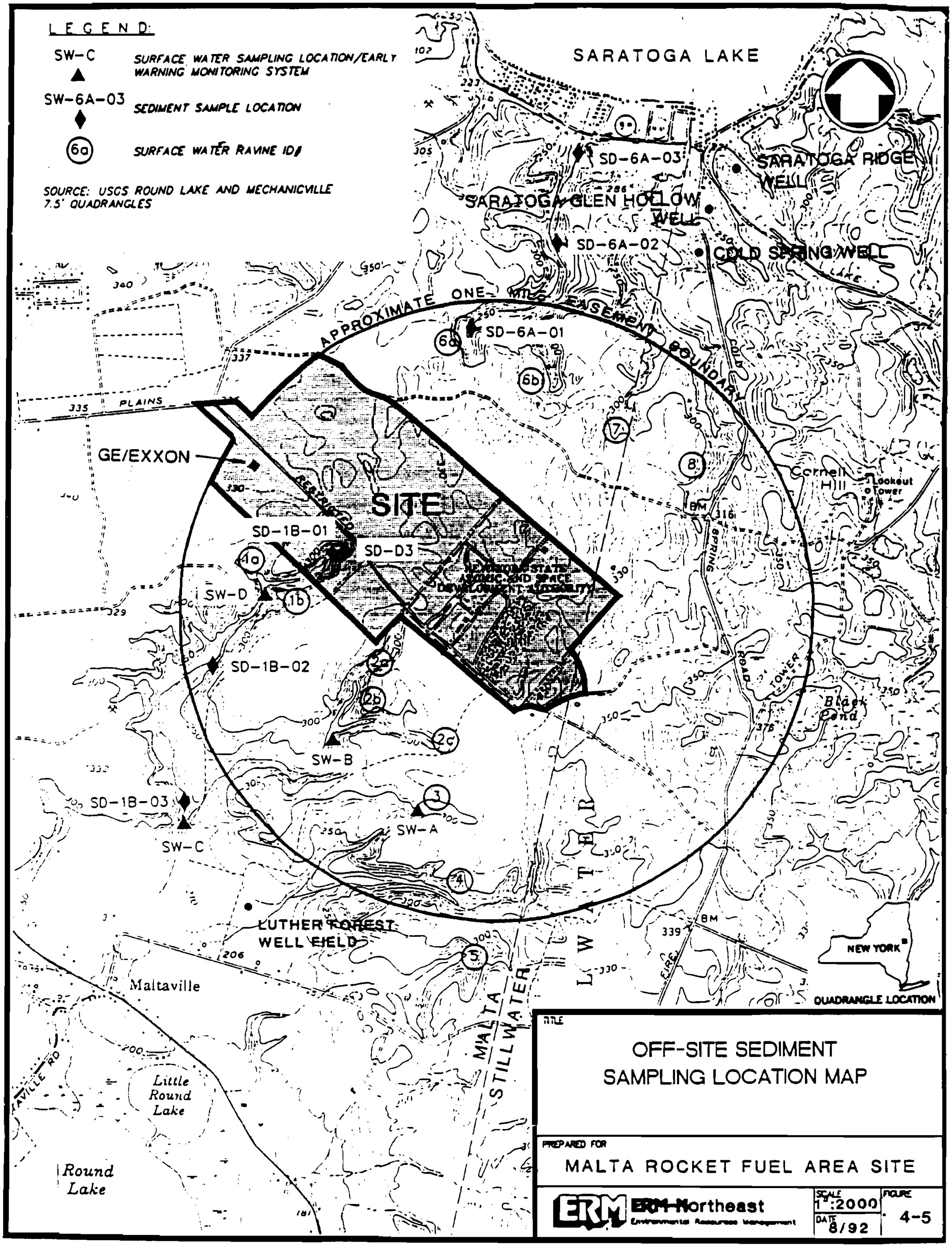
TEST STATION SEDIMENT
SAMPLING LOCATION MAP

PREPARED FOR

MALTA ROCKET FUEL AREA SITE

ERM
ERM-Northeast

SCALE 1"=500'	FIGURE 4-4	
DATE 04/94		



TITLE

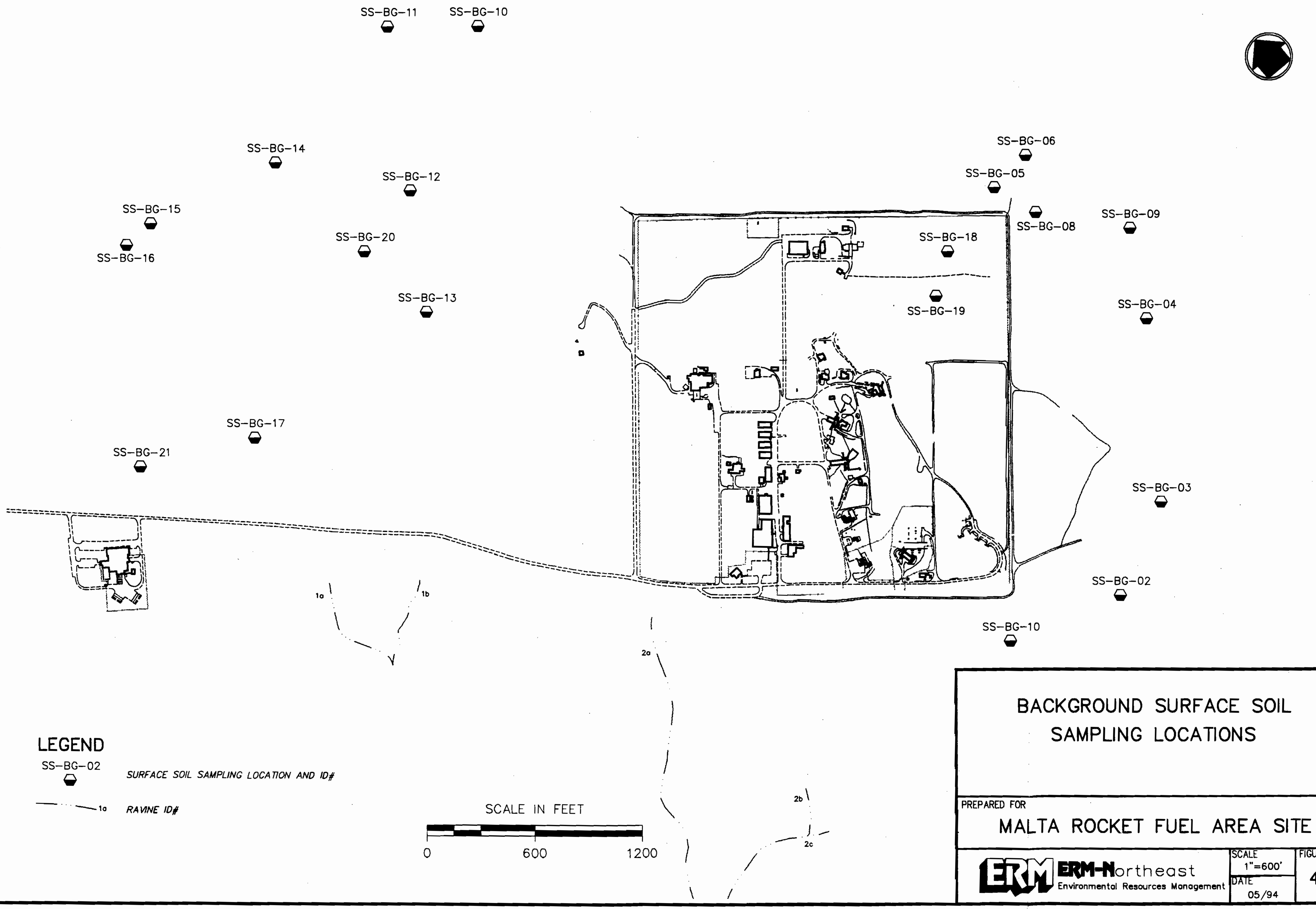
OFF-SITE SEDIMENT SAMPLING LOCATION MAP

PREPARED FOR

MALTA ROCKET FUEL AREA SITE

ERM ERM-Northeast
Environmental Resources Management

SCALE 1":2000	FIGURE 4-5
DATE 8/92	



BACKGROUND SURFACE SOIL SAMPLING LOCATIONS

PREPARED FOR

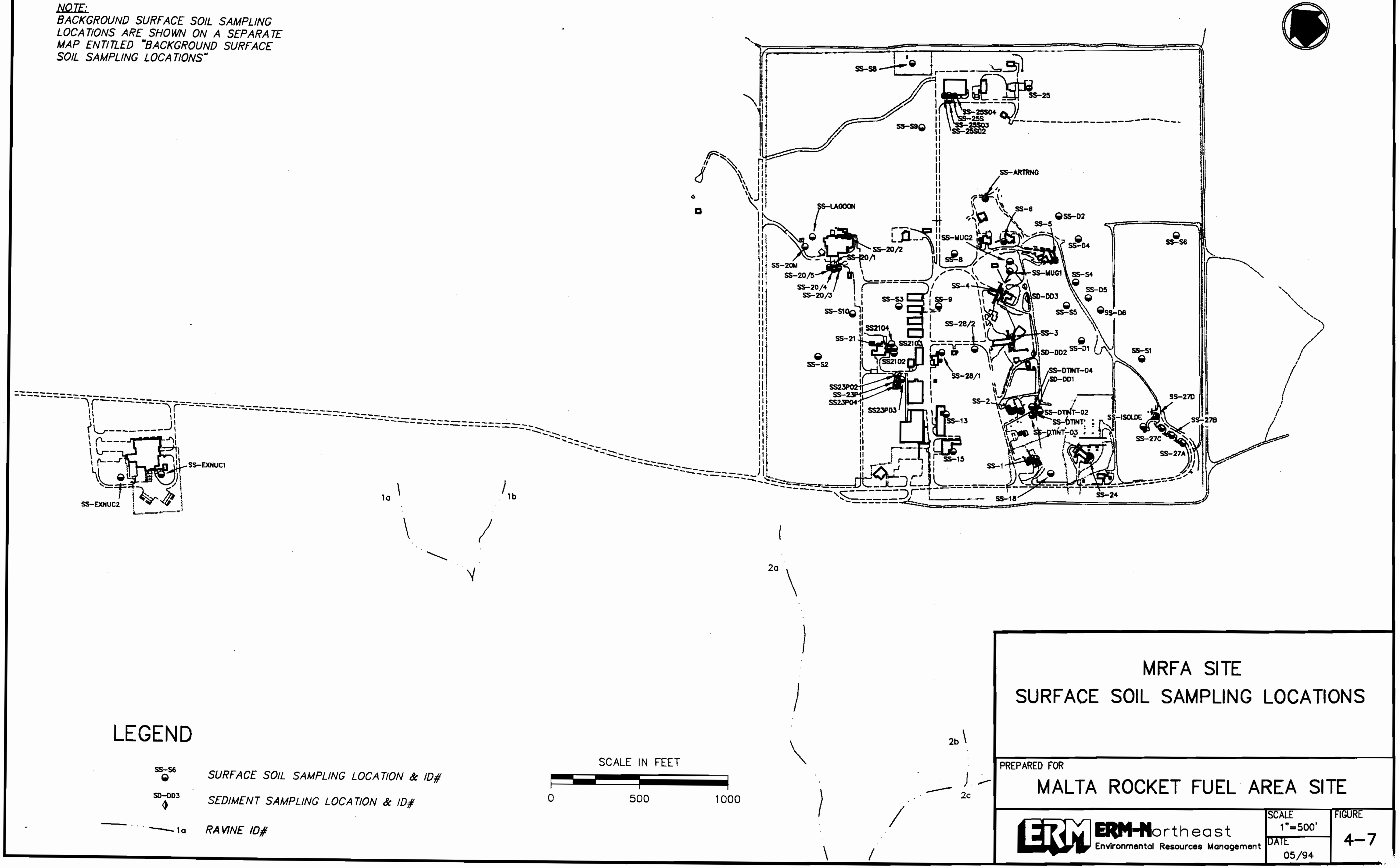
MALTA ROCKET FUEL AREA SITE

ERM-Northeast
Environmental Resources Management

SCALE 1"=600'	FIGURE 4-6
DATE 05/94	

380037-9A0126

NOTE:
BACKGROUND SURFACE SOIL SAMPLING LOCATIONS ARE SHOWN ON A SEPARATE MAP ENTITLED "BACKGROUND SURFACE SOIL SAMPLING LOCATIONS"



MRFA SITE
SURFACE SOIL SAMPLING LOCATIONS

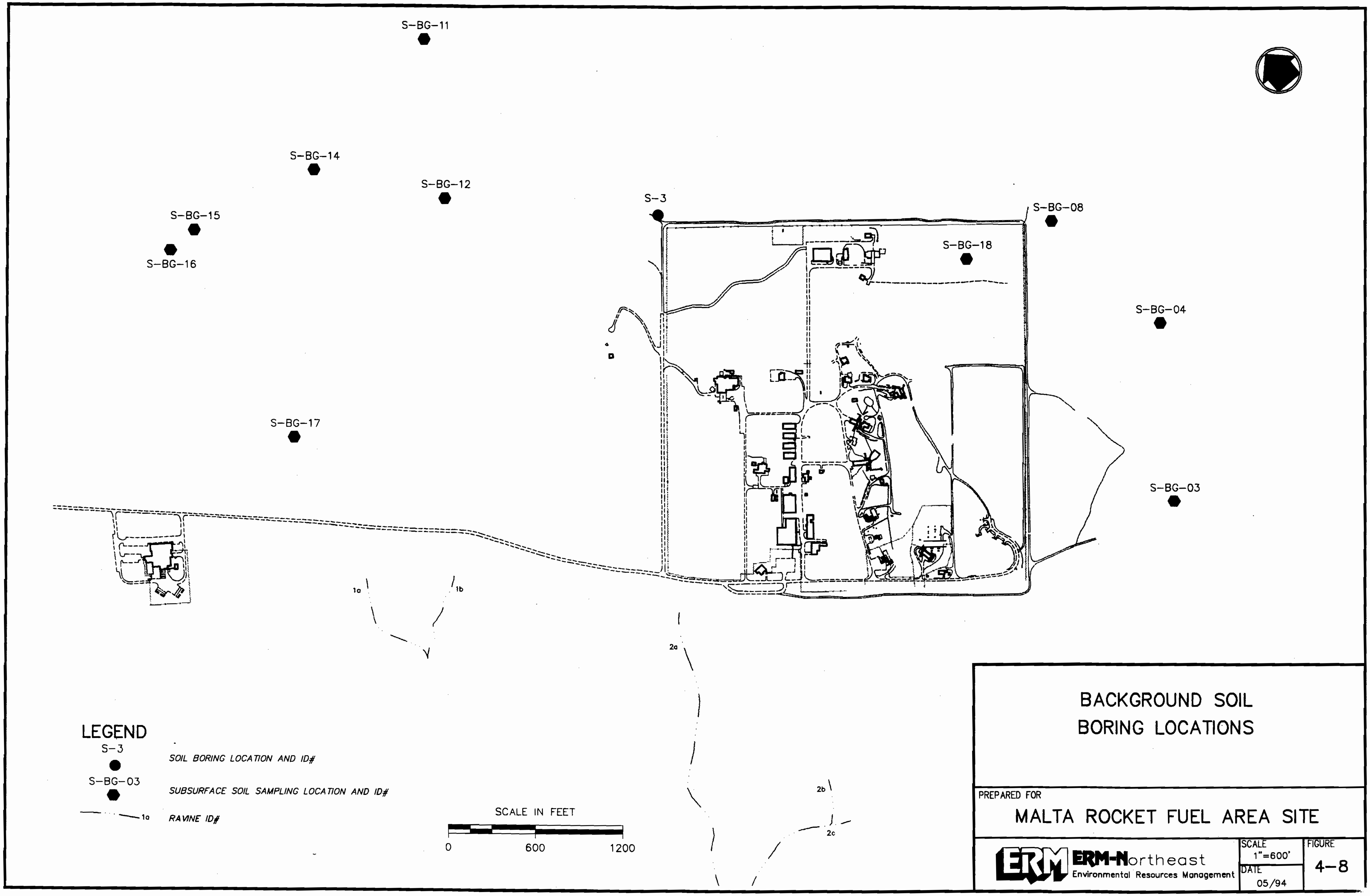
PREPARED FOR

MALTA ROCKET FUEL AREA SITE

ERM-Northeast
Environmental Resources Management

SCALE	FIGURE
1"=500'	4-7
DATE 05/94	

30037-940119



BACKGROUND SOIL
BORING LOCATIONS

PREPARED FOR

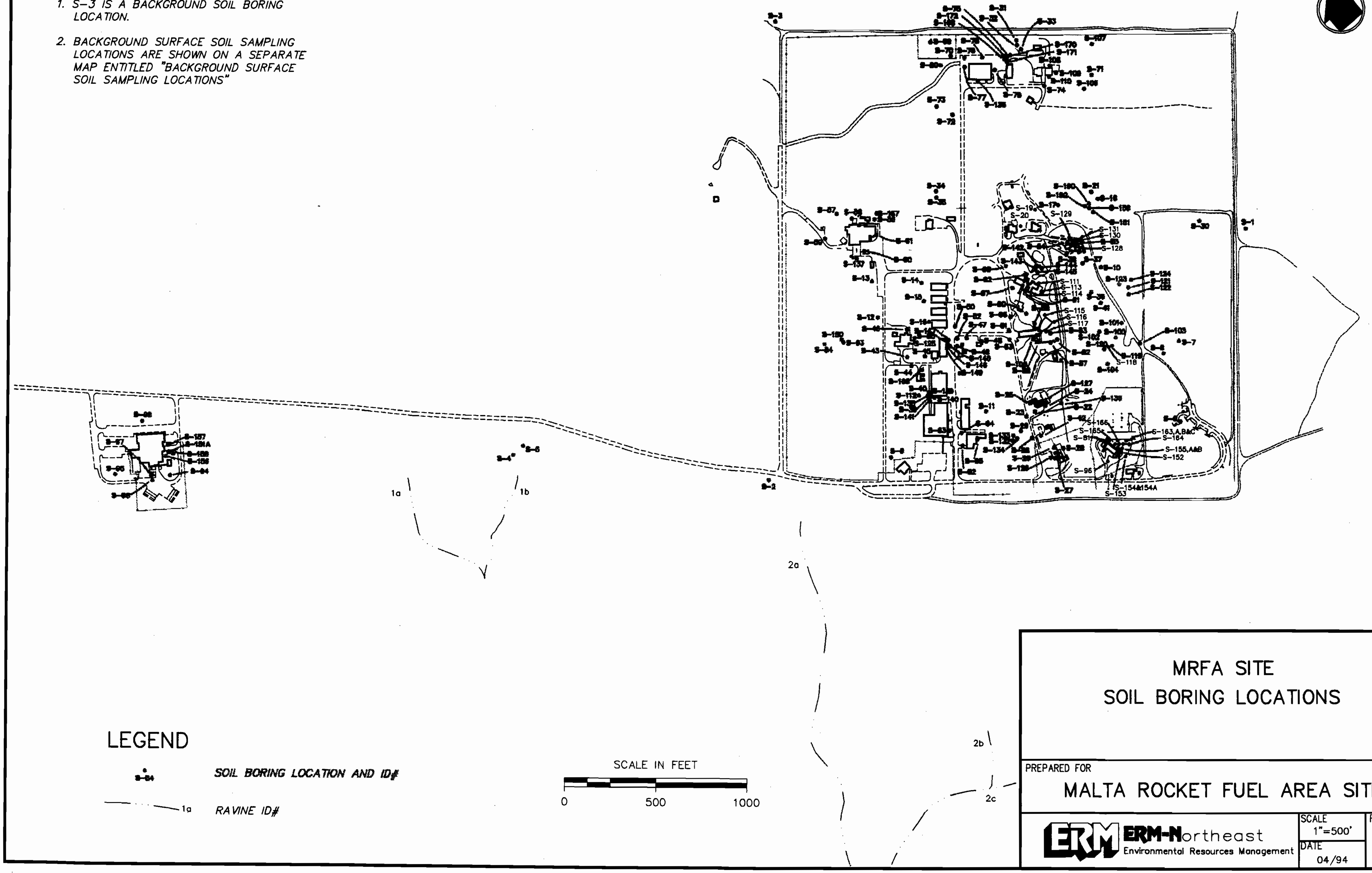
MALTA ROCKET FUEL AREA SITE

ERM-Northeast
Environmental Resources Management

SCALE 1"=600'	FIGURE 4-8
DATE 05/94	

20037-940127

NOTES:
1. S-3 IS A BACKGROUND SOIL BORING LOCATION.
2. BACKGROUND SURFACE SOIL SAMPLING LOCATIONS ARE SHOWN ON A SEPARATE MAP ENTITLED "BACKGROUND SURFACE SOIL SAMPLING LOCATIONS"



LEGEND

SOIL BORING LOCATION AND ID#

1a RAVINE ID#

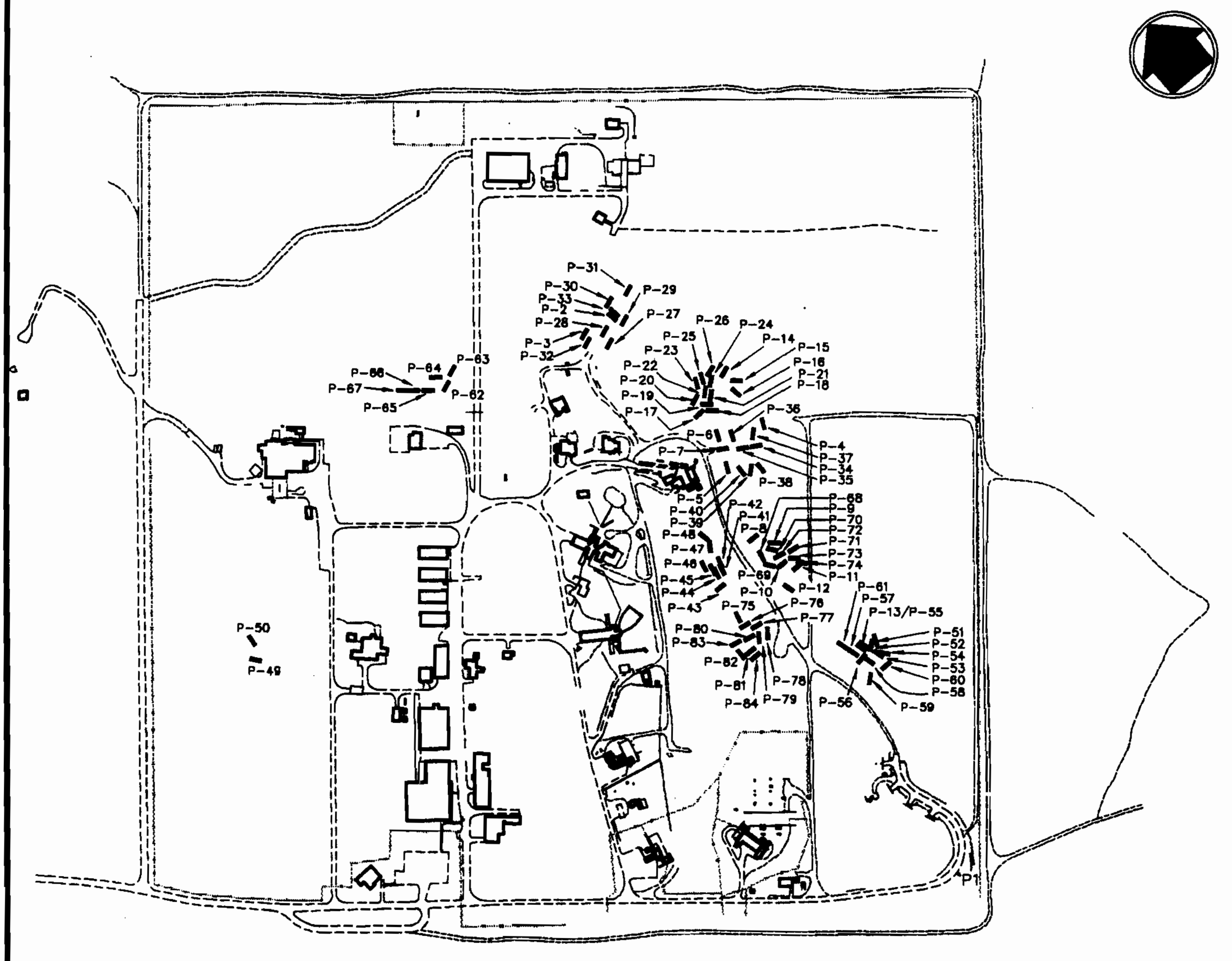
MRFA SITE
SOIL BORING LOCATIONS

PREPARED FOR
MALTA ROCKET FUEL AREA SITE

ERM-Northeast
Environmental Resources Management

SCALE 1"=500'	FIGURE	
DATE 04/94	4-9	

380037-94015



SCALE IN FEET

0 500 1000

LEGEND

P-13 TEST PIT LOCATION AND ID#

TEST PIT LOCATIONS

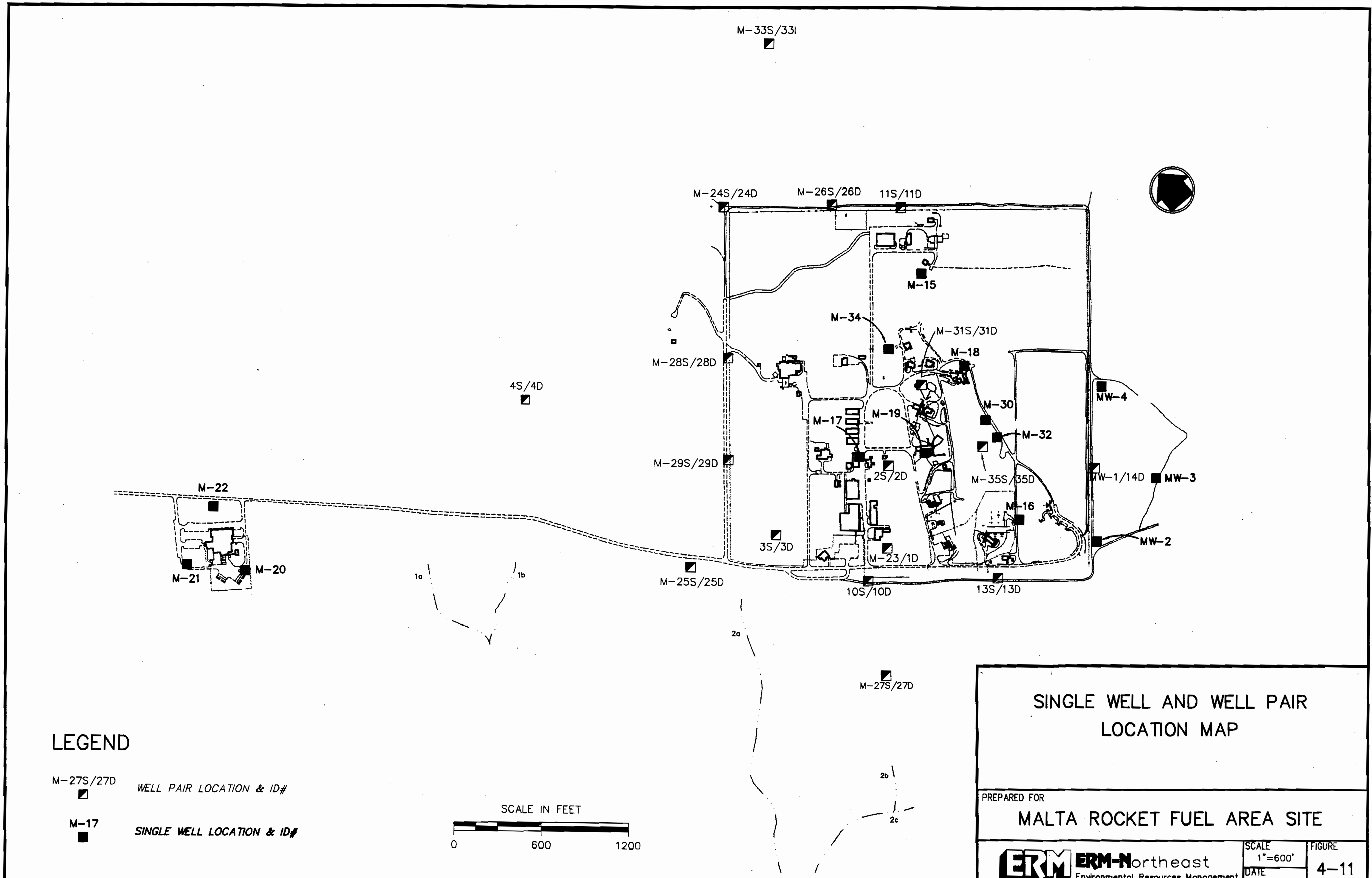
PREPARED FOR

MALTA ROCKET FUEL AREA SITE

ERM

ERM-Northeast

SCALE 1"=500'	FIGURE 4–10
DATE 05/94	



LEGEND

M-27S/27D ◪ *WELL PAIR LOCATION & ID#*

M-17 ■ ***SINGLE WELL LOCATION & ID#***

SCALE IN FEET

0 600 1200

SINGLE WELL AND WELL PAIR
LOCATION MAP

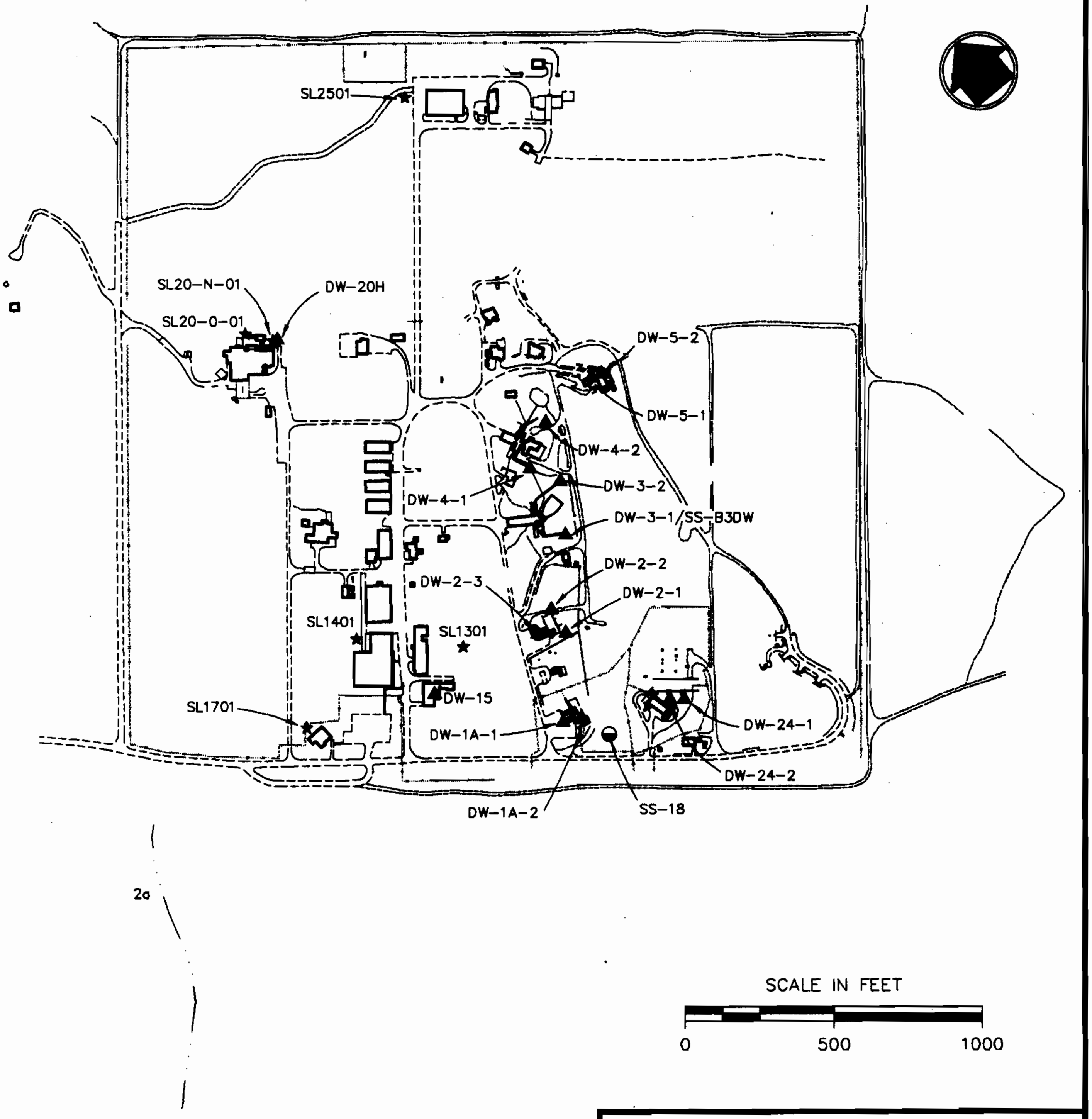
PREPARED FOR

MALTA ROCKET FUEL AREA SITE

ERM ERM-Northeast
Environmental Resources Management

SCALE 1"=600'	FIGURE	
DATE 05/94	4-11	

380037-940111



LEGEND

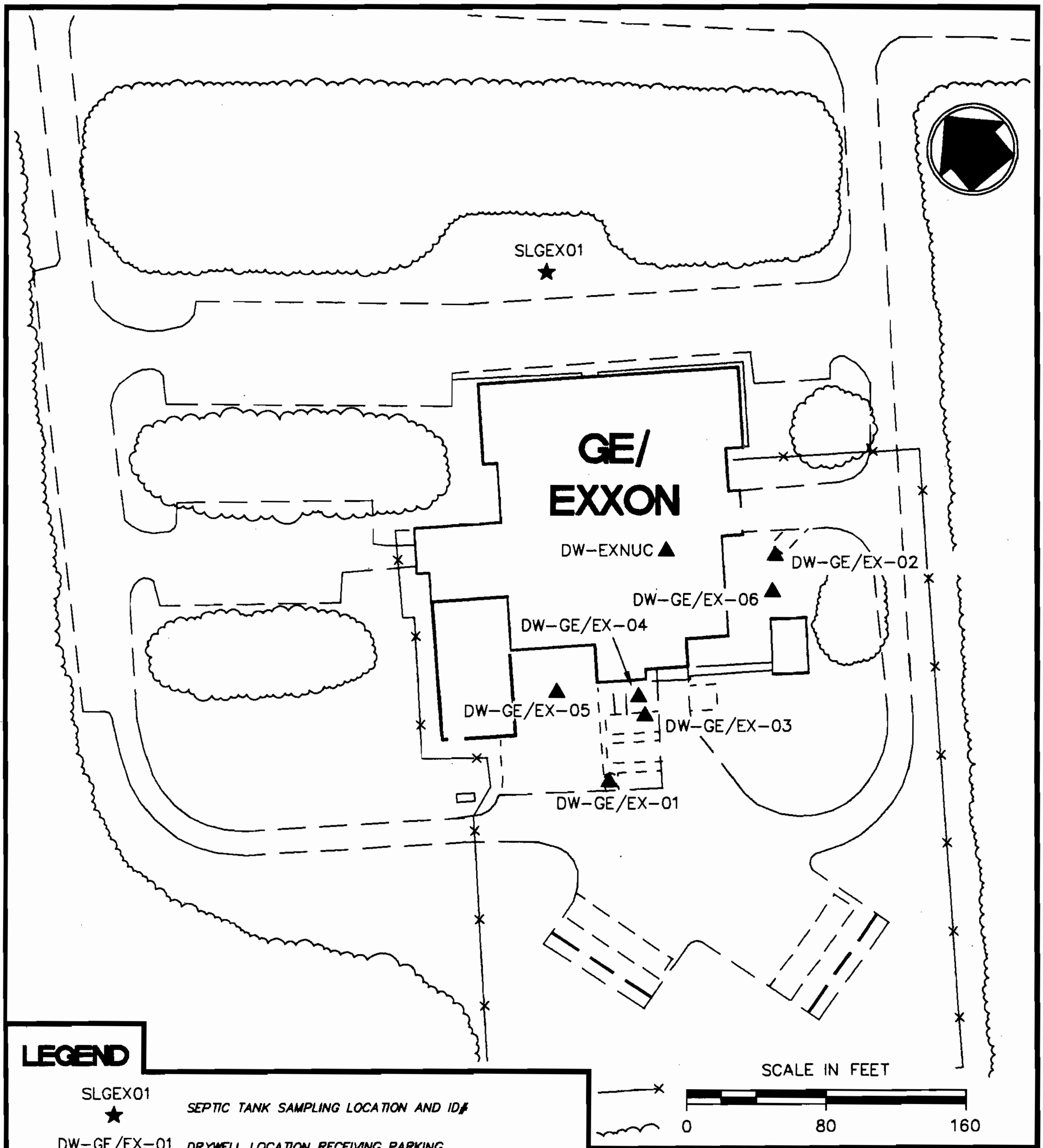
SS-18 ◓	*SURFACE SOIL SAMPLE LOCATION & ID#*
DW-EXNUC ▲	*DRY WELL SAMPLING LOCATION & ID#*
★ SLGEX01	*SEPTIC TANK SAMPLING LOCATION & ID#*
—— · · · —— 1a	*RAVINE ID#*

TEST STATION
DRY WELL AND SEPTIC TANK
SAMPLING LOCATION MAP

PREPARED FOR
MALTA ROCKET FUEL AREA SITE

ERM
ERM-Northeast

SCALE 1"=500'	FIGURE 4-12
DATE 05/94	



LEGEND

SLGEX01 ★	*SEPTIC TANK SAMPLING LOCATION AND ID#*
DW-GE/EX-01 ▲	*DRYWELL LOCATION RECEIVING PARKING LOT STORMWATER RUNOFF*
DW-GE/EX-03 DW-GE/EX-04 ▲	*SUSPECTED DRYWELL LOCATION FILLED WITH GRAVEL TO 2'-3' BELOW GRADE*
DW-GE/EX-05 ▲	*SUSPECTED DRYWELL, UNKNOWN RECEPTOR SOURCES*
DW-GE/EX-02 DW-GE/EX-06 ▲	*DRYWELLS RECEIVING PARKING LOT & ROOF DRAIN STORMWATER RUNOFF*
DW-EXNUC ▲	*FLOOR DRAIN WITHOUT PIPING*

FORMER GE/EXXON
DRY WELL AND
SEPTIC TANK LOCATIONS

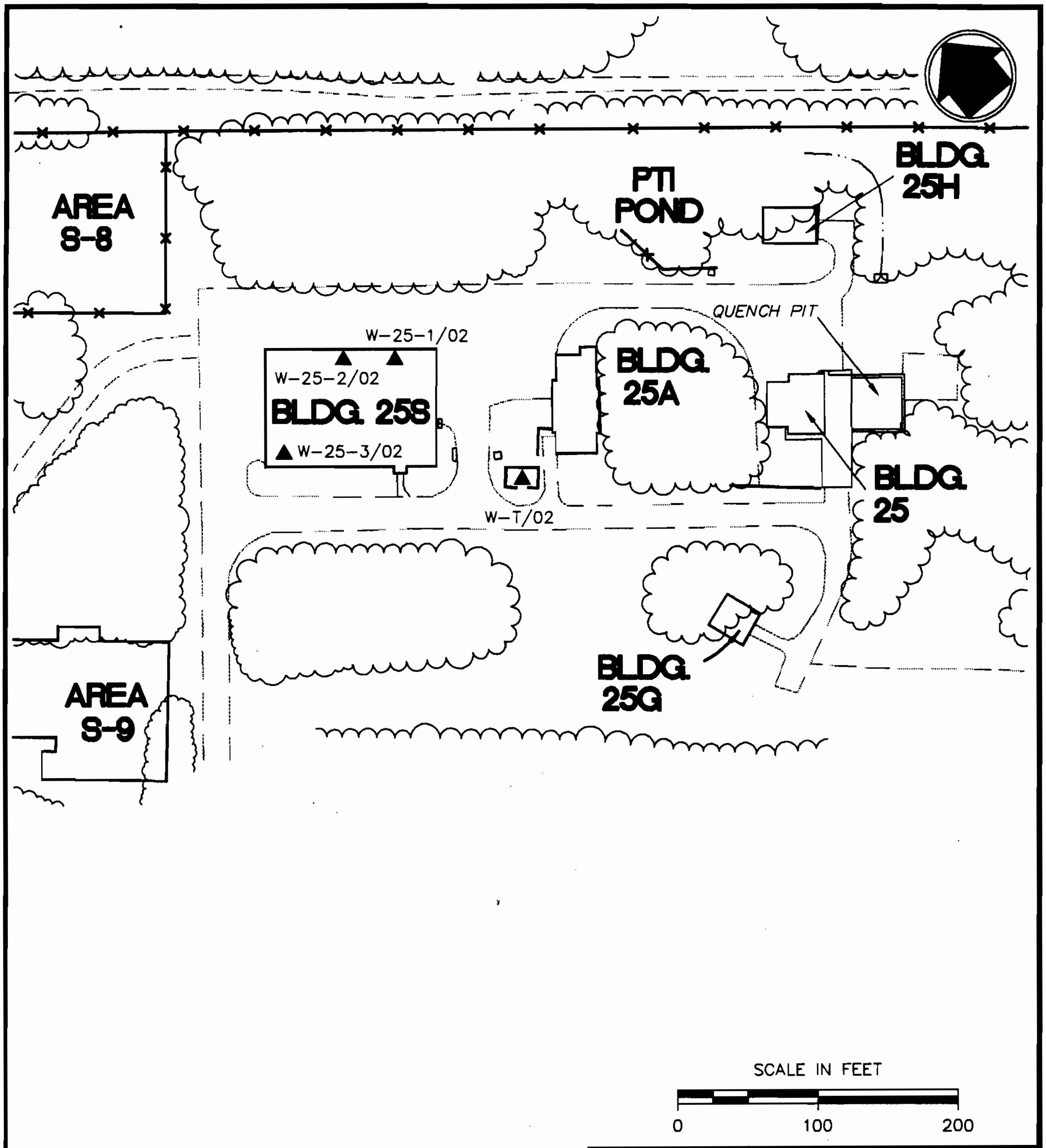
PREPARED FOR

MALTA ROCKET FUEL AREA SITE

ERM **ERM-Northeast**
Environmental Resources Management

SCALE	FIGURE
1"=80'	4-13
DATE 05/94	

980/07-94/44



LEGEND

W-25-3/02
▲ *WIPE SAMPLING LOCATION & ID#*

WIPE SAMPLING LOCATIONS
BUILDING 25 (PTI) AREA

PREPARED FOR

MALTA ROCKET FUEL AREA SITE

ERM ERM-Northeast
Environmental Resources Management

SCALE 1"=100'	FIGURE 4-14
DATE 05/94	

90097-34A08

APPENDIX B

RI Tables of Constituents Detected Above the MRFA Criteria

TABLE 5-15
MALTA ROCKET FUEL AREA SITE
SURFACE WATER SAMPLE LOCATIONS WITH ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Area	Sample No.	Analyte	Conc.	MRFA Comparative Criteria
Bldg. 3	SW-B3-02	Iron	10700	300
		Manganese	569	300
		Aldrin	0.041J	0.001
		Heptachlor Epoxide	0.087	0.001
Bldg. 4	SW-B4-02	Antimony	28J	3*
		Iron	2550J	300
Bldg. 25	SW-PTI-01	Iron	1890	300
	SW-B25-02	Antimony	22J	3*
		Iron	9310	300
Muggett's Pond	SWMUG01	Iron	1340	300
		Manganese	1010J	300
D-3 (Ravine 1b)	SWD301 headwater	Aluminum	307	47.0
		Calcium	98000	57900
		Iron	31500	300
		Manganese	4080J	300
		Potassium	3490	845
Ravine 1b	SW-1B-01 headwater	Aluminum	171	47.0
		Calcium	116000	57900
		Iron	8340J	300
		Manganese	2120	300
		Potassium	3910	845
		Sodium	5740	4840
Ravine 1b	SW-1B-02 midstream	Aluminum	71.5	47.0
		Potassium	932	845
		Sodium	5530	4840
Ravine 1b	SW-1B-03 downstream	Aluminum	113	47.0
		Iron	344J	300
		Sodium	4930	4840

Notes:

1. All results and criteria are in ug/l (ppb).
2. * = Guidance value.
3. J = Semi-quantitative value due to QA/QC data validation requirements.

SWABCR.XLS 8/9/94

TABLE 5-16

MALTA ROCKET FUEL AREA SITE SEDIMENT SAMPLE LOCATIONS WITH ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Area	Sample No.	Analyte	Conc.	MRFA Comparative Criteria
Bldg. 3	SD-3	Cadmium	2.8BJ	0.8
		Copper	294J	19
		Lead	46.2J	27
		Zinc	1430J	85
		Aroclor-1260	1200	0.08
Bldg. 25	SD-PTI	Arsenic	20.3J	5.0
		Cadmium	38.4J	0.8
		Chromium	101J	26
		Copper	642J	19
		Iron	307000J	24000
		Lead	5710J	27
		Manganese	987J	428
		Mercury	0.27BJ	0.11
		Nickel	141J	22
		Zinc	6940J	85
		Methoxychlor	85J	6
		Aroclor-1254	7400	0.08
		Aroclor-1260	13000	0.08
Muggett's Pond	SD-MP1	Cadmium	1.2	0.8
		Copper	61.0	19
		Lead	71.7	27
		Mercury	1.1J	0.11
		Nickel	32.8	22
		Zinc	219	85
		Benzo (b) Fluoranthene	64J	13
		Benzo (k) Fluoranthene	51J	13
		Benzo (a) Pyrene	70J	13
		Indeno (1,2,3-cd) Pyrene	75J	13
		Phenol (total unchlorinated)	210J	5
		gamma-Chlordane	1.9J	8x10E-7
		Aroclor-1260	280	0.08
Muggett's Pond	SD-MP2	Cadmium	1.4B	0.8
		Copper	56.1	19
		Lead	57.7	27
		Mercury	4.0J	0.11
		Nickel	26.6	22
		Zinc	261	85
		Benzo (a) Anthracene	700J	13
		Benzo (b) Fluoranthene	740J	13
		Benzo (k) Fluoranthene	390J	13
		Benzo (a) Pyrene	560J	13
		Chrysene	480J	13
		Indeno (1,2,3-cd) Pyrene	320J	13
		Aroclor-1260	1300	0.08
Muggett's Pond Drainage Ditch	SD-DD1	Mercury	124	8.1*
		PCBs (Aroclor-1254, 1260)	1280	1000*

TABLE 5-16 (Cont'd)
MALTA ROCKET FUEL AREA SITE
SEDIMENT SAMPLE LOCATIONS WITH
ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Area	Sample No.	Analyte	Conc.	MRFA Comparative Criteria
D-3 Ravine 1b	SD-D3	Barium	51.7J	35.6
		Lead	50.1J	27
		Manganese	2410	428
Ravine 1b	SD-1B01	Aluminum	4960	2890
		Barium	85.70	35.6
		Beryllium	0.22B	0.14
		Cobalt	3.4B	2.8
		Copper	31.7J	19
		Magnesium	1720	1550
		Manganese	3210	428
		Potassium	528B	297
		Vanadium	14.5J	13.2
Ravine 1b	SD-1B03	Aluminum	3120	2890
		Potassium	437B	297
Ravine 6a	SD-6A01	Arsenic	5.5	5.0

Notes:

1. Inorganics are in mg/kg (ppm), organics are in ug/kg (ppb).
2. * = Surface soil MRFA Comparative Criteria.
3. J = Semi-quantitative value due to QA/QC data validation requirements.
4. B = Value is above the Instrument Detection Limit (IDL) but below the Contract Required Detection Limit (CRDL).

SDABCR.XLS 8/11/94

TABLE 5-18
MALTA ROCKET FUEL AREA SITE
SURFACE SOIL SAMPLE LOCATIONS WITH ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Area	Sample No.	Analyte/ Compound	Conc.	MRFA Comparative Criteria
S-1	SS-S1	Aroclor-1260	1200P	1000
Bldg. 6	SS-6	Benzo (a) Pyrene	91J	61
Bldg. 20	SS-20/1	Mercury	24.4J	8.1
Bldg. 21	SS-21	Mercury	45.5J	8.1
		Aroclor-1260	1600PDCJ	1000
Bldg. 23P	SS-23P	Aroclor-1260	4100PDCJ	1000
Bldg. 23P	SS-23P/03	Aroclor-1262	2600	1000
Bldg. 23P	SS-23P/04	Lead	1090	500
		Aroclor-1262	16000	1000
		Aroclor-1268	4300	1000
Bldg. 24	SS-24	Benzo (a) Anthracene	2100	220
		Benzo (a) Pyrene	1800	61
		Benzo (b) Fluoranthene	2800	1100
		Chrysene	1900	400
		Dibenzo (a,h) Anthracene	400	14
Bldg. 25	SS-25	Antimony	11.4	10.8
		Copper	1000	999
		Lead	897J	500
Bldg. 25S	SS-25S	Lead	764	500
Bldg. 27B	SS-27B	Dibenzo (a,h) Anthracene	45J	14
Bldg. 27C	SS-27C	Benzo (a) Anthracene	380J	220
		Benzo (a) Pyrene	330J	61
		Dibenzo (a,h) Anthracene	93J	14
Muggett's Pond Drainage Ditch	SS-DT1NT	Mercury	13	8.1

Notes:

1. Inorganics are in mg/kg (ppm), organics are in ug/kg (ppb).
2. J = Semi-quantitative value due to QA/QC data validation requirements.
3. P = >25% difference for detected concentrations between the two GC columns. The lower value is reported.
4. C = Compound identification was confirmed by GC/MS.
5. D = Analysis performed at a higher dilution factor.

SSABCR.XLS 8/11/94

TABLE 5-21
MALTA ROCKET FUEL AREA SITE
SUBSURFACE SOIL SAMPLE LOCATIONS WITH ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Area	Sample No.	Analyte/ Compound	Conc.	MRFA Comparative Criteria
S-2	S-84 0-2'	Acetone	300BJ	200
Bldg. 6	S-19 2'-4'	Tetrachloroethene	1400EJ	1400
Bldg. 11	S-85 4'-6'	Acetone	580BJD	200
Bldg. 14	S-39 0-2'	Total VOCS	12680J	10000
		Dodecane	87000JN	50000
		Eicosane	61000JN	50000
		Heptadecane	130000JN	50000
		Hexadecane	130000JN	50000
		Nonadecane	85000JN	50000
		Octadecane	110000JN	50000
		Pentadecane	130000JN	50000
		Pentadecane, 2,6,10, 14-Tetramethyl	66000JN	50000
		Tetradecane	140000JN	50000
		Tridecane	96000JN	50000
		Undecane	80000JN	50000
		Unknown Alkanes	172000J	50000
		Total SVOCs	1287000	500000
Bldg. 24	S-81 2'-4'	Acetone	710BJDE	200
Bldg. 25	S-75 2'-4'	Phenol	140J	30
Bldg. 25	S-80 0-2'	Phenol	46J	30

Notes:

1. Inorganics are in mg/kg (ppm), organics are in ug/kg (ppb).
2. J = Semi-quantitative value due to QA/QC data validation requirements.
3. B = Compound was detected in associated method blank.
4. N = Compound was identified with a Chemical Abstract Services (CAS) number.
5. D = Result is from a secondary dilution analysis.
6. E = Value reported is higher than the linear calibration range.

SBABCR.XLS 8/11/94

TABLE 5-22
MALTA ROCKET FUEL AREA SITE
TEST PIT SUBSURFACE SOIL SAMPLE LOCATIONS WITH ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Area	Sample No.	Analyte/ Compound	Conc.	MRFA Comparative Criteria
D-1	P-78 2'-4'	Tetrachloroethene	2200EDJ	1400
		Diphenyl Ether	96000J	50000
		Total VOCs	15962J	10000
D-2	P-19 2'-4'	Vanadium	914	189
		Benzo (a) Pyrene	160J	61
D-5	P-70 2'-4'	Cadmium	60.8	13.5
D-6	P-11 2'-4'	Arsenic	9.1	8.1

Notes:

1. Inorganics are in mg/kg (ppm), organics are in ug/kg (ppb).
2. J = Semi-quantitative value due to QA/QC data validation requirements.
3. E = Result is above instrument calibration range.
4. D = Result is from secondary dilution analysis.

TPABCR.XLS 8/11/94

TABLE 5-34
MALTA ROCKET FUEL AREA SITE
GROUND WATER SAMPLE LOCATIONS WITH UNFILTERED ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Monitoring Well	Analyte/ Compound	MRFA Comparative Criteria	June 1992 Conc.	November 1992 Conc.	March 1994 Conc.
MW-1	Aluminum	5900	11300	19200	
	Antimony	3	19.0B	ND	
	Calcium	66200	175000	140000	
	Cobalt	7	24.9	21.1B	
	Iron	300	35000	38600	
	Lead	15	24.6	20.2J	
	Manganese	300	2770	2090	
	Potassium	2280	ND	5850	
	Vanadium	13	27.9	43.3B	
14D	Iron	300	2370	2420	
MW-2	Aluminum	5900	10200	12800	
	Antimony	3	ND	45.6BJ	
	Calcium	66200	143000	88200	
	Cobalt	7	17.0B	9.7B	
	Iron	300	30700	23500	
	Lead	15	20.5	-	
	Manganese	300	1600	765	
	Potassium	5850	ND	4110B	
	Vanadium	13	26.0B	27.5B	
MW-3	Antimony	3	18.2B	ND	
	Iron	300	6120	12500	
	Manganese	300	365	509	
MW-4	Aluminum	5900	42900	18700	ND
	Antimony	3	22.6B	ND	ND
	Beryllium	3	3.2B	-	ND
	Calcium	66200	465000	235000	-
	Chromium	50	53.7	-	ND
	Cobalt	7	50.2	21.2B	ND
	Iron	300	86900	39800	-
	Lead	15	56.5	22.6J	ND
	Manganese	300	6220	2590	-
	Potassium	2280	12800	5910	-
	Vanadium	13	97.5	47.9B	ND
1D	Iron	300	1340	4130	
	Zinc	300	-	342	
	Carbon Tetrachloride	5	11	16	
	Trichloroethene	5	11	7	
	bis (2-Ethylhexyl) Phthalate	5	89B	ND	

TABLE 5-34 (Cont'd)
MALTA ROCKET FUEL AREA SITE
GROUND WATER SAMPLE LOCATIONS WITH UNFILTERED ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Monitoring Well	Analyte/ Compound	MRFA Comparative Criteria	June 1992 Conc.	November 1992 Conc.
M-23	Aluminum	5900	36300	22700
	Calcium	66200	241000	166000
	Chromium	50	81.0	-
	Cobalt	7	27.1B	12.1B
	Copper	200	972	-
	Iron	300	60800	35100
	Lead	15	273	-
	Magnesium	35000	67700	39700
	Manganese	300	1930	1130
	Potassium	2280	11100	7450
	Vanadium	13	67.1	42.6B
	Zinc	300	647	-
	Carbon Tetrachloride	5	16	14
2S	Aluminum	5900	43000	39500
	Calcium	66200	364000	355000
	Chromium	50	62.0	58.3
	Cobalt	7	37.1B	29.5B
	Iron	300	87500	76200
	Lead	15	47.9	37.3
	Magnesium	35000	35500	35200
	Manganese	300	3320	2980
	Potassium	2280	11100	11200
	Vanadium	13	93.1	84.0
	Carbon Tetrachloride	5	140	67
	Chloroform	7	ND	8
	Trichloroethene	5	21	18
2D	Iron	300	4020	2040
	Zinc	300	596	-
	Carbon Tetrachloride	5	90J	44
	Chloroform	7	ND	7
	Trichloroethene	5	68J	49
3S	Aluminum	5900	13400	-
	Calcium	66200	180000	176000
	Cobalt	7	13.3B	8.4B
	Iron	300	26200	9710
	Manganese	300	1130	1080
	Potassium	2280	3960B	-
	Vanadium	13	28.0B	-
	Carbon Tetrachloride	5	22	24
	Trichloroethene	5	44	59
3D	Calcium	66200	71400	69200
	Iron	300	19700	20000
	Lead	15	61	17.2
	Zinc	300	1560	815
	Carbon Tetrachloride	5	7.0J	10
	Trichloroethene	5	16	24

TABLE 5-34 (Cont'd)
MALTA ROCKET FUEL AREA SITE
GROUND WATER SAMPLE LOCATIONS WITH UNFILTERED ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Monitoring Well	Analyte/ Compound	MRFA Comparative Criteria	June 1992 Conc.	November 1992 Conc.
4S	Aluminum	5900	40700	45800
	Calcium	66200	323000	285000
	Chromium	50	60.2	63.9
	Cobalt	7	38.9B	34.2B
	Iron	300	86300	77100
	Lead	15	44.5	33.1
	Manganese	300	3480	2870
	Potassium	2280	10100	14100
	Vanadium	13	87.1	94.7
4D	Aluminum	5900	-	8390
	Chromium	50	-	153.0
	Iron	300	51500	135000
	Lead	15	-	17.8
	Manganese	300	1240	2780
	Potassium	2280	2520B	3270B
	Vanadium	13	-	18.0B
	Zinc	300	884	1130J
	bis (2-Ethylhexyl) Phthalate	5	ND	320B
10S	Aluminum	5900	6320	14600
	Calcium	66200	109000	147000
	Cobalt	7	ND	12.5B
	Iron	300	11700	28700
	Manganese	300	450	974
	Potassium	2280	2670B	5760
	Vanadium	13	13.4B	34.9B
10D	Iron	300	521	953
11S	Aluminum	5900	8320	7200
	Calcium	66200	205000	252000
	Cobalt	7	17.3B	19.8B
	Iron	300	28000	25300
	Lead	15	31.6	27.9
	Manganese	300	2070	2560
	Vanadium	13	20.6B	21.1B
	Trichloroethene	5	14	17
11D	Calcium	66200	-	76500
	Iron	300	1980	1350
	Zinc	300	-	322J
	Carbon Tetrachloride	5	ND	6
	Trichloroethene	5	9J	7
13S	Aluminum	5900	7040	10100
	Antimony	3	25.0BJ	ND
	Calcium	66200	111000	133000
	Chromium	50	504	748J
	Cobalt	7	7.2B	7.3B
	Iron	300	14300	19800
	Manganese	300	495	598
	Potassium	2280	7530	5640
	Vanadium	13	16.0B	21.7B
	Carbon Tetrachloride	5	6J	18

TABLE 5-34 (Cont'd)
MALTA ROCKET FUEL AREA SITE
GROUND WATER SAMPLE LOCATIONS WITH UNFILTERED ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Monitoring Well	Analyte/ Compound	MRFA Comparative Criteria	June 1992 Conc.	November 1992 Conc.
13D	Chromium	50	98.4	-
	Iron	300	1160	703
M-15	Aluminum	5900	68700	32500
	Beryllium	3	5.1	-
	Calcium	66200	674000	298000
	Chromium	50	92.8	56.4J
	Cobalt	7	62.0J	26.8B
	Copper	200	261J	-
	Iron	300	144000	68600
	Lead	15	95.5	31.7J
	Magnesium	35000	64300	-
	Manganese	300	7710	3000
	Nickel	100	140J	-
	Potassium	2280	15300	9100
	Vanadium	13	151	71
	Zinc	300	409	-
	Carbon Tetrachloride	5	-	7J
M-16	Aluminum	5900	-	11500
	Calcium	66200	131000	151000
	Chromium	50	-	67.6J
	Cobalt	7	ND	10.2B
	Iron	300	6440	20500
	Manganese	300	412	649
	Potassium	2280	ND	4380B
	Vanadium	13	-	24.2B
	Zinc	300	391	-
	Carbon Tetrachloride	5	5J	8
M-17	Aluminum	5900	130000	50200
	Antimony	3	40.3B	ND
	Barium	1000	1280	-
	Beryllium	3	9.8	3.4B
	Calcium	66200	1270000	441000
	Chromium	50	394.0	228.0
	Cobalt	7	154	52.7
	Copper	200	910	286J
	Iron	300	331000	106000
	Lead	15	185	61.9
	Magnesium	35000	138000	60100
	Manganese	300	20600	6990
	Nickel	100	491	240
	Potassium	2280	26100	13800
	Vanadium	13	311	114
	Zinc	300	1030	494
	Carbon Tetrachloride	5	27	22
	Trichloroethene	5	16	14

TABLE 5-34 (Cont'd)
MALTA ROCKET FUEL AREA SITE
GROUND WATER SAMPLE LOCATIONS WITH UNFILTERED ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Monitoring Well	Analyte/ Compound	MRFA Comparative Criteria	June 1992 Conc.	November 1992 Conc.
M-18	Aluminum	5900	14000	-
	Calcium	66200	151000	67400
	Iron	300	38300	4220
	Lead	15	34.1	-
	Magnesium	35000	37700	-
	Manganese	300	7440	2530
	Potassium	2280	-	2940B
	Tetrachloroethene	5	9J	6
M-19	Aluminum	5900	227000	92100
	Antimony	3	64.7	40.9B
	Arsenic	25	-	27.1
	Barium	1000	3440	-
	Beryllium	3	20.7	6.5
	Calcium	66200	1150000	216000
	Chromium	50	263	199
	Cobalt	7	243	83
	Copper	200	942	311J
	Iron	300	416000	167000
	Lead	15	187	94.2
	Magnesium	35000	114000	41000
	Manganese	300	48100	13700
	Nickel	100	506	237
	Potassium	2280	37200	21900
	Vanadium	13	400	182
	Zinc	300	1350	538
	Carbon Tetrachloride	5	140	220
	Chloroform	7	ND	32
	Trichloroethene	5	140	280
M-20	Aluminum	5900	93800	21700
	Antimony	3	ND	59.8
	Beryllium	3	6.3	-
	Calcium	66200	656000	298000
	Chromium	50	273.0	-
	Cobalt	7	98.6J	44.0B
	Copper	200	715J	-
	Iron	300	213000	50200
	Lead	15	123	57.9
	Magnesium	35000	81500	-
	Manganese	300	8440	4330
	Nickel	100	303J	-
	Potassium	2280	16700	3410B
	Vanadium	13	208.0	41.8B
	Zinc	300	638	-

TABLE 5-34 (Cont'd)
MALTA ROCKET FUEL AREA SITE
GROUND WATER SAMPLE LOCATIONS WITH UNFILTERED ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Monitoring Well	Analyte/ Compound	MRFA Comparative Criteria	June 1992 Conc.	November 1992 Conc.
M-21	Aluminum	5900	87200	36000
	Antimony	3	31.2B	ND
	Arsenic	25	27.4J	-
	Beryllium	3	5.6	-
	Calcium	66200	550000	185000
	Chromium	50	330.0	120J
	Cobalt	7	89.2J	33.1B
	Copper	200	331J	-
	Iron	300	193000	73400
	Lead	15	89.1	32.5J
	Magnesium	35000	94000	-
	Manganese	300	8220	2560
	Nickel	100	322J	126J
	Potassium	2280	15500	8770
	Sodium	20000	22600	-
	Vanadium	13	185	74.8
	Zinc	300	590	402J
M-22	Aluminum	5900	61800	35100
	Beryllium	3	4.6B	-
	Calcium	66200	547000	280000
	Chromium	50	94.9	156J
	Cobalt	7	72.1J	36.1B
	Copper	200	266J	-
	Iron	300	138000	79100
	Lead	15	84.4	41.9J
	Magnesium	35000	50900	-
	Manganese	300	6480	3080
	Nickel	100	147J	111J
	Potassium	2280	12100	9030
	Vanadium	13	139	78.2
	Zinc	300	402	379J
M-24S	Aluminum	5900	88100	23300
	Beryllium	3	5.4	-
	Calcium	66200	348000	124000
	Chromium	50	121	137J
	Cobalt	7	68.7	19.8B
	Copper	200	278	-
	Iron	300	181000	45500
	Lead	15	92.4	23.15
	Magnesium	35000	68900	-
	Manganese	300	6170	1460
	Nickel	100	156	114J
	Potassium	2280	19300	5970
	Vanadium	13	186	52.9
	Zinc	300	468	-

TABLE 5-34 (Cont'd)
MALTA ROCKET FUEL AREA SITE
GROUND WATER SAMPLE LOCATIONS WITH UNFILTERED ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Monitoring Well	Analyte/ Compound	MRFA Comparative Criteria	June 1992 Conc.	November 1992 Conc.
M-24D	Iron	300	662	423
	Potassium	2280	2320B	-
	Zinc	300	724	795J
	Carbon Tetrachloride	5	10	-
M-25S	Aluminum	5900	28100	25900
	Antimony	3	35.0B	ND
	Calcium	66200	176000	165000
	Chromium	50	-	55.7
	Cobalt	7	23.0B	17.4B
	Iron	300	60300	48900
	Lead	15	34	23.6
	Manganese	300	2050	1660
	Potassium	2280	7250	8000
	Sodium	20000	21700	-
	Vanadium	13	59.2	55.1
	Carbon Tetrachloride	5	ND	22J
	Trichloroethene	5	6J	13J
M-25D	Sodium	20000	-	20800
	Zinc	300	568	536
	Carbon Tetrachloride	5	48	R
M-26S	Aluminum	5900	80300	6410
	Beryllium	3	5.8	-
	Calcium	66200	665000	397000
	Chromium	50	121	-
	Cobalt	7	91.3	30.8B
	Copper	200	308	-
	Iron	300	170000	21400
	Lead	15	82.6	63
	Magnesium	35000	47200	-
	Manganese	300	9430	3870
	Nickel	100	178	-
	Potassium	2280	20900	-
	Vanadium	13	181	18.2B
	Zinc	300	472	-
M-26D	Iron	300	342	-
	Zinc	300	518	939J
M-27S	Aluminum	5900	-	38000
	Antimony	3	ND	37.4B
	Calcium	66200	87800	156000
	Chromium	50	-	57.4
	Cobalt	7	9.7B	28.7B
	Iron	300	13700	72100
	Lead	15	-	31.2
	Manganese	300	1220	2920
	Potassium	2280	ND	10100
	Vanadium	13	-	83.4
	Chloromethane	5	40	ND

TABLE 5-34 (Cont'd)
MALTA ROCKET FUEL AREA SITE
GROUND WATER SAMPLE LOCATIONS WITH UNFILTERED ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Monitoring Well	Analyte/ Compound	MRFA Comparative Criteria	June 1992 Conc.	November 1992 Conc.
M-27D	Iron	300	-	461
	Zinc	300	544	913
	Carbon Tetrachloride	5	75	23
	Chloromethane	5	28	ND
M-28S	Aluminum	5900	20600	12800
	Antimony	3	16.7B	ND
	Cadmium	5	127	211
	Calcium	66200	181000	392000
	Cobalt	7	21.7B	38.8B
	Iron	300	44400	53200
	Lead	15	30.1	1340
	Magnesium	35000	-	36300
	Manganese	300	2110	5050
	Potassium	2280	6170	2690B
	Vanadium	13	46.2B	33.9B
	Zinc	300	-	534J
	Carbon Tetrachloride	5	46	33
	Trichloroethene	5	47	49
M-28D	Zinc	300	625	456J
	Carbon Tetrachloride	5	31	42
	1,1,1-Trichloroethane	5	37	51
M-29S	Aluminum	5900	49600	11100
	Antimony	3	19.8BJ	ND
	Beryllium	3	3.2B	-
	Calcium	66200	284000	195000
	Chromium	50	169	-
	Cobalt	7	47.5B	22.0B
	Iron	300	114000	29900
	Lead	15	49.8	27.6
	Magnesium	35000	51900	-
	Manganese	300	4730	2630
	Nickel	100	166	-
	Potassium	2280	12500	-
	Vanadium	13	111	24.8B
	Zinc	300	306	-
	Carbon Tetrachloride	5	32	43
	Trichloroethene	5	24	28
M-29D	Antimony	3	17.5BJ	ND
	Iron	300	388	-
	Zinc	300	831	1430J
	Carbon Tetrachloride	5	79	84
	Chloroform	7	ND	14
	Trichloroethene	5	19	24

TABLE 5-34 (Cont'd)
MALTA ROCKET FUEL AREA SITE
GROUND WATER SAMPLE LOCATIONS WITH UNFILTERED ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Monitoring Well	Analyte/ Compound	MRFA Comparative Criteria	June 1992 Conc.	November 1992 Conc.
M-30	Aluminum	5900	77400	28500
	Beryllium	3	5	-
	Calcium	66200	261000	96800
	Chromium	50	111	-
	Cobalt	7	61.8J	17.8B
	Copper	200	256J	-
	Iron	300	128000	38200
	Lead	15	73.6	17.2
	Magnesium	35000	67400	-
	Manganese	300	6080	1610
	Nickel	100	144J	-
	Potassium	2280	17900	9240
	Vanadium	13	143	49.1B
	Zinc	300	316	-
	Carbon Tetrachloride	5	12J	14
	Trichloroethene	5	8J	11
M-31S	Aluminum	5900	49500	22100
	Beryllium	3	4.0B	-
	Cadmium	5	ND	9.6
	Calcium	66200	142000	-
	Chromium	50	78.6	-
	Cobalt	7	29.8B	8.8B
	Copper	200	240	-
	Iron	300	81000	35500
	Lead	15	60.2	-
	Manganese	300	1780	739
	Potassium	2280	9450	7200
	Vanadium	13	170	69.3
M-31D	Iron	300	2190	607
	Zinc	300	-	446J
M-32	Aluminum	5900	32200	6850
	Antimony	3	17.7B	ND
	Calcium	66200	200000	102000
	Cobalt	7	23.1B	ND
	Iron	300	52900	9490
	Lead	15	21.6	-
	Magnesium	35000	45000	-
	Manganese	300	1950	349
	Potassium	2280	9340	2560
	Vanadium	13	60	-
	Carbon Tetrachloride	5	56	63
	Tetrachloroethene	5	8J	18
	Trichloroethene	5	76	95

TABLE 5-34 (Cont'd)
MALTA ROCKET FUEL AREA SITE
GROUND WATER SAMPLE LOCATIONS WITH UNFILTERED ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Monitoring Well	Analyte/ Compound	MRFA Comparative Criteria	March 1994 Conc.
M-33S	Iron	300	909
M-33I	Calcium	66200	93600
	Iron	300	1730
	Potassium	2280	12900
	Sodium	20000	27400
M-34	Aluminum	5900	16300
	Calcium	66200	132000
	Chromium	50	76.4
	Cobalt	7	9.7B
	Iron	300	27000
	Lead	15	18.1
	Manganese	300	876
	Potassium	2280	6030
	Vanadium	13	33.2B
	Carbon Tetrachloride	5	8J
M-35S	Calcium	66200	94800
	Iron	300	3760J
	Manganese	300	531
	Carbon Tetrachloride	5	44
	Chloroform	7	8J
	Tetrachloroethene	5	57
	Trichloroethene	5	58
M-35D	Iron	300	1920

Notes:

1. All concentrations are in ug/l (ppb).
2. ND = analyte/compound was not detected.
3. - = analyte/compound was detected below the MRFA Comparative Criteria.
4. R = analyte/compound was detected above the MRFA Comparative Criteria but was rejected.
5. J = Semi-quantitative value due to QA/QC data validation requirements.
6. B (inorganics) = Value is above the Instrument Detection Limit (IDL) but below the Contract Required Detection Limit (CRDL).
7. B (organics) = Compound was detected in associated method blank.

GWABU.XLS 8/11/94

TABLE 5-35
MALTA ROCKET FUEL AREA SITE
GROUND WATER SAMPLE LOCATIONS WITH FILTERED ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Monitoring Well	Analyte/ Compound	MRFA Comparative Criteria	June 1992 Conc.	November 1992 Conc.	March 1994 Conc.
2S	Calcium	66200	70800	82900	
3S	Calcium	66200	79500	68200	
3D	Calcium	66200	69700	66600	
10S	Calcium	66200	69100	-	
13S	Antimony	3	22.4B	R	
	Calcium	66200	70700	80800	
	Chromium	50	512	834J	
	Potassium	2280	4440B	3660B	
M-16	Calcium	66200	99800	98900	
M-17	Calcium	66200	95700	88600	
	Zinc	300	-	355	
M-19	Calcium	66200	67600	-	
	Iron	300	546	-	
M-21	Calcium	66200	99000	75800	
	Sodium	20000	20900	-	
M-22	Calcium	66200	103000	101000	
M-24D	Zinc	300	537J	731J	
M-25S	Sodium	20000	21400	-	
M-25D	Sodium	20000	-	20100	
	Zinc	300	589	492	
M-26S	Calcium	66200	74400	-	
M-26D	Zinc	300	365J	778J	
M-27D	Zinc	300	531J	817	
M-28S	Antimony	3	17.7	ND	
	Cadmium	5	19	ND	
	Iron	300	379	-	
M-28D	Zinc	300	549	608J	
M-29S	Antimony	3	ND	48.5BJ	
	Calcium	66200	70500	73000	
M-29D	Potassium	2280	2610B	ND	
	Zinc	300	727J	1660J	
M-31S	Iron	300	1480	4170	
	Manganese	300	313	394	
M-31D	Zinc	300	-	393J	
M-32	Calcium	66200	70500	75700	
M-331	Potassium	2280			12400
	Sodium	20000			27500
M-35S	Calcium	66200			74000
M-35D	Potassium	2280			2840
	Sodium	20000			20900

Notes:

1. All concentrations are in ug/l (ppb).
2. ND = analyte/compound was not detected.
3. - = analyte/compound was detected below the MRFA Comparative Criteria.
4. R = analyte/compound was detected above the MRFA Comparative Criteria but was rejected.
5. J = Semi-quantitative value due to QA/QC data validation requirements.
6. B = Value is above the Instrument Detection Limit (IDL) but below the Contract Required Detection Limit (CRDL).

GWABP.XLS 9/16/94

TABLE 5-37
MALTA ROCKET FUEL AREA SITE
DRY WELL SAMPLE LOCATIONS WITH
ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Area	Sample No.	Analyte/ Compound	Conc.	MRFA Comparative Criteria
Bldg. 1	DW-1A-1*	Mercury	40.7J	8.1
		Benzo (a) Anthracene	1100	220
		Benzo (a) Pyrene	550	61
		Benzo (b) Fluoranthene	1300	1100
		Chrysene	660	400
		Dibenzo (a,h) Anthracene	160J	14
		Aroclors-1254, 1260	23400	10000
Bldg. 1 open sump	DW-1A-2**	Cadmium	2.3	0.8
		Chromium	26.6J	26
		Copper	131J	19
		Iron	28200	24000
		Lead	254J	27
		Mercury	0.99J	0.11
		Zinc	719J	85
		Aroclor-1260	430	0.08
Bldg. 2	DW-2-3*	Arsenic	9.8	8.1
		Mercury	207J	8.1
		Benzo (a) Anthracene	810J	220
		Benzo (a) Pyrene	890J	61
		Benzo (b) Fluoranthene	1200J	1100
		Chrysene	1100J	400
		Dibenzo (a,h) Anthracene	350J	14
		4,4'-DDE	5700C	2100
		4,4'-DDD	25000BCD	2900
		4,4'-DDT	48000BCD	2100
Bldg. 3	DW-3-1***	Arsenic	13	8.1
		Aroclor-1260	15000JNCD	1000
Bldg. 3	SS-B3DW***	Aroclor-1262	9200J	1000
		Aroclor-1268	9300J	1000
Bldg. 3	DW-3-2***	Aroclor-1260	1000J	1000
Bldg. 4	DW-4-2*	Total VOCs	12830J	10000
		Unknown C13-Alkane	96000J	50000
		Unknown C14-Alkanes	176000J	50000
		Unknown C15-Alkanes	115000J	50000
		Unknown C16-Alkane	73000J	50000
		Total SVOCs	772000J	500000
Bldg. 5	DW-5-1**	Arsenic	5.1J	5.0
		Cadmium	2.2J	0.8
		Copper	41.0J	19
		Lead	56.6J	27
		Mercury	3.0J	0.11
		Zinc	171J	85
		4,4'-DDE	7	0.1
		4,4'-DDT	7.5	0.1
		Aroclor-1254	110	0.08
		Aroclor-1260	170J	0.08

TABLE 5-37 (Cont'd)
MALTA ROCKET FUEL AREA SITE
DRY WELL SAMPLE LOCATIONS WITH
ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Area	Sample No.	Analyte/ Compound	Conc.	MRFA Comparative Criteria
Bldg. 5	DW-5-2**	Cadmium	12.6J	0.8
		Copper	85.2J	19
		Lead	85.9J	27
		Mercury	5.2J	0.11
		Nickel	27.1	22
		Zinc	95.9J	85
		4,4'-DDE	23J	0.1
		4,4'-DDT	70J	0.1
		Aroclor-1260	210J	0.08
Bldg. 15	DW-15**	Arsenic	22.3J	5
		Cadmium	10.1J	0.8
		Chromium	38.0J	26
		Copper	540J	19
		Iron	91900	24000
		Lead	938J	27
		Manganese	679J	428
		Mercury	1130J	0.11
		Nickel	39.1	22
		Zinc	1410J	85
		4,4'-DDE	5.4J	0.1
		4,4'-DDT	99	0.1
		Aroclor-1254	350J	0.08
		Aroclor-1260	1700	0.08
Bldg. 20	DW-20H**	Lead	34.5J	27
		Mercury	0.16J	0.11
		Benzo (a) Anthracene	38J	13
		Benzo (b) Fluoranthene	29J	13
		Benzo (k) Fluoranthene	41J	13
		Benzo (a) Pyrene	32J	13
		Chrysene	38J	13
Bldg. 24	DW-24-1**	Arsenic	8.3	5.0
		Copper	38.7	19
		Lead	44.4	27
		Manganese	554	428
		Mercury	0.11J	0.11
		Zinc	288	85
		Benzo (a) Anthracene	79J	13
		Benzo (b) Fluoranthene	97J	13
		Benzo (k) Fluoranthene	45J	13
		Benzo (a) Pyrene	54J	13
		Chrysene	64J	13
		Indeno (1,2,3-cd) Pyrene	36J	13
		Phenol (total unchlorinated)	110J	5
		4,4'-DDT	4.3J	0.1
		Aroclor-1260	110	0.08

TABLE 5-37 (Cont'd)
MALTA ROCKET FUEL AREA SITE
DRY WELL SAMPLE LOCATIONS WITH
ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Area	Sample No.	Analyte/ Compound	Conc.	MRFA Comparative Criteria
Bldg. 24	DW-24-2**	Arsenic	9.1	5.0
		Cadmium	0.97B	0.8
		Copper	38.9	19
		Lead	43.2	27
		Manganese	570	428
		Mercury	0.11J	0.11
		Nickel	23.1	22
		Zinc	375	85
		Benzo (a) Anthracene	84J	13
		Chrysene	80J	13
		Phenol (total unchlorinated)	550J	5
		Aroclor-1260	160	0.08
former GE/Exxon Building	DW-GE/EX-2*	Benzo (a) Anthracene	900	220
		Benzo (a) Pyrene	1000	61
		Chrysene	980	400
		Dibenzo (a,h) Anthracene	180J	14

Notes:

1. Inorganics are in mg/kg (ppm), organics are in ug/kg (ppb).
2. * = Subsurface soil MRFA Comparative Criteria used.
3. ** = Sediment MRFA Comparative Criteria used.
4. *** = Surface soil MRFA Comparative Criteria used.
5. J = Semi-quantitative value due to QA/QC data validation requirements.
6. N = >50% difference for detected concentrations between the two GC columns. The lower value is reported.
7. B (inorganics) = Value is above the Instrument Detection Limit (IDL) but below the Contract Required Detection Limit (CRDL).
8. B (organics) = Compound was detected in associated method blank.
9. C = Compound identification was confirmed by GC/MS.
10. D = Analysis performed at a higher dilution factor.

TABLE 5-39
MALTA ROCKET FUEL AREA SITE
SEPTIC TANK SAMPLE LOCATIONS WITH ANALYTES ABOVE MRFA COMPARATIVE CRITERIA

Area	Sample No.	Analyte/ Compound	Conc.	MRFA Comparative Criteria
Bldg. 13	SL1301	Aluminum	6010	2000
		Cadmium	60.1	20
		Chromium	174	100
		Copper	2250	1000
		Iron	36400	600
		Lead	327J	50
		Mercury	5.9	4
		Zinc	7330	5000
		Iron + Manganese	36642	1000
		Acetone	90	50
		1,2-Dichloroethene	160	5
		1,4-Dichlorobenzene	35	4.7
		Total Phenols	20	2
		Toluene	5J	5
		Total PCBs	0.7PJ	0.1
Bldg. 17	SL1701	Sodium	81200	40000 (g)
		Acetone	89	50
		Total Phenols	610D	2
Bldg. 20	SL20-N-01	Iron	1250	600
		Iron + Manganese	1291.4	1000
		Toluene	37	5
		Total Phenols	30J	2
Bldg. 20	SL20-O-01	Aluminum	2130	2000
		Iron	4460	600
		Sodium	76300	40000 (g)
		Iron + Manganese	4591	1000
Bldg. 25	SL2501	Aluminum	2610	2000
		Cadmium	45.7	20
		Iron	27200J	600
		Lead	257J	50
		Silver	212J	100
		Iron + Manganese	27345J	1000
		1,2-Dichloroethene	4000	5
		Toluene	41J	5
		1,4-Dichlorobenzene	44J	4.7
		Total PCBs	1.71PJ	0.1
former GE/Exxon Bldg.	SLGEX01	Sodium	53300	40000 (g)
		Acetone	150	50
		Toluene	90	5
		Xylene	36	5
		Total Phenols	850	2

Notes:

1. All results and criteria are in ug/l (ppb).
2. (g) = Guidance value from NYSGWS.
3. J = Semi-quantitative value due to QA/QC data validation requirements.
4. D = Reported values are from secondary dilution analysis.
5. P = >25% difference for detected concentrations between the two GC columns. The lower value is reported.

SEPABCR.XLS 8/11/94

APPENDIX C

Estimates of Soil Volume

Appendix C

Estimate of Soil Volumes

Malta Rocket Fuel Area Site

Location	Samples (concentrations)	Approximate Volume Dimensions (Length x Width x Depth in feet)	Estimated Volume to be Considered for Remediation (Cubic Yards)
PCBs/Lead - Soil containing PCBs and lead at Building 23P (see Attachment C-1)			
Building 23P	SS-23P/04 (PCBs = 20.3 ppm) SS-23P/04 (lead = 1090 ppm)	15'x5'x1'	3 cy (Use 5 cy for cost estimating)
Mercury - Soil containing mercury at elevated concentrations (see Attachment C-2)			
Muggett's Pond Drainage Ditch Intersection	SD-DD1 (124 ppm)	3'x30'x1'	3 cy

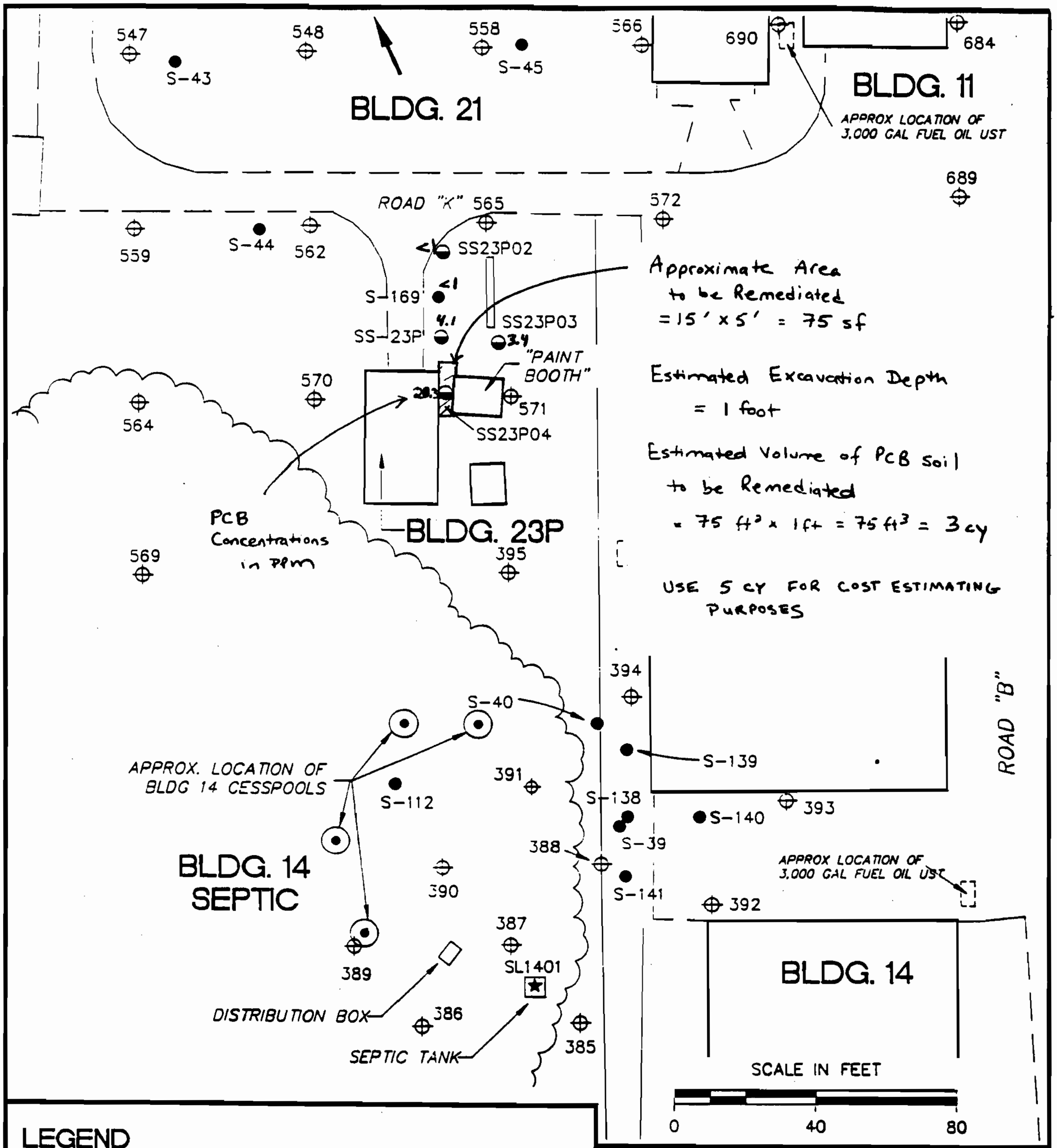
Determination of Remediation Levels:

PCBs: The remediation level for PCBs is 10 ppm for surface soil and 25 ppm for subsurface soil (i.e., below 1 foot depth) based on the Toxic Substances Control Act (TSCA). Risk calculations are provided in the attached ENVIRON memorandum dated October 4, 1995.

Lead: The lead remediation level for the Site, which is an industrial setting, is based on the upper bound of the Center for Disease Control's recommended remediation level for residential settings (500-1,000 ppm of lead) based on elevation of blood lead levels in children, a sensitive sub-population (see EPA OSWER Directive No. 9355.4-02).

Mercury: Based on risk calculations, remediation of the concrete-lined Muggett's Pond Drainage Ditch intersection area is recommended since mercury is known to biomagnify in terrestrial food chains. The soil remediation level for mercury is 2 ppm. Risk-based calculations for soil remediation levels for mercury are provided in the attached ENVIRON memorandum dated June 21, 1995.

K:\FS\APPEND\VOLUME2.APP



PCB Concentrations in ppm

Approximate Area to be Remediated = 15' x 5' = 75 sf

Estimated Excavation Depth = 1 foot

Estimated Volume of PCB soil to be Remediated = 75 ft² x 1 ft = 75 ft³ = 3 cy

USE 5 CY FOR COST ESTIMATING PURPOSES

LEGEND

⊙	CESSPOOLS
390 ⊕	SOIL GAS SAMPLING LOCATION & ID#
S-40 ●	SOIL BORING LOCATION & ID#
SS-23P ◒	SURFACE SOIL SAMPLE LOCATION & ID#
SL1401 ★	SEPTIC TANK SAMPLING LOCATION & ID#

SAMPLING LOCATIONS FOR BUILDINGS 23 AND 23P

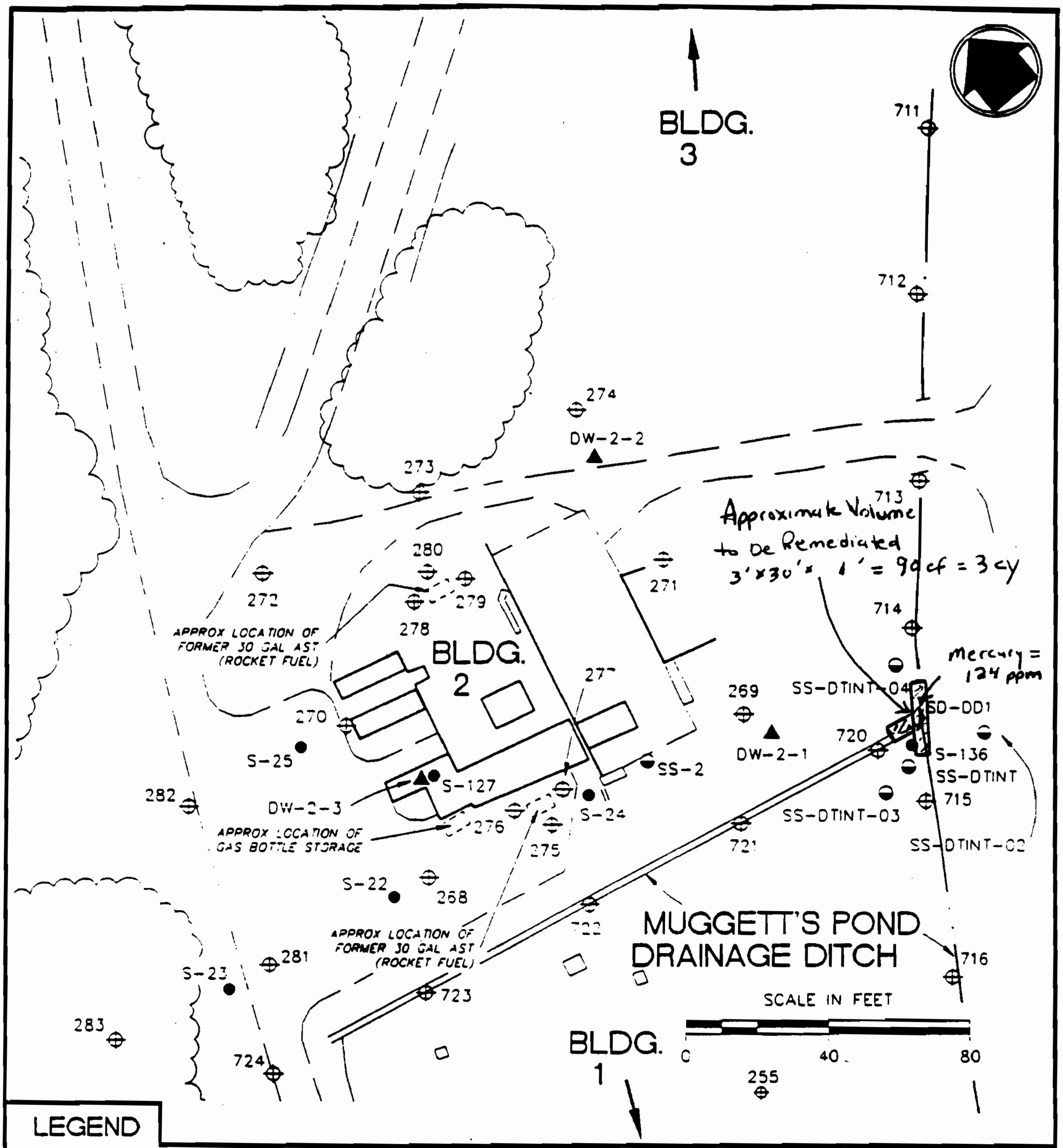
Appendix C - Attachment C-1

PREPARED FOR

MALTA ROCKET FUEL AREA SITE

ERM-Northeast
Environmental Resources Management

SCALE 1"=40'
DATE 06/94
FIGURE 6-31



LEGEND

254 ⊕	SOIL GAS SAMPLING LOCATION & ID#
S-25 ●	SOIL BORING LOCATION & ID#
SS-DTINT ⊖	SURFACE SOIL SAMPLE LOCATION & ID#
SD-DD1 ◊	SEDIMENT SAMPLE LOCATION & ID#
DW-2-1 ▲	DRY WELL SAMPLING LOCATION & ID#

SAMPLING LOCATIONS FOR BUILDING 2

Appendix C - Attachment C-2

PREPARED FOR

MALTA ROCKET FUEL AREA SITE

ERM ERM-Northeast
Environmental Resources Management

SCALE 1"=40'
DATE 03/94
FIGURE 6-18

MEMO 16004-16024

ENVIRON

MEMORANDUM

Date: October 4, 1995

From: R.L. Shuler

To: K. Begor, G.E.

Subject: Risk Estimates Based on Building 23P Cleanup to 10 ppm PCBs

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At your request, ENVIRON has calculated the hypothetical risks associated with exposure to surface soils at the Malta Rocket Fuel Area Site following cleanup of Building 23P to 10 ppm for PCBs. The future child (age 1-6) resident receptor was chosen for this evaluation based on the *Final Revised Risk Assessment, Malta Rocket Fuel Area Site, Towns of Malta and Stillwater, New York* (June 1995), as this receptor was most sensitive to PCB exposure in surface soils. Estimated excess lifetime cancer risk and noncarcinogenic hazard index (HI) were calculated for the incidental ingestion of surface soils.

Specifically, the surface soil PCB concentrations (including Building 23P) used to estimate the risks in the *Final Revised Risk Assessment* were 0.6 mg/kg, 16.0 mg/kg and 4.3 mg/kg for Aroclors 1260, 1262 and 1268, respectively. As reported in the *Final Revised Risk Assessment*, the resulting estimated excess lifetime cancer risk (summed for all COCs) was 1.9×10^{-4}, while the HI (summed for all COCs) was estimated to be 1.2.

In the evaluation presented here, the surface soil PCB concentrations (including Building 23P) following cleanup to 10 ppm PCBs were 0.6 mg/kg, 9.1 mg/kg and 4.3 mg/kg for Aroclors 1260, 1262 and 1268, respectively. The resulting estimated excess lifetime cancer risk (summed for all COCs) is 1.3×10^{-4}, while the HI (summed for all COCs) is estimated to be 0.8. Thus, the resulting estimated risks are lower following remediation to 10 ppm PCBs in surface soils, as would be expected.

Based upon these calculations and the discussions presented in the *Final Revised Risk Assessment*, no unacceptable risk is expected to be presented by surface soils following cleanup of the Building 23P area to 10 ppm. It should be noted that the exposure assumptions used in these calculations are designed to be conservative (health protective); therefore, any actual risk posed by exposure to surface soils is likely to be overestimated by these calculations.

A division of APBI Environmental Sciences Group, Inc.
214 Carnegie Center • Princeton, New Jersey 08540-6284 • USA • Tel: (609) 452-9000 • Fax: (609) 452-0284

ENVIRON MEMORANDUM

To: K. Begor, GE
Date: 21 June 1995

From: W. Kappleman
Project: 02-2413F

Subject: Derivation of Mercury Remediation Level for Soils

A preliminary soil remediation level for mercury has been calculated at the GE Malta site for the protection of ecological receptors. This soil level was derived by back-calculating, using a food chain exposure model, from a hazard quotient of one for an ecologically sensitive species. The species utilized for this calculation was the short-tailed shrew, which was the only terrestrial indicator species with hazard quotients exceeding one in the baseline ecological risk assessment. The short-tailed shrew is a mid-trophic level predator with a relatively high food intake rate, and it thus has a relatively large exposure via its food. The shrew is also a food source for higher-trophic level predators. Thus, potential adverse impacts to both the shrew and their predators (by reductions in food supply) are addressed. Potential impacts to higher trophic level species from consuming shrews are addressed in the risk assessment; significant risks were not predicted at baseline soil levels. The food chain exposure model, and associated input values, were the same as used in the risk assessment:

$$DI_x = \sum \frac{AFR \times AMC_{xi} \times PDC_i}{ABW} \qquad (1)$$

where:
DI_x = Average intake of constituent x (μg/g-BW/day)
AFR = Average feeding rate (g food/day)
AMC_{xi} = Average concentration of constituent x in food item i (μg/g)
PDC_i = Percentage of diet for food item i
ABW = Average body weight (g)

The back-calculation involves setting DI_x to the toxicological threshold for the shrew (equivalent to a hazard quotient of one) and solving for the soil concentration portion of the AMC term. Input values used in the model (references for these values can be found in the risk assessment) were:

DI_x = 0.25 μg/g-BW/day
AFR = 7.95 g food/day
PDC_i = Earthworms - 0.87
Plants - 0.11
Soil - 0.02
ABW = 16.9 g

The AMC term is composed of three subterms for earthworm ingestion, plant ingestion, and incidental soil ingestion. The tissue concentrations in earthworms was calculated by multiplying the soil concentration by a soil-to-earthworm bioaccumulation factor of 0.96 and dividing by 4 (to convert from dry weight to wet weight). The tissue concentrations in plants was calculated by multiplying the soil concentration by a soil-to-plant bioaccumulation factor of 0.90 and dividing by 20 (to convert from dry weight to wet weight). An incidental soil ingestion factor of two percent of the total dietary intake was also applied.

The soil remediation level is thus 2.27 mg/kg for mercury as follows:

$$0.25 = \frac{[(7.95)(2.27*0.9/20)(0.11)] + [(7.95)(2.27*0.96/4)(0.87)] + [7.95*2.27*0.02]}{16.9}$$

Table 1 compares this value to mean baseline soil concentrations, as well as to projected mean soil concentrations following remediation of Building 23P and the Muggett's Pond drainage ditch (sample SD-DD1). Use of the soil level for mercury based on the shrew should be used with caution. The habitats present in areas where hazard quotients exceed one following the proposed remedial activities currently outlined in the risk assessment (i.e., developed areas) contain limited suitable habitat for this species. Also, the exposure model assumes that all of the shrew's food comes from the specified habitats (developed, etc.). Thus, clean-up levels based on this approach are likely to be overprotective.

Please call me at 703-516-2342 if you have any questions.

c.c. D. Woltering
G. Lage, ERM
B. Hotchkin, RUST

TABLE 1
Preliminary Mercury Soil Clean-up Levels - GE Malta Site

Chemical	Potential Clean-up Level (mg/kg)	Mean Baseline Soil Concentration (mg/kg)[a]	Mean Projected Soil Concentration (mg/kg)[ab]
Mercury - Entire Site	2.3[c]	**4.0**	1.9
Mercury - Forested	2.3	0.2	0.2
Mercury - Field/Shrub	2.3	**10.6**	1.2
Mercury - Developed	2.3	**2.5**	**2.5**

[a] Shading indicates soil concentrations that are below the potential clean-up level; bolding indicates soil concentrations that are above the potential clean-up level.

[b] Following remediation of Building 23P and Muggett's Pond drainage ditch.

[c] Based on a wildlife ingestion threshold value for mammals (Eisler 1987).

APPENDIX D

Groundwater Modelling for Evaluation of Groundwater Remedial Alternatives

1.0 INTRODUCTION

1.1 General

The groundwater remedial alternatives have been evaluated using a groundwater flow model, the results of which are presented as follows. The evaluation was based on information reported in the Site remedial investigation (RI), mathematical modeling of groundwater flow in the vicinity of the Site, and an estimation of contaminant recovery rate as a function of the groundwater flow velocity and estimation of advective retardation of contaminant migration relative to groundwater flow. The purpose of the evaluation was to provide a basis of comparison of the remedial alternatives considered in the feasibility study. The analyses presented herein do not constitute a design study for the remedial alternatives considered. Additional data collection and evaluation may be required in conjunction with the design and implementation of the selected remedial alternative.

1.2 Site Geology, Hydrogeology and Chemistry

The MRFA Site and surrounding area is characterized by gently undulating uplands with occasional rises and extensive 50-foot deep ravines incised in unconsolidated deposits consisting of aeolian sand at the surface, and a sequence of glacio-lacustrine deposits that become progressively finer grained with depth. The RI Report characterized these glacio-lacustrine deposits as comprising three layers: medium to fine sand (upper water bearing zone), fine sand and silt (lower water bearing zone), and basal silt and clay (confining layer). The water table typically occurs in the lower 10 to 20 feet of the medium to fine sand layer creating a total saturated thickness of approximately 50 feet for the combined water bearing zones. The hydraulic interconnection between these two zones may be imperfect as indicated by the presence of their slightly differing groundwater flow regimes (see RI Report) and the absence of observed drawdown in the upper water bearing zone after 24 hours of continuous pumping from the lower water bearing zone during a 1986 pumping test. However, for FS purposes and long-term, steady state pumping conditions, the two water bearing zones are considered to be a single hydrogeologic unit. Groundwater is recharged by precipitation, discharged locally by the nearby spring-fed ravines and extracted as needed by the Site water supply wells that are screened in the lower water bearing zone.

Isoconcentration contour maps presented in the RI Report indicate that a plume of contaminated groundwater underlies the Malta Test Station (MTS). The plume consists primarily of dissolved volatile organic compounds (VOCs), principally carbon tetrachloride and trichloroethene (TCE). The highest concentrations were detected in the central portion of the MTS, where carbon tetrachloride was detected at 220 ug/l (ppb) in the upper water bearing zone. Carbon tetrachloride was also detected in the lower water bearing zone. The lateral and vertical extent of the carbon tetrachloride and TCE plume appears to encompass the groundwater plume defined by other VOC contaminants, and therefore serves as a convenient indicator of groundwater contamination at the MTS.

2.0 ANALYSIS

Groundwater flow was simulated using the two-dimensional analytical groundwater model TWODAN (Fitts, 1994). This model simulates the behavior of an aquifer by superimposing analytical solutions for the various elements that comprise the site-specific model.

2.1 Conceptual Groundwater Flow Model

For this study the MRFA Site was modeled as a homogeneous, unconfined "aquifer" of infinite horizontal extent with a maximum potential saturated thickness of 80 feet. The actual saturated thickness varies over the horizontal extent of the "aquifer" depending on the distribution and strength (flow rate) of the model water sources (infiltration, injection wells) and sinks (pumping wells and linesinks).

Recharge to the "aquifer" is assumed to be provided by infiltration of rainwater uniformly distributed over the entire extent of the "aquifer". Discharge from the model is provided by linesinks placed at the location of the ravines to the north and south of the Site. The linesinks remove water from the "aquifer" at a constant rate along their length so that the groundwater elevation at the center of the linesink is equal to the ground surface elevation at the center of the linesink.

The model configuration is shown on Figure D-1. For the purposes of this discussion, directions are referenced to the site plan shown on Figure D-1, i.e., plan north is actually northeast.

2.2 Groundwater Flow Model Calibration

Prior to simulating remedial alternatives, the groundwater model was calibrated against available site data. The goal of the model calibration was to obtain simulated heads similar to those reported in the RI for the current, negligible facility pumping rates (averaging approximately 0.6 gallons per minute (gpm), as discussed in Section 1.2.8 of the FS) at the time of the water level measurements. Figure D-2 shows the simulated heads for a recharge infiltration rate (I) of 12 inches per year (in/yr) and an “aquifer” hydraulic conductivity (K) of 10 feet per day (ft/day). Comparing these results to Figure 1-5, it can be seen that 1) the Elev. 290 ft contour is in approximately the correct location, 2) the groundwater mound to the east of the Site is in approximately the correct location and, 3) the simulated groundwater divide is within 200 feet of the groundwater divide interpreted from the groundwater level measurements taken at the Site.

The same simulated groundwater elevations can be obtained by varying I and K proportionally, e.g., I equal to 6 in/yr and K equal to 5 ft/day. A value of I equal to 12 in/yr was selected for the simulation because a water budget analysis at the nearby Moreau site calculated an average infiltration rate of 12.75 in/yr (Dunn, 1984). A value of K = 10 ft/day was selected for the simulations as a value between the 3 to 4 ft/day measured in slug tests performed on the groundwater monitoring wells during the RI and a value of 15 to 48 ft/day from the 1986 pumping test on Well 1D (Blasland & Bouck, 1986) recalculated for an estimated saturated thickness of 50 feet.

The no-pumping calibration of the model was checked against reported test pumping of Wells 1D and 2D. C. T. Male Associates, P.C. (1979) reports test pumping of the wells after rehabilitation in

1959. For Well 1D (82 feet deep, 20-foot screen), a pumping rate of 30 gpm resulted in a drawdown in the well to approximately Elev. 264 ft. This test pumping was simulated with the model by drawing down the "aquifer" to Elev. 264 ft. The calculated flow rate was 31.4 gpm. Drawing the "aquifer" down to a slightly higher elevation (i.e., assuming some small well loss) would reproduce the reported 30 gpm pumping rate.

For Well 2D (86 feet deep, 8-foot screen), a pumping rate of 25 gpm resulted in a drawdown in the well to approximately Elev. 266 ft after rehabilitation in 1959. This test pumping was simulated with the model by assuming a 30 percent well loss and drawing down the "aquifer" to Elev. 273.5 ft. The calculated flow rate was 27.3 gpm.

It is concluded that these simulation results indicate reasonable calibration of the model considering uncertainties about pumping duration, partial penetration effects, and control and accuracy of the pumping rate. A well loss of 30 percent was assumed for the simulation of remedial alternatives.

The 1986 pump test of Well 1D (20 gpm for 0.943 days) was simulated using the transient well feature of the computer program. The specific yield was set to the average of the specific yields calculated by Blasland & Bouck (1986) using the Theis and distance-drawdown methods (0.00085). The simulated drawdown (from pre-pumping groundwater elevations) contours are shown on Figure D-3. The simulated drawdowns are in good general agreement with the measured drawdowns: Well 10D (0.95 ft measured, 1.8 ft predicted); Well 2D (0.74 ft measured, 0.75 ft predicted); Well 13D (0.35 ft measured, 0.45 ft predicted); Well 14D (0.07 ft measured, 0.1 ft predicted). The disagreement at Well 10D may be due to the short duration of pumping, delayed yield or "aquifer" variability. Since the pumping durations to be simulated in the evaluation of the remedial alternatives are very long compared to this pump test, the simulated results of the 1986 pump test are considered to be adequate for the purpose of comparing the remedial alternatives.

3.0 SIMULATION OF REMEDIAL ALTERNATIVES

3.1 Capture Zone and Travel Time Estimations

The remedial alternatives were simulated using the model described above. The results of the simulations are characterized by the capture zones of the pumping wells and the travel times and pumping rates to achieve remediation of the plume. The capture zones were defined by tracking particle pathlines in the upgradient direction from the pumping wells. The plume remediation times (including active pumping and passive natural flushing) were estimated by generating timed pathlines where the particle velocity is the apparent velocity divided by the effective porosity and the retardation factor. An effective porosity of 0.2 and a retardation coefficient of 2 were used for the simulations presented in the following sections.

Recharge of the treated pumping well effluent to the "aquifer" was simulated by injection wells with a collective flow rate approximately equal to collective discharge rate (Q) of the pumping wells for remedial alternatives G3, G4a and G4b. The locations of the injection wells were adjusted to enhance active recovery of the contaminant plume.

3.2 Alternative G1

Natural flushing of the contaminated groundwater in the absence of pumping at the Site was simulated by generating timed particle pathlines beginning at the upgradient edge of the plume. Figure D-4 shows the travel path of the plume to the southern and northern ravines over a period of 110 years.

3.3 Alternative G2b

This alternative represents the existing conditions of the water supply system currently in use at the Site as described in Section 1.2.8 of the FS. Wells 1D and 2D are assumed to be pumped at a collective rate of 0.6 gpm, 0.3 gpm at each well. Figure D-5 shows the simulated groundwater elevation contours and active capture zone for pumping at this rate. Remediation of the plume is estimated to take approximately 110 years.

3.4 Alternative G3

A preliminary evaluation of various pumping rates at wells 1D and 2D indicated that pumping 1D alone creates a capture zone encompassing more of the plume. Therefore, for this alternative, Well 1D is assumed to be pumped at a rate of 25 gpm with well 2D reserved as a backup well. An injection well with a flow rate of 25 gpm, is located approximately 700 feet northwest of Well 1D. Figure D-6 shows the simulated groundwater elevation contours and active capture zone for pumping at this rate. Remediation of the plume is estimated to take approximately 90 years.

3.5 Alternative G4a

For this alternative, Wells 1D and 2D are assumed to be pumped at a combined rate of 75 gpm (1D pumped at 37 gpm and 2D pumped at 38 gpm). Two injection wells are located near the southwest corner of the Site each with a flow rate of approximately 38 gpm. Figure D-7 shows the simulated groundwater elevation contours and active capture zone for pumping at this rate. Remediation of the plume is estimated to take approximately 80 years.

3.6 Alternative G4b

For this alternative, Wells 1D and 2D plus two additional wells located in the downgradient lobes of the plume are assumed to be pumped at a combined rate of 140 gpm (1D pumped at 37 gpm, 2D pumped at 40 gpm, west recovery well at 40 gpm and east recovery well at 23 gpm). Three injection wells are located west of the Site each with approximate flow rates of 40 gpm. A fourth injection well is located approximately 400 ft west of Well 1D with an approximate flow rate of 19 gpm. Figure D-8 shows the simulated groundwater elevation contours and active capture zone for pumping at this rate. Remediation of the plume is estimated to take approximately 60 years.

3.7 Sensitivity Analysis

The calculated capture zones and travel times presented above are dependent upon the selected values of the input parameters hydraulic conductivity, effective porosity and retardation factor. Capture zones for natural flushing and Alternatives G1, G2b, G4a and G4b will be unaffected by variation of the estimated hydraulic conductivity because of the relatively constant stress on the "aquifer" for a given alternative (defined by pumping to a defined elevation rather than a defined rate). This is because the infiltration rate is varied in proportion to the hydraulic conductivity to achieve calibration to the measured, no-pumping groundwater elevations.

The capture zone for Alternative G3, defined by a constant pumping rate, will be effected by variation of the estimated hydraulic conductivity. For lower values of K, e.g., 5 ft/day, the capture zone is somewhat larger because the "aquifer" is more highly stressed. For higher values of K, the capture zone will be somewhat smaller because of the lower stress on the "aquifer".

Estimated travel times for all of the alternatives will be directly affected by the assumed retardation factor and effective porosity, and inversely affected by the assumed hydraulic conductivity. That is, doubling the retardation factor or effective porosity will double the estimated travel time. Also, halving the hydraulic conductivity will double the estimated travel time.

Estimated pumping rates for Alternatives G4a and G4b will be directly affected by the assumed hydraulic conductivity. That is, doubling the hydraulic conductivity will double the estimated pumping rate for the defined drawdown in the "aquifer".

4.0 CONCLUSIONS AND LIMITATIONS

Capture zones and contaminant travel times have been calculated for five remedial alternatives (G1, G2b, G3, G4a, G4b) at the MRFA Site. The calculations were based on the following simplifying assumptions:

1. The "aquifer" at the Site is unconfined, homogeneous and isotropic with a hydraulic conductivity of 10 ft/day and areal recharge due to infiltration of 12 in/year. The influence of the hydraulic conductivity and the infiltration rate is discussed in Section 3.7. The assumption of unconfined conditions and isotropic "aquifer" properties will tend to underestimate actual clean-up times if there is, in fact, significant vertical hydraulic resistance between the upper and lower portions of the "aquifer". The lack of drawdown in the shallow wells observed during the short-term pumping test of Well 1D indicated some hydraulic resistance between the upper and lower portions of the "aquifer". However, it is our opinion that this condition is not areally extensive and is not likely to be influential for long-term pumping on the scale of the estimated clean-up times. If aggressive pumping is selected for remediation of the site, it is recommended that long-term pump testing be performed to evaluate effects of "aquifer" inhomogeneities.

2. Flow within the "aquifer" is horizontal. The assumption of horizontal flow is implicit for the use of a two-dimensional, areal groundwater model. The result is that no flow in the vertical dimension is modeled. Under aggressive pumping, some vertical component of flow would be induced in the vicinity of the well. Aside from the potential for "aquifer" inhomogeneity discussed in assumption No. 1 above, the assumption of horizontal flow is not anticipated to have a significant influence on the predicted well capture zones or the estimated clean-up times.

3. Advective contaminant flow is dominant in the transport process and the dispersive contaminant flux can be neglected. It is our opinion that uncertainties in the estimated clean-up times and well capture zones due to dispersive (hydrodynamic and diffusive) contaminant flux are small compared to the uncertainties in hydraulic conductivity and retardation factor discussed in Section 3.7.

4. The retardation factor for dissolved VOCs in the groundwater is 2. The influence of the assumed retardation factor is discussed in Section 3.7. No site-specific retardation factor data is available. The estimated clean-up times are therefore best used as relative measures for the comparison of the remedial alternatives considered.

5. No source of additional VOCs are present at the Site which would continue to contaminate groundwater. No sources of additional VOCs at the Site were identified during the RI. If a source of VOCs exists, actual clean-up times would be longer than estimated herein.

The travel times presented in this report should be viewed as estimates only and are best used to compare the efficiency of the remedial alternatives under consideration. Specific site conditions may result in longer or shorter times for contaminant recovery during remediation. Additional data collection and evaluation may be required in conjunction with the design and implementation of the selected remedial alternative.

5.0 REFERENCES

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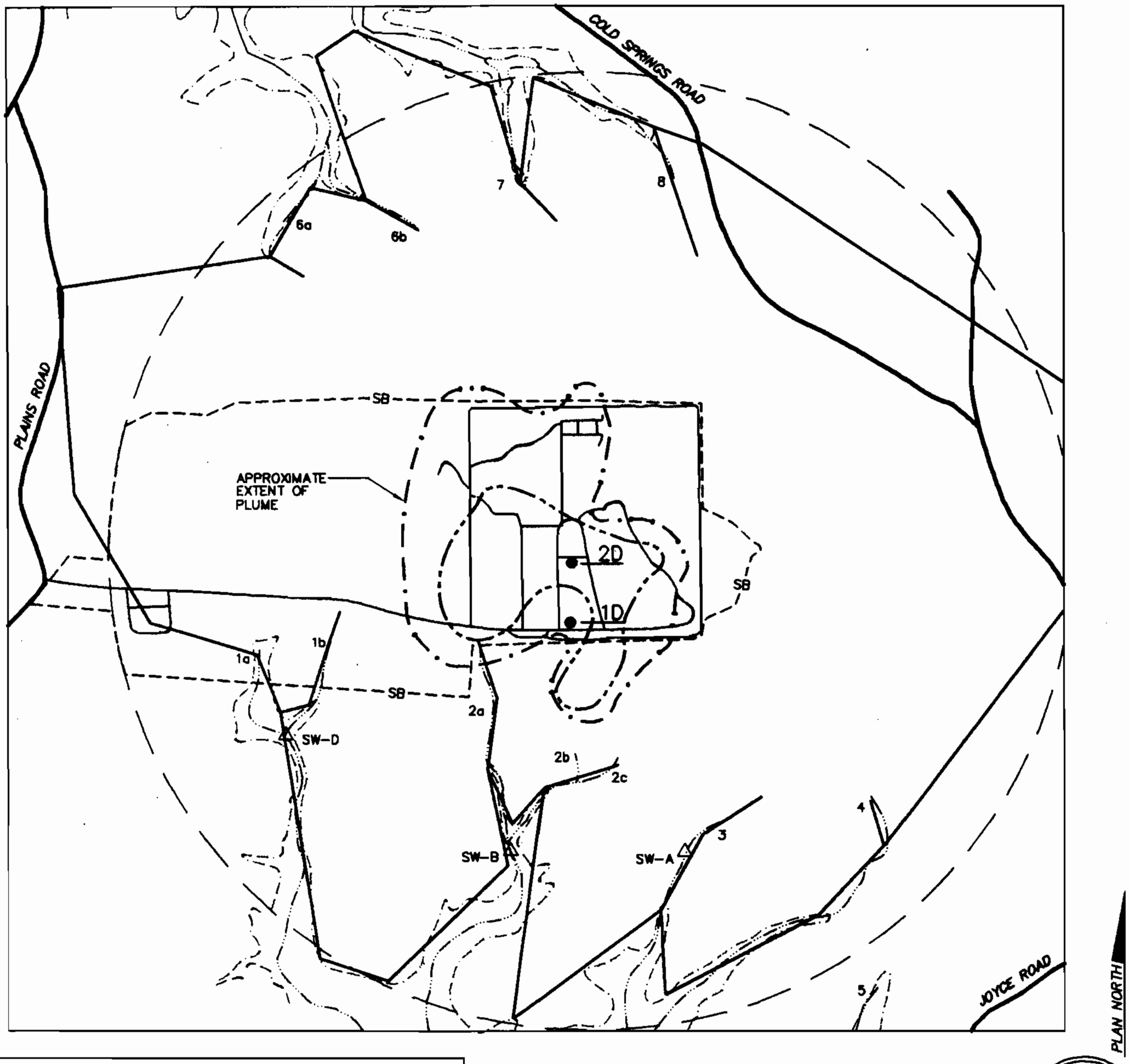
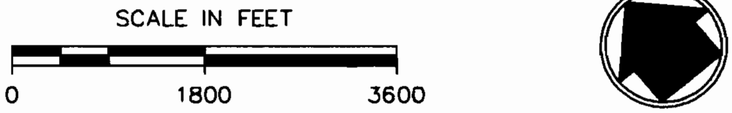




LEGEND

●	*EXISTING WELL LOCATION*
△ SW-C	*SURFACE WATER SAMPLING LOCATION & ID #*
- - - 2c	*RAVINE LOCATION & ID#*
- - -	*250' GROUND SURFACE CONTOUR LINE*
—·—·—	*CENTRAL PORTION OF PLUME (SEE FIGURE 1-6)*
—·— —	*APPROXIMATE EXTENT OF PLUME (SEE FIGURE 1-6)*
- - - SB - - -	*APPROXIMATE MRFA SITE BOUNDARY (as described in the UAO)*
— — —	*APPROXIMATE ONE MILE EASEMENT BOUNDARY*
——	*GROUNDWATER MODEL LINESINK LOCATIONS*

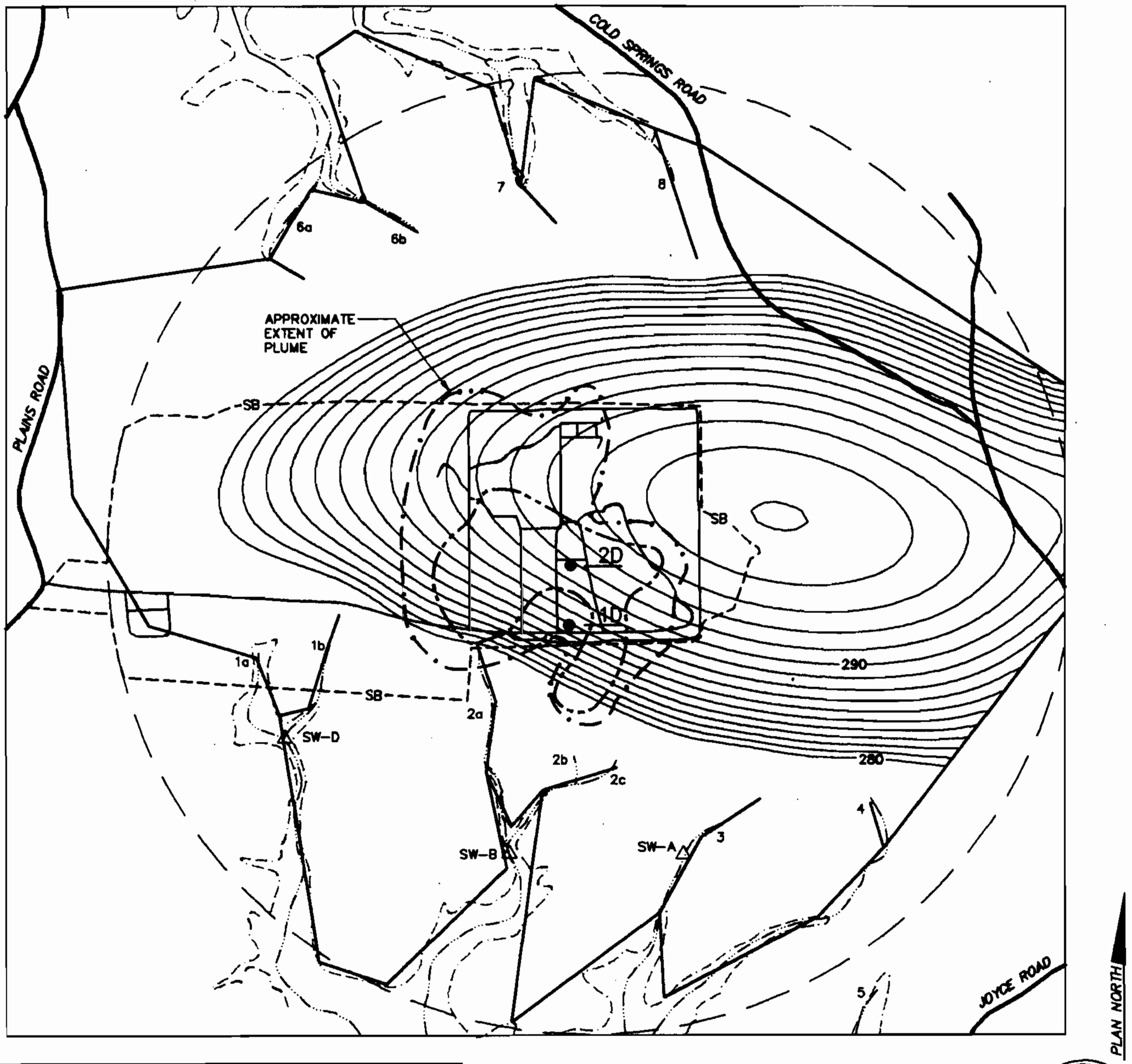
RUST ENVIRONMENT & INFRASTRUCTURE

CONCEPTUAL GROUNDWATER FLOW MODEL

MALTA ROCKET FUEL AREA SITE
FEASIBILITY STUDY

PROJECT No. 38833.080	DATE 05/04/95	DWG. No. 38833D01	SCALE AS SHOWN	FIGURE No. D-1

DRAWING No. 38833D01.DWG



SCALE IN FEET

0 1800 3600

LEGEND

● *EXISTING WELL LOCATION*

△ SW-C *SURFACE WATER SAMPLING LOCATION & ID #*

2c *RAVINE LOCATION & ID#*

250' GROUND SURFACE CONTOUR LINE

CENTRAL PORTION OF PLUME (SEE FIGURE 1-6)

APPROXIMATE EXTENT OF PLUME (SEE FIGURE 1-6)

---SB--------- *APPROXIMATE MRFA SITE BOUNDARY (as described in the UAO)*

APPROXIMATE ONE MILE EASEMENT BOUNDARY

GROUNDWATER MODEL LINESINK LOCATIONS

290 *SIMULATED GROUNDWATER ELEVATION CONTOURS*

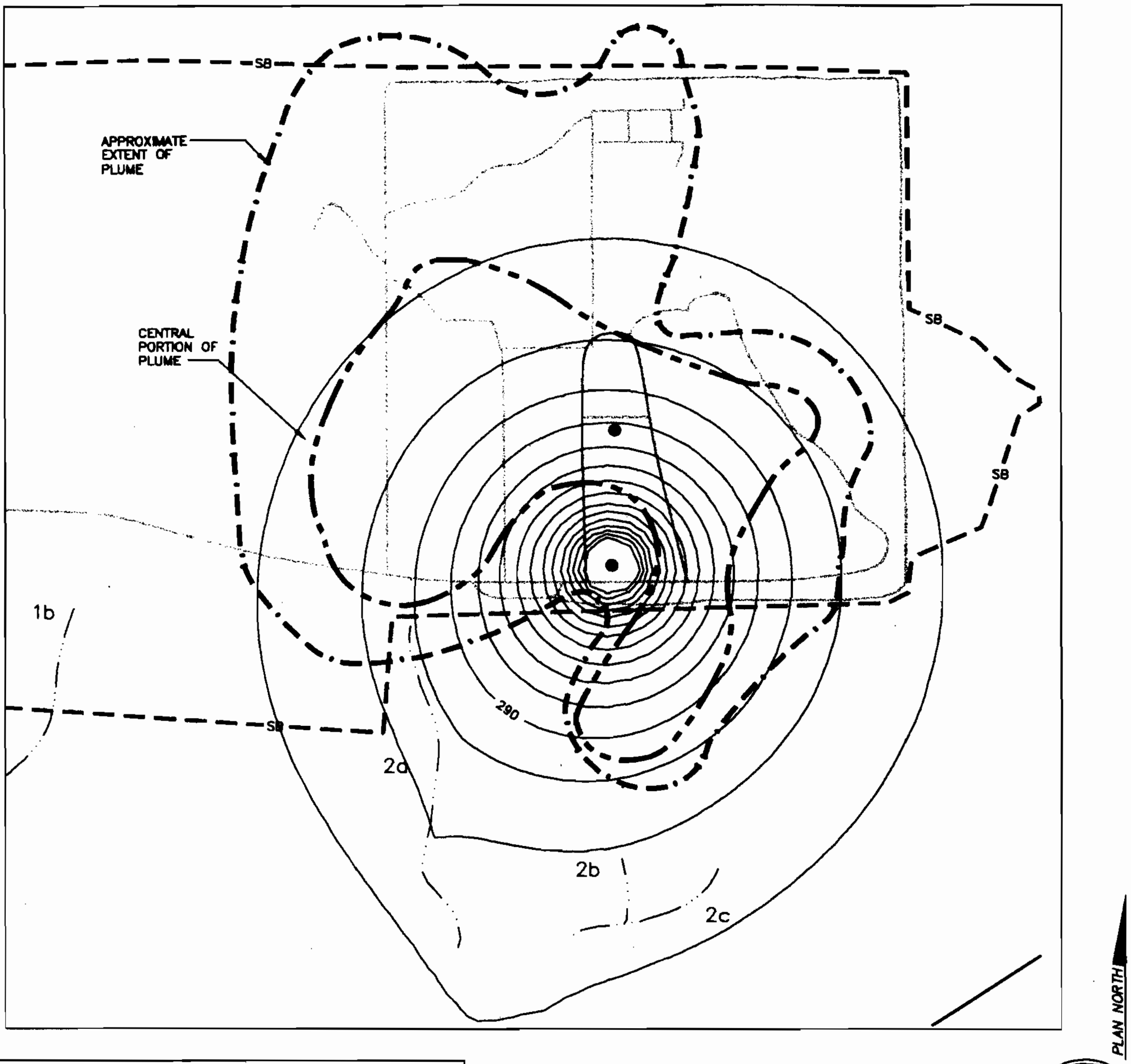
RUST ENVIRONMENT & INFRASTRUCTURE

SIMULATION OF GROUNDWATER ELEVATIONS FOR NO PUMPING

MALTA ROCKET FUEL AREA SITE
FEASIBILITY STUDY

PROJECT No. 38833.080	DATE 05/04/95	DWG. No. 38833D02	SCALE AS SHOWN	FIGURE No. D-2

DRAWING No. 38833D02.DWG



LEGEND

● EXISTING WELL LOCATION

2c RAVINE LOCATION & ID#

CENTRAL PORTION OF PLUME (SEE FIGURE 1-6)

APPROXIMATE EXTENT OF PLUME (SEE FIGURE 1-6)

SCALE IN FEET

0 800 1600

SB APPROXIMATE MRFA SITE BOUNDARY (as described in the UAO)

APPROXIMATE ONE MILE EASEMENT BOUNDARY

290 SIMULATED GROUNDWATER ELEVATION CONTOURS

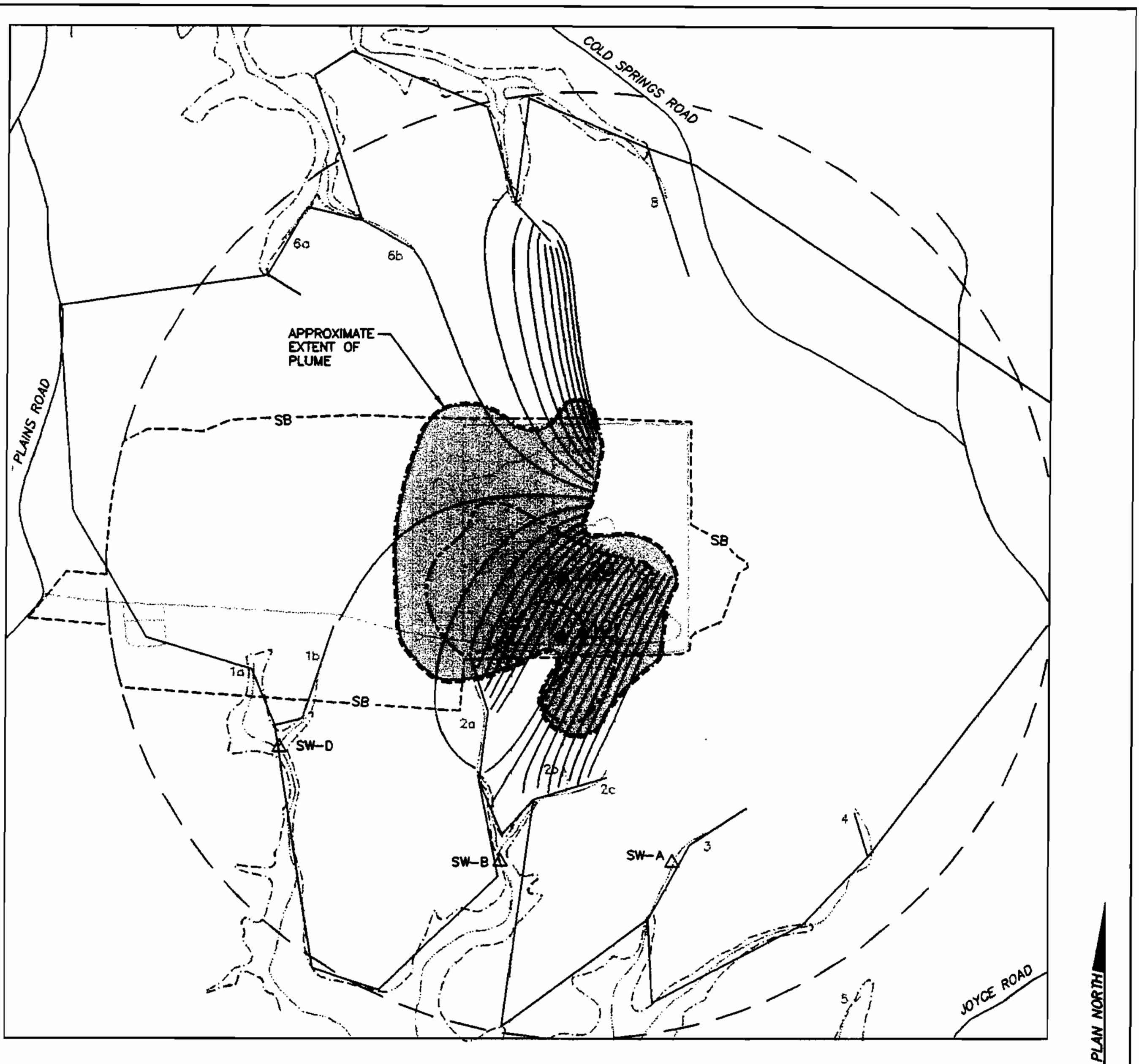
RUST ENVIRONMENT & INFRASTRUCTURE

SIMULATION OF 1986 PUMP TEST DRAWDOWN

MALTA ROCKET FUEL AREA SITE
FEASIBILITY STUDY

PROJECT No. 38833.080	DATE 05/04/95	DWG. No. 38833D03	SCALE AS SHOWN	FIGURE No. D-3

DRAWING No. 38833D03.DWG



LEGEND

●	*EXISTING WELL LOCATION*
△ SW-C	*SURFACE WATER SAMPLING LOCATION & ID #*
2c	*RAVINE LOCATION & ID#*
	250' GROUND SURFACE CONTOUR LINE
	CENTRAL PORTION OF PLUME (SEE FIGURE 1-6)
	APPROXIMATE EXTENT OF PLUME (SEE FIGURE 1-6)
▨	*PORTION OF PLUME THAT WILL BE REMEDIATED THROUGH NATURAL ATTENUATION*
SB	*APPROXIMATE MRFA SITE BOUNDARY (as described in the UAO)*
	APPROXIMATE ONE MILE EASEMENT BOUNDARY
	GROUNDWATER MODEL LINESINK LOCATIONS
	SIMULATED GROUNDWATER FLOW PATHS

SCALE IN FEET

0 1800 3600

RUST ENVIRONMENT & INFRASTRUCTURE

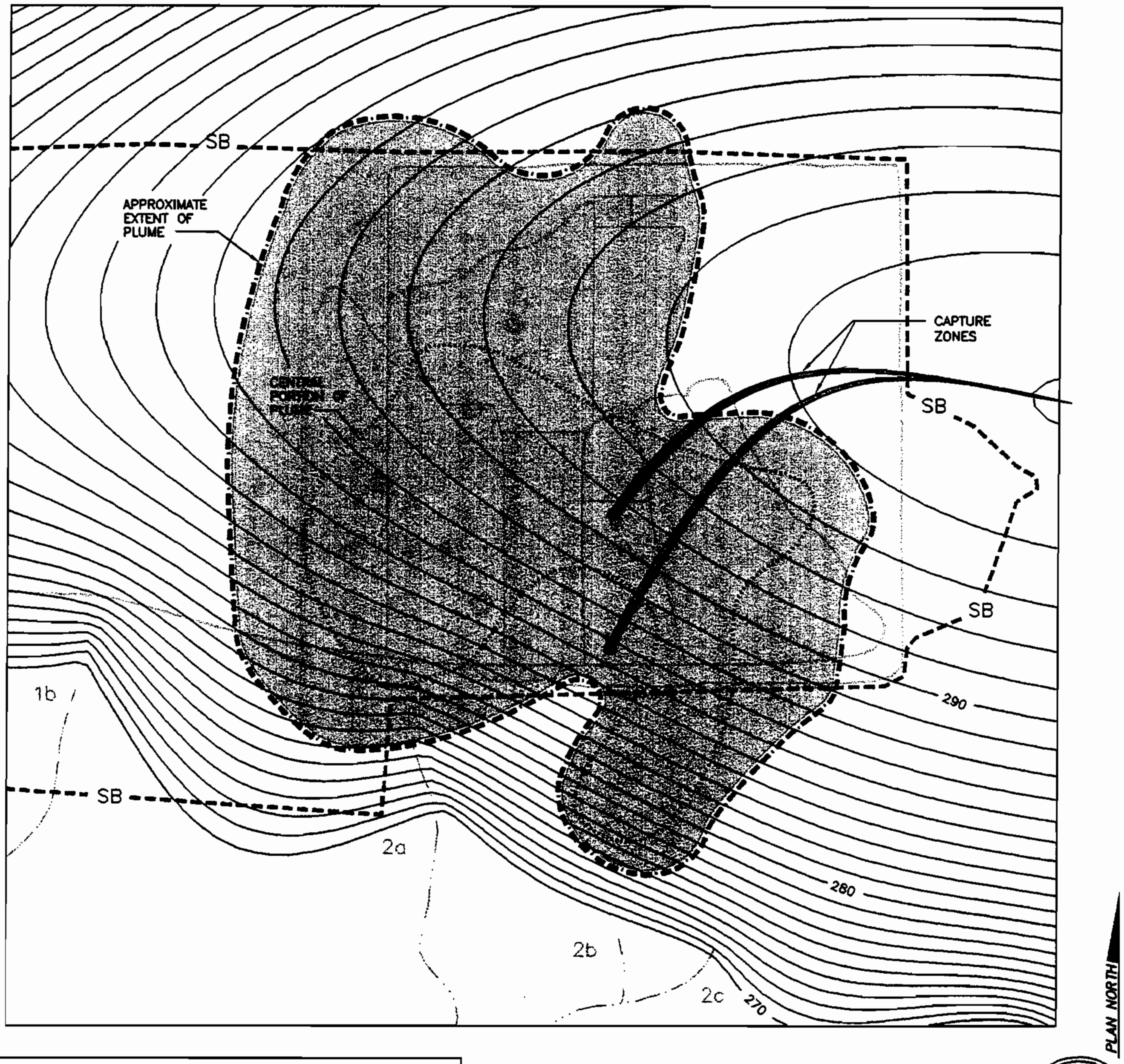
ALT G1 (NO PUMPING)

SIMULATION OF PARTICLE PATHS FOR T=110 YEARS

MALTA ROCKET FUEL AREA SITE
FEASIBILITY STUDY

PROJECT No. 38833.080	DATE 05/04/95	DWG. No. 38833D04	SCALE AS SHOWN	FIGURE No. D-4

DRAWING No. 38833D04.DWG



LEGEND

● EXISTING WELL LOCATION

2c RAVINE LOCATION & ID#

CENTRAL PORTION OF PLUME (SEE FIGURE 1-6)

APPROXIMATE EXTENT OF PLUME (SEE FIGURE 1-6)

Q = COLLECTIVE DISCHARGE RATE FROM WELL ID AND 2D

▨ PORTION OF PLUME THAT WILL BE REMEDIATED THROUGH NATURAL ATTENUATION

■ CAPTURE ZONE

SCALE IN FEET

0 800 1600

---- SB -------- APPROXIMATE MRFA SITE BOUNDARY (as described in the UAO)

290 SIMULATED GROUNDWATER ELEVATION CONTOURS

SIMULATED GROUNDWATER FLOW PATHS WHICH REPRESENT CAPTURE ZONE

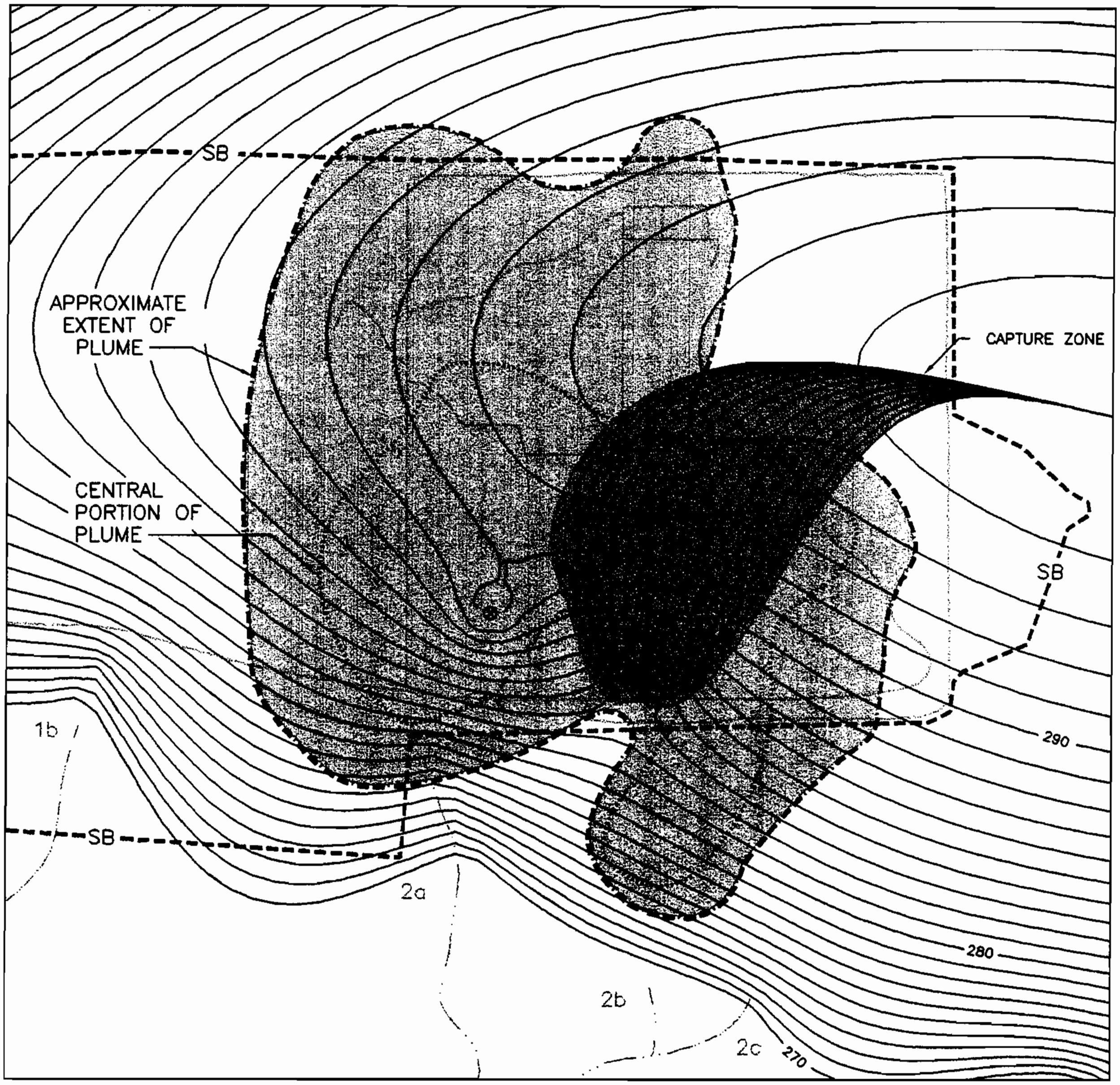
RUST ENVIRONMENT & INFRASTRUCTURE

SIMULATION OF ALT. G2b CAPTURE ZONE
WELL 1D, 2D; Q=0.6 GPM

MALTA ROCKET FUEL AREA SITE
FEASIBILITY STUDY

PROJECT No. 38833.080	DATE 05/04/95	DWG. No. 38833D05	SCALE AS SHOWN	FIGURE No. D-5

DRAWING No. 38833D05.DWG



LEGEND

⊗	*NEW INJECTION WELL LOCATION*
●	*EXISTING WELL LOCATION*
— · — 2c	*RAVINE LOCATION & ID#*
··············	*CENTRAL PORTION OF PLUME (SEE FIGURE 1–6)*
— · — · —	*APPROXIMATE EXTENT OF PLUME (SEE FIGURE 1–6)*
Q =	*COLLECTIVE DISCHARGE RATE FROM WELL 1D*
▒	*PORTION OF PLUME THAT WILL BE REMEDIATED THROUGH NATURAL ATTENUATION*
▓	*CAPTURE ZONE*
– – – SB – – – – – –	*APPROXIMATE MRFA SITE BOUNDARY (as described in the UAO)*
290	*SIMULATED GROUNDWATER ELEVATION CONTOURS*
	SIMULATED GROUNDWATER FLOW PATHS WHICH REPRESENTS CAPTURE ZONE

SCALE IN FEET

0 800 1600

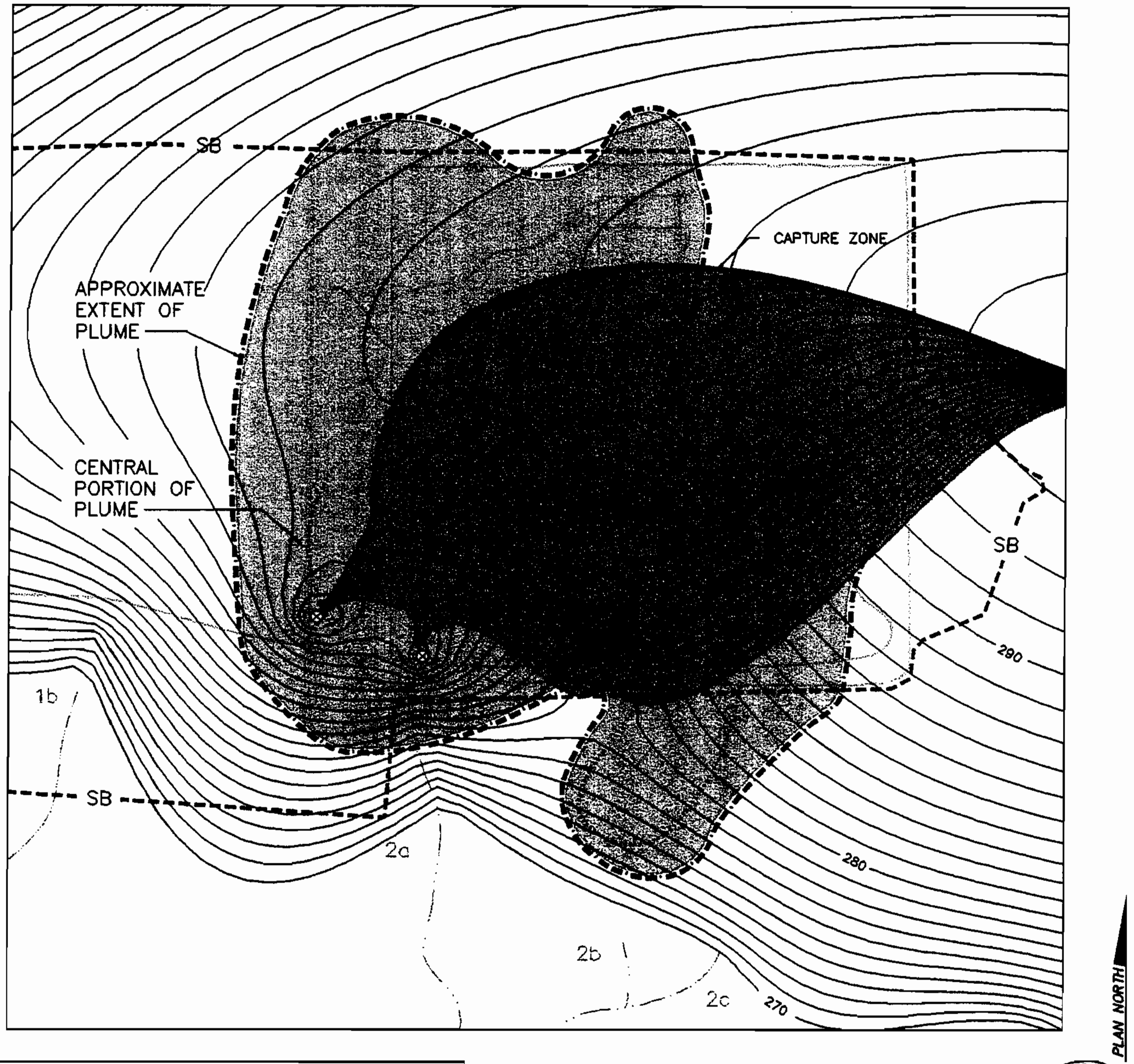
RUST ENVIRONMENT & INFRASTRUCTURE

SIMULATION OF ALT. G3 CAPTURE ZONE WELL 1D; Q=25 GPM; WITH REINJECTION

MALTA ROCKET FUEL AREA SITE
FEASIBILITY STUDY

PROJECT No. 38833.080	DATE 9/27/95	DWG. No. 38833D06	SCALE AS SHOWN	FIGURE No. D–6

DRAWING No. 38833D06.DWG



LEGEND

⊗ *NEW INJECTION WELL LOCATION*

● *EXISTING WELL LOCATION*

2c *RAVINE LOCATION & ID#*

CENTRAL PORTION OF PLUME (SEE FIGURE 1-6)

APPROXIMATE EXTENT OF PLUME (SEE FIGURE 1-6)

Q = *COLLECTIVE DISCHARGE RATE FROM WELLS 1D AND 2D*

▒ *PORTION OF PLUME THAT WILL BE REMEDIATED THROUGH NATURAL ATTENUATION*

▓ *CAPTURE ZONE*

SCALE IN FEET

0 800 1600

---SB--------- *APPROXIMATE MRFA SITE BOUNDARY (as described in the UAO)*

290 *SIMULATED GROUNDWATER ELEVATION CONTOURS*

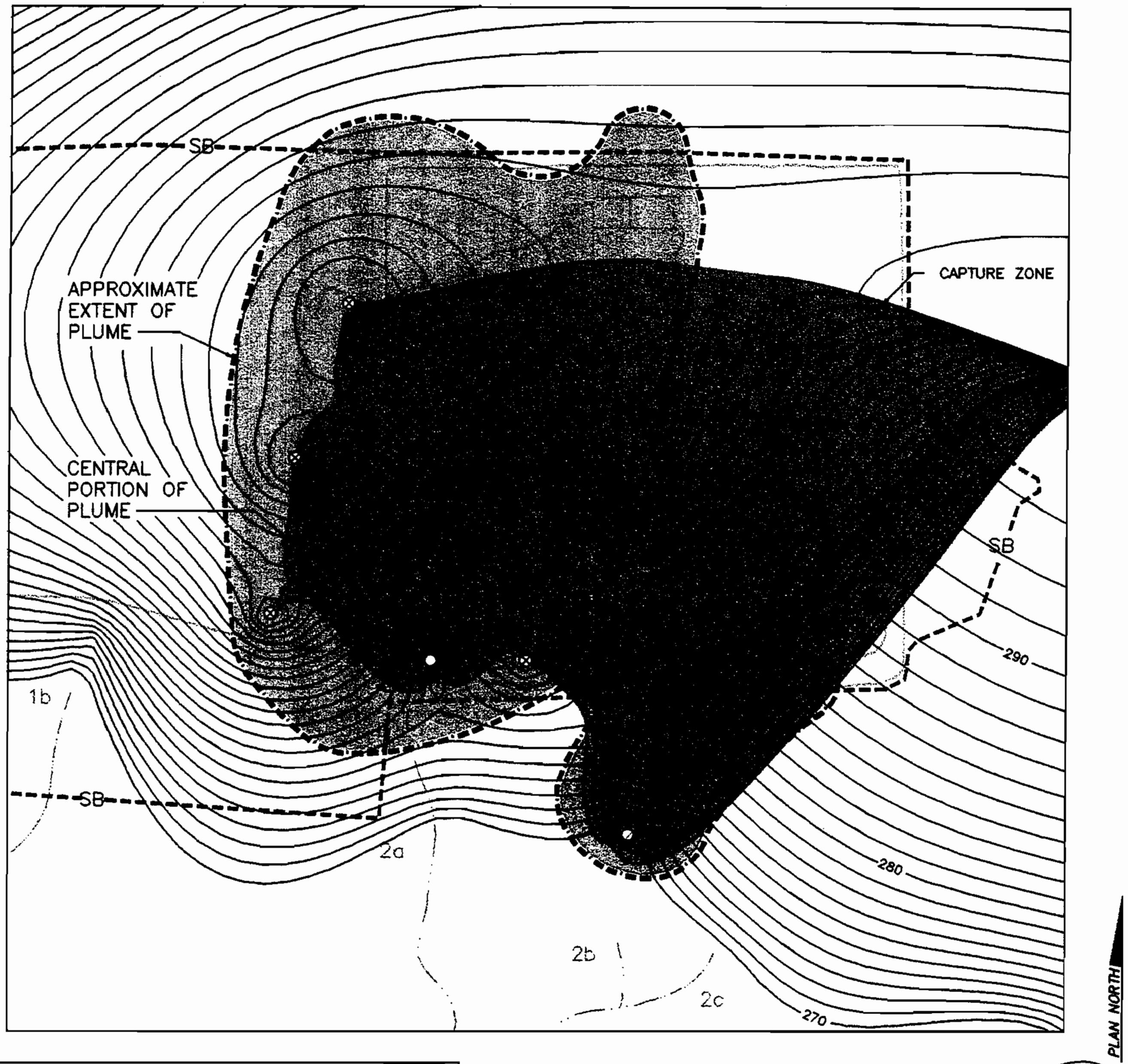
SIMULATED GROUNDWATER FLOW PATHS WHICH REPRESENTS CAPTURE ZONE

RUST ENVIRONMENT & INFRASTRUCTURE

SIMULATION OF ALT. G4a CAPTURE ZONE
WELLS 1D, 2D; Q=75 GPM; WITH REINJECTION
MALTA ROCKET FUEL AREA SITE
FEASIBILITY STUDY

PROJECT No. 38833.080	DATE 05/04/95	DWG. No. 38833D07	SCALE AS SHOWN	FIGURE No. D-7

DRAWING No. 38833D07.DWG



SCALE IN FEET

0 800 1600

LEGEND

⊗	*NEW INJECTION WELL LOCATION*
○	*NEW RECOVERY WELL LOCATION*
●	*EXISTING WELL LOCATION*
— · — 2c	*RAVINE LOCATION & ID#*
⋯⋯⋯	*CENTRAL PORTION OF PLUME (SEE FIGURE 1-6)*
— • — •	*APPROXIMATE EXTENT OF PLUME (SEE FIGURE 1-6)*
Q =	*COLLECTIVE DISCHARGE RATE FROM FOUR PUMPING WELLS*
▨	*PORTION OF PLUME THAT WILL BE REMEDIATED THROUGH NATURAL ATTENUATION*
■	*CAPTURE ZONE*
- - - SB - - - - - - -	*APPROXIMATE MRFA SITE BOUNDARY (as described in the UAO)*
290	*SIMULATED GROUNDWATER ELEVATION CONTOURS*
	SIMULATED GROUNDWATER FLOW PATHS WHICH REPRESENTS CAPTURE ZONE

RUST ENVIRONMENT & INFRASTRUCTURE

SIMULATION OF ALT. G4b CAPTURE ZONE 4 WELLS; Q=140 GPM; WITH REINJECTION

MALTA ROCKET FUEL AREA SITE
FEASIBILITY STUDY

PROJECT No. 38833.080 | DATE 05/04/95 | DWG. No. 38833D08 | SCALE AS SHOWN | FIGURE No. D-8

DRAWING No. 38833D08.DWG

APPENDIX E

Estimation of Air Stripper Emission Rates

Appendix E - Estimation of Air Stripper Emission Rates

Maximum potential annual airborne emissions for different possible water loading scenarios for the MRFA Site air stripper system was estimated as shown on the attached calculation sheet. The evaluation was performed according to NYS Air Guide-1, Division of Air Resources, 1994 Edition.

Assumptions:

Influent concentrations:

(peak between 4/90 and 11/94):	carbon tetrachloride = 150 ug/l (ppb)
	trichloroethene = 80 ug/l (ppb)
(average between 4/90 and 11/94):	carbon tetrachloride = 60 ug/l (ppb)
	trichloroethene = 40 ug/l (ppb)

Flow rate of water through an air stripper could range from 1 to 100 gpm.

The effective stack height is 25 feet.

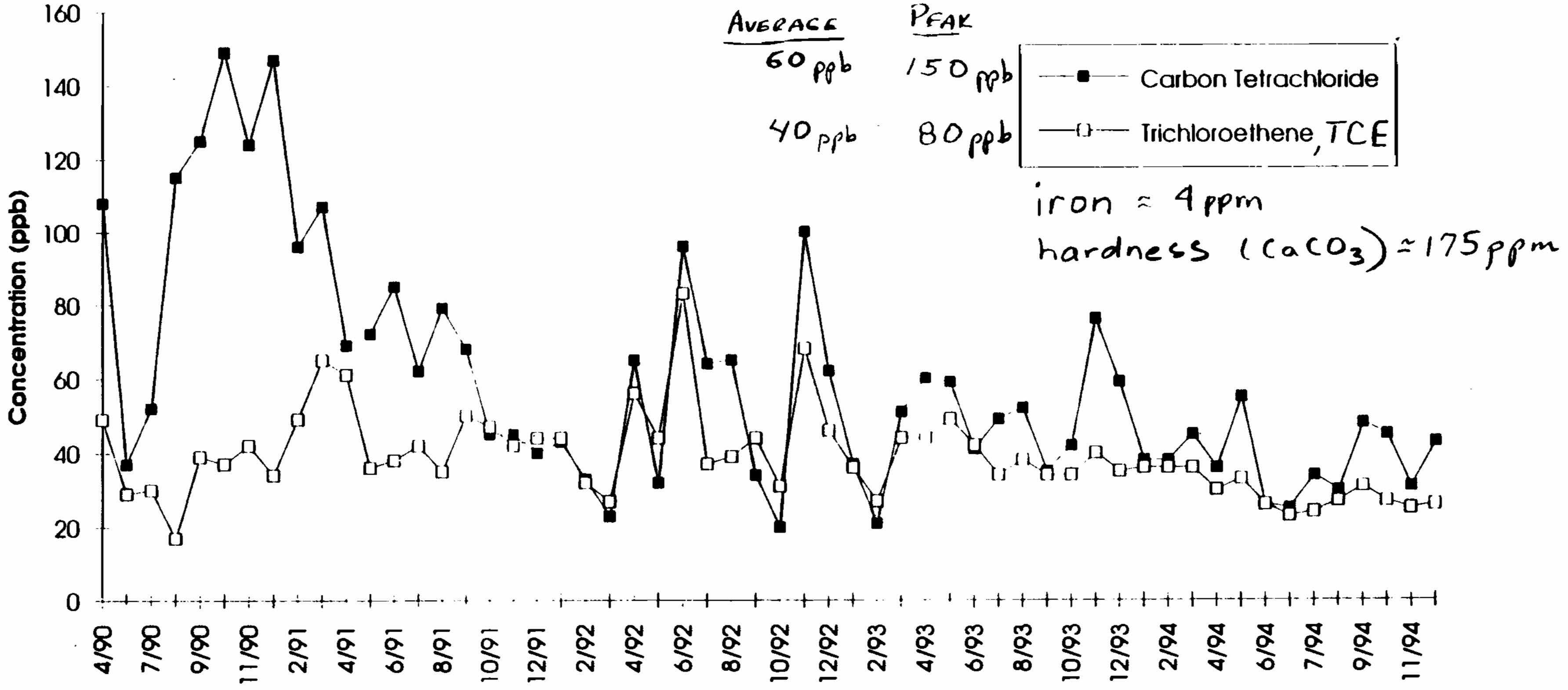
Summary:

Operating the air stripper at a pumping rate of 25 gpm, which is the manufacturer's maximum recommended capacity of the existing on-site system, the potential annual emissions based on the point source analysis method is 0.07 mg/m3 for carbon tetrachloride. This equals the NYS Air Guide-1 Annual Guideline Concentration (AGC) for this compound. It is anticipated that a refined analysis (i.e., a model of the air flow from the point source to the property boundary which considers distance, attenuation, wind direction, etc.) would result in estimated emissions for pumping rates up to 100 gpm (potential annual impact = 0.28 ug/m3) that would not exceed the AGC at the property boundary.

K:\FS\APPEND\AIREMMIS.APP

INfluENT TO Air Stripper

FIGURE 2-2



	Average	Peak
	60 ppb	150 ppb
	40 ppb	80 ppb

iron ≈ 4 ppm

hardness ($CaCO_3$) ≈ 175 ppm

STRIP.XLS Chart 1 3/22/95

APPENDIX F

Assumption for Groundwater and Soil Remediation Cost Estimates

Malta Rocket Fuel Area Site

Assumptions for Groundwater and Soil Remediation Cost Estimates

A CAPITAL COSTS:

A-1 General

A-1.1 Costs include legal negotiating and drafting of deed restrictions and local administrative fees. Estimated costs are $5,000 for groundwater alternatives and $12,000 for soil alternatives, which also includes surveying.

A-1.2 Engineering costs are estimated as a percentage of direct capital costs or estimated lump sum and includes design, technical support, construction oversight, reporting and regulatory activities.

A-1.3 Mobilization/Demobilization is estimated for the soil alternatives as alump sum and includes preparation of work plan, health and safety plan, quality assurance plan and other related deliverables; equipment mobilization and demobilization; and site controls during remedial construction (e.g., dust control). For groundwater alternatives, mob/demob costs are incorporated in the specific line items (e.g. well installation).

A-1.4 Health and safety facilities is estimated for the soil alternatives as a lump sum and includes construction of a temporary decontamination pad, air monitoring equipment, personnel protective equipment. Costs are based on performing all remediation activities in Level D protection.

A-1.5 Potential contingency costs may be significant for groundwater and soil restoration alternatives due to the uncertainties inherent in subsurface characterization and remedial activities.

A-2 Extraction Wells

A-2.1 The condition of the existing wells is uncertain. The water hardness, iron and sand content, and documented past need for well rehabilitation suggest that it may be prudent to evaluate and rehabilitate the wells at the start of the program. Although some of this work could be considered routine maintenance, these activities are included in the FS cost estimate.

The following activities would be included in the costs for evaluating and rehabilitating the existing production wells 1D and 2D:

- conducting a one-day step rate pump test to document existing well capacity
- taking the well off-line temporarily and pulling the pump
- inspecting the pumps and probing the wells

- treating the well to remove precipitates and scale, if necessary
- flushing/redeveloping the wells to enhance hydraulic connection with the water bearing unit
- handling of the development water, as necessary
- reinstalling the pump and installing a stilling tube to measure future water levels
- repeating the well test to document restored well capacity

For each well, it is assumed that the rehabilitation and testing effort would require approximately seven days by a well service contractor (6 days x $1,000/day for a two-man crew) plus equipment ($1,000).

A-2.2 New wells will be tested to document their production capacity and produce baseline specific capacity data for future evaluation of well condition. It is anticipated the test will consist of a step drawdown test whereby the well is pumped consecutively at three progressively higher pumping rates and drawdown is measured. It is assumed that the well will be pumped using a temporary pump furnished by the contractor. Test duration would be approximately 8 hours. It is estimated that the test will cost approximately $4,000 per well.

A-2.3 Cost estimate for installation of new extraction wells includes mob/demob, per diems, utility line search, drilling pilot holes and wells, split-spoon sampling, soil grain size analyses for full screen length, grouting, decon pad, well installation, and well development. The estimate is based on recent price quotes from drillers for similar sites and assumes that wells are 80 feet deep and 8 inches in diameter with a 50 foot stainless steel screen.

A-2.4 Estimate for new extraction wells include pumps, control boxes, pitless adapters, drop pipes and contractor installation costs. Discharge piping assumes 4-inch PVC pipe installed. Assumptions for length of piping is based on the well locations selected through groundwater modeling.

A-3 Water Treatment System

A-3.1 The cost developed for Alternative G3 includes the water conditioning equipment (bag filters and/or sequestering equipment) only. The costs for Alternatives G4a and G4b include water conditioning equipment, packed tower air stripper, transfer pump, valves, gauges, meters, fittings, electrical components, mechanical and electrical installations, and building modifications. The capacity for the air stripper included in Alternatives G4a and G4b is 100 gpm (2 ft diam) and 200 gpm (3 ft diam), respectively.

A-3.2 Operation and monitoring start-up costs include four weeks of training, sampling (one effluent sample per day for 30 days), and general operation and debugging of system. Also included is the cost for three monthly rounds of water level measurements within which time the aquifer is anticipated to reach steady state. The cost estimate assumes no air monitoring is required.

A-4 Treated Water Discharge Piping and Reinjection System

A-4.1 Costs are based on construction of underground 8-inch HDPE pipe for Alt. G4a to carry the full 75 gpm flow from Building 15 to the relatively closely spaced reinjection points, and 4-inch HDPE pipe for Alt. G4b to carry the 140 gpm flow from Building 15 to the widely distributed reinjection points. Costs for the 8-inch pipe is estimated at $21 per foot, installed and the 4-inch pipe is estimated at $15 per foot, installed.

A-4.2 Reinjection wells are assumed for the purposes of the cost estimate. Actual recharge system may consist of infiltration trenches or another appropriate technology. For the purposes of this FS, it is assumed that two reinjection wells would be required for each extraction well. The cost for an injection well is estimated to be the same an installation of a new recovery well.

A-5 Baseline Monitoring

A-5.1 Includes one round of groundwater sampling and analysis for the 48 wells in the vicinity of the Test Station. Time and materials is estimated at $35,000 based on the costs for previous RI sampling rounds. Analytical costs are estimated to be $175 per sample for VOCs. Data validation and report preparation is estimated to cost $10,000.

A-5x Cap

A-5.1x The cost for a bituminous asphalt cap is based upon Mean's 1995 budgetary pricing guide and pricing provided by local suppliers.

A-6 Soil Excavation and Disposal

A-6.1 Soil staging is based upon use of temporary polyethylene liner, including placement and removal.

A-6.2 This estimate assumes hand excavation.

A-6.3 This estimate assumes composite samples per EPA protocols.

A-6.4 This estimate assumes disposal at Model City, N.Y.

A-6.5 This estimate assumes an on-site source, compaction and revegetation.

B OPERATION AND MAINTENANCE COSTS:

B-1 Groundwater Monitoring

B-1.1 Semi-annual sampling and analysis of the EWMS is estimated at a cost of $12,500/yr as estimated by ERM Northeast, Inc., 1995.

B-1.2 Estimate assumes that one day's worth of water level measurements (8 hours x $50/hr) at wells on or adjacent to the site will be performed following the same schedule as the EWMS (total cost of $800/year). The purpose is to monitor the extent of the capture zone. Estimates also include the cost for performing water quality monitoring for VOCs every five years to verify and/or forecast restoration of groundwater quality in the water bearing zone. It is assumed that approximately half the wells sampled during baseline monitoring will be used and therefore the cost would be approximately half or $30,000. This cost divided over 5 years yields an estimated annual cost of $6,000.

B-2 Water Treatment System

B-2.1 Operation and maintenance of the air stripper system for Alternative G2b will consist of current influent and effluent sampling and periodic replacement of the air stripper packing material (approximately every 5 years).

Current sampling and analysis of the air stripper influent and effluent, as required by NYSDOH, occurs four times per year. One influent and one effluent sample is collected at the air stripper and analyzed for volatile organic compounds ($175 per analysis) for each well. In addition, two samples are collected at the former GE/EXXON Building and MTI taps. A total of 16 samples will be collected per year (4 samples x 4 times per year). It is assumed that samples will be collected by Wright-Malta personnel and that no additional QA/QC samples are required.

The existing air stripper contains approximately 13 feet of packing material and has a nominal 1 foot diameter. The volume of required packing material equals approximately 10 cf. New packing material costs approximately $20 per cf (Lantec Products, Inc. Agoura Hills, CA). Packing material changeout would require approximately 1 day (2 people at $50/hr for 10 hours) plus approximately $300 for equipment, totaling $1,300 per day. Disposal of packing material by incineration would cost approximately $500. The total cost per event is estimated to be $2,000. This cost divided over 5 years would represent an annual cost of $400 per year.

B-2.2 Operation and maintenance of the air stripper system for Alternatives G3 and G4 (a and b) will consist of the air stripper packing material replacement as discussed above, plus, due to the proposed reinjection of excess recovered groundwater, monthly inspections, sampling of influent/effluent and preparation of monthly discharge monitoring reports would be required to fulfill SPDES requirements. Specifically, SPDES requires monthly effluent sampling for specific analytes. The assumed sampling schedule is provided in the table below. At a minimum, inspections will involve monitoring pressure and flow gauges, visual inspection of filters and other water conditioning equipment, packing material. Monitoring is estimated to take one person (approximately $50/hr) one 8 hour day per month plus approximately $100 for miscellaneous equipment ($500/month). Report preparation and recordkeeping is estimated at $800/per month. VOC analysis is estimated at $175 per sample and total SPDES analysis at $500 per sample. Total cost is estimated at $1,975/month or $23,700/yr, plus $400/yr from above.

Assumed Treatment System Sampling for Alts. with Reinjection/Recharge (G3, G4a/G4b)

	J	F	M	A	M	J	J	A	S	O	N	D	Total VOC	Total SPDES
Stripper Influent	x			x			x			x			4	
Stripper Effluent	x	x	x	x	x	x	x	x	x	x	x	x		12
MTI Tap	x			x			x			x			4	
Former GE/Exxon Tap	x			x			x			x			4	
Annual Total													12	12

B-3 Extraction Well Maintenance

B-3.1 Extraction well maintenance includes evaluation and rehabilitation (as described in Item A-2.1; $7,000) every 5 years. Cost is estimated at $700 per year per well.

B-4 Asphalt Cap Maintenance

B-4.1 Estimate is based upon one day per year of inspection and patching.

B-5 Present Worth

B-5.1 For alternatives with an estimated system operation and maintenance duration of greater than 30 years, a 30 year period was used to calculate present worth.