



TETRA TECH EC, INC.

# **DRAFT PHASE III REMEDIAL ACTION PLAN REVISION 0**

**FIREWORKS I SITE  
(FORMER FIREWORKS FACILITY)  
HANOVER, MASSACHUSETTS  
TIER 1A PERMIT #100223  
RTN: 4-0090**

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Prepared for:

The Fireworks Site Joint Defense Group

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## TABLE OF CONTENTS

1.0	INTRODUCTION	1-1
1.1	BACKGROUND	1-1
1.2	SUMMARY OF PHASE II CSA FINDINGS	1-1
1.3	MASSDEP UPPER CONCENTRATION LIMIT EXCEEDANCES IN SOIL AND GROUNDWATER	1-3
1.4	SUMMARY OF PHASE II RISK CHARACTERIZATION	1-3
1.4.1	Assessment of Risks to Human Health	1-4
1.4.2	Assessment of Environmental Risks	1-5
1.4.3	Assessment of Risk to Safety	1-6
2.0	PHASE III EVALUATION PROCESS	2-1
3.0	SITE-WIDE RISK MANAGEMENT APPROACH	3-1
4.0	DEVELOPMENT OF PRELIMINARY REMEDIAL OBJECTIVES AND PRELIMINARY REMEDIATION GOALS	4-1
4.1	PRELIMINARY REMEDIAL OBJECTIVES	4-1
4.1.1	Preliminary Remedial Objectives for Soil	4-2
4.1.2	Preliminary Remedial Objectives for Groundwater	4-2
4.1.3	Preliminary Remedial Objectives for Sediment	4-2
4.2	PRELIMINARY REMEDIATION GOALS	4-3
4.2.1	Human Health PRGs	4-3
4.2.2	Environmental PRGs	4-4
4.3	DEVELOPMENT OF PROPOSED REMEDIAL OBJECTIVES	4-5
4.3.1	Revised Remedial Objectives for Soil	4-6
4.3.2	Revised Remedial Objectives for Groundwater	4-7
4.3.3	Revised Remedial Objectives for Sediment	4-7
5.0	DEVELOPMENT AND SCREENING OF REMEDIAL TECHNOLOGIES AND REMEDIAL ALTERNATIVES ASSEMBLY FOR SOIL	5-1
5.1	IDENTIFICATION AND INITIAL SCREENING OF REMEDIAL TECHNOLOGIES	5-1
5.2	ASSEMBLY OF REMEDIAL ALTERNATIVES	5-3
5.3	DETAILED SOIL ALTERNATIVE DESCRIPTIONS	5-4
5.3.1	Upper North Area Soil Alternative Descriptions	5-4
5.3.2	Potential Greenway Area Soil Alternative Descriptions	5-6
5.3.3	Southern Disposal Area Soil Alternative Descriptions	5-8
5.3.4	Southern Conservation Commission Area Soil Alternative Descriptions	5-13
5.3.5	Marsh Upland Area Soil Alternative Descriptions	5-16
5.3.6	Floodplain Area Soil Alternative Descriptions	5-19
6.0	DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES FOR GROUNDWATER	6-1
6.1	IDENTIFICATION AND INITIAL SCREENING OF REMEDIAL TECHNOLOGIES	6-1
6.2	ASSEMBLY OF REMEDIAL ALTERNATIVES	6-2

6.3	DETAILED GROUNDWATER ALTERNATIVE DESCRIPTIONS	6-2
6.3.1	Southern Disposal Area Groundwater Alternative Descriptions	6-2
6.3.2	Marsh Upland Area Groundwater Alternative Descriptions	6-5
7.0	DEVELOPMENT AND SCREENING OF REMEDIAL TECHNOLOGIES AND ASSEMBLY OF REMEDIAL ALTERNATIVES FOR SEDIMENT	7-1
7.1	IDENTIFICATION AND INITIAL SCREENING OF REMEDIAL TECHNOLOGIES	7-1
7.2	ASSEMBLY OF REMEDIAL ALTERNATIVES	7-2
7.3	DETAILED DESCRIPTION OF SEDIMENT ALTERNATIVES (EXCLUSIVE OF ALTERNATIVES FOR MARSH UPLAND AREA SEDIMENT)	7-3
7.3.1	Sediment Alternative 1 – No Action	7-4
7.3.2	Sediment Alternative 2 – Limited Action	7-4
7.3.3	Sediment Alternative 3 – Removal in the Eastern Channel Corridor Only	7-6
7.3.4	Sediment Alternative 4 – Removal Such that Site-wide SWA Total Mercury Concentration Meets Human Health and Ecological PRGs for Total Mercury	7-6
7.3.5	Sediment Alternative 5 – Removal Such that Each Sediment Risk Characterization Area SWA Total Mercury Concentration Meets Human Health and Ecological PRGs for Total Mercury	7-8
7.3.6	Sediment Alternative 6 – Widespread Removal to Approach Site-Specific Background Total Mercury Concentration in Sediment	7-9
7.4	DETAILED DESCRIPTION OF SEDIMENT ALTERNATIVES FOR MARSH UPLAND AREA SEDIMENT	7-10
7.4.1	Marsh Upland Area Sediment Alternative 1 – No Action	7-11
7.4.2	Marsh Upland Area Sediment Alternative 2 – Limited Action	7-11
7.4.3	Marsh Upland Area Sediment Alternative 3 – Spot Removal	7-11
7.4.4	Marsh Upland Area Sediment Alternative 4 – Limited Thin Capping	7-12
7.4.5	Marsh Upland Area Sediment Alternative 5 – Widespread Removal	7-12
8.0	ASSEMBLY AND COMPARATIVE ANALYSIS OF SITE-WIDE REMEDIAL ALTERNATIVES	8-1
8.1	SITE-WIDE ALTERNATIVES	8-1
8.1.1	Alternative 1 – Monitoring and Non-Engineering Measures	8-1
8.1.2	Alternative 2 – Targeted Removal to Address Soil and Groundwater UCLs and ECC Sediments	8-1
8.1.3	Alternative 3 – Targeted Removal to Address Soil and Groundwater UCLs and Limited Removal of Sediments to Meet Human Health and Ecological THg PRGs (Overall Sediment SWA < 22.2 mg/Kg THg)	8-2
8.1.4	Alternative 4 – Targeted Removal to Address Soil and Groundwater UCLs, Intermediate Range Soil Removal to Address Human Health and Ecological Risks not Co-located with UCL Exceedances and Limited Removal of Sediments to Meet Human Health and Ecological THg PRGs in Each Sediment RCA (Sediment SWA < 22.2 mg/Kg THg in Each Sediment RCA)	8-2

8.1.5	Alternative 5 – “Approaching Background”	8-2
8.2	REGULATORY REQUIREMENTS	8-3
8.2.1	Chapter 91 Waterways Permit	8-3
8.2.2	401 Water Quality Certification for Dredging Activities	8-3
8.2.3	Massachusetts Wetlands Protection Act and Local By-laws	8-4
8.3	DESCRIPTION OF EVALUATION CRITERIA	8-4
8.4	DETAILED COMPARATIVE EVALUATION OF REMEDIAL ACTION ALTERNATIVES	8-4
8.5	RECOMMENDED REMEDIAL ACTION ALTERNATIVE	8-5
8.6	FEASIBILITY EVALUATIONS	8-5
8.6.1	Technological Feasibility	8-6
8.6.2	Benefit-Cost Analysis	8-7
8.7	STEPS TO ACHIEVE A PERMANENT SOLUTION	8-8
9.0	COMPLETION STATEMENT	9-1
10.0	REFERENCES	10-1
APPENDIX A	Development of Human Health and Environmental Risk-Based Preliminary Remediation Goals	
APPENDIX B	Cost Estimates for the Site-wide Alternatives	

## LIST OF TABLES

Table 1-1	Listing of Soil and Groundwater UCL Exceedances
Table 1-2	Summary of Phase II CSA Risk Characterization
Table 4-1	Site-Specific Soil PRGs and Benchmark Values for Comparison
Table 4-2	Site-Specific Sediment PRGs and Benchmark Values for Comparison
Table 5-1	Fireworks Site Soil – Initial Screening of Remedial Technologies
Table 5-2	Assembled Soil Alternatives for Upper North Area
Table 5-3	Assembled Soil Alternatives for Potential Greenway Area
Table 5-4	Assembled Soil Alternatives for Southern Disposal Area
Table 5-5	Assembled Soil Alternatives for Southern Conservation Commission Area
Table 5-6	Assembled Soil Alternatives for Marsh Upland Area
Table 5-7	Assembled Soil Alternatives for Floodplain Area
Table 5-8	Soil Alternatives Summary Table
Table 6-1	Fireworks Site Groundwater – Initial Screening of Remedial Technologies
Table 6-2	Assembled Alternatives for Groundwater in Southern Disposal Area
Table 6-3	Assembled Alternatives for Groundwater in Marsh Upland Area
Table 7-1	Fireworks Site Sediment – Initial Screening of Remedial Technologies
Table 7-2	Sediment Alternatives for Eastern Channel Corridor, Lower Drinkwater River Corridor, Lily/Upper Factory Pond, and Middle/Lower Factory Pond
Table 7-3	Sediment Alternatives for Marsh Upland Sediment Area
Table 8-1	Retained Soil, Groundwater, and Sediment Alternatives – For Assembly into Site-wide Alternatives
Table 8-2	Assembled Site-wide Alternatives
Table 8-3	Regulatory Requirements Summary
Table 8-4	Summary of Detailed Evaluation of Site-wide Alternatives
Table 8-5	Comparative Analysis of Site-wide Alternatives
Table 8-6	No Risk Index of Human Health and Ecological Receptors Compared to Site-wide Remedial Alternatives for Soil and Sediment

## LIST OF FIGURES

- Figure 1-1 Site Map with Sampling Locations and Risk Characterization Areas
- Figure 1-2 Soil and Groundwater UCL Exceedance Locations
- Figure 2-1 Fireworks Site Phase III Flowchart
- Figure 5-1 UNA Soil Alternatives 2, 3A, and 3B
- Figure 5-2 PGA Soil Alternatives 2, 4A, 4B, and 4C
- Figure 5-3 PGA Soil Alternatives 3A, 3B, and 3C
- Figure 5-4 SDA Soil Alternatives 2, 5A, and 5B
- Figure 5-5 SDA Soil Alternatives 3A and 3B
- Figure 5-6 SDA Soil Alternatives 4A and 4B
- Figure 5-7 SDA Soil Alternative 4C
- Figure 5-8 SDA Soil Alternative 5C
- Figure 5-9 SCCA Soil Alternatives 2, 4A, 4B, and 4C
- Figure 5-10 SCCA Soil Alternatives 3A, 3B, and 3C
- Figure 5-11 MUA Soil Alternatives 2, 4A, and 4B
- Figure 5-12 MUA Soil Alternatives 3A and 3B
- Figure 5-13 MUA Soil Alternative 4C
- Figure 5-14 FPA Soil Alternatives 2, 3A, and 3B
- Figure 6-1 SDA Groundwater Alternative SDGW-3
- Figure 6-2 SDA Groundwater Alternative SDGW-4
- Figure 6-3 MUA Groundwater Alternative MUGW-3
- Figure 6-4 MUA Groundwater Alternative MUGW-4
- Figure 7-1 Sediment Management Units [Exclusive of Marsh Upland Sediment Area]
- Figure 7-2 Marsh Upland Area (MUA) Sediment Management Units
- Figure 7-3 Sediment Alternative 3
- Figure 7-4 Sediment Alternative 4
- Figure 7-5 Sediment Alternative 5

**LIST OF FIGURES (continued)**

- Figure 7-6 Sediment Alternative 6
- Figure 7-7 MUA Sediment Alternative 3
- Figure 7-8 MUA Sediment Alternative 4
- Figure 7-9 MUA Sediment Alternative 5
- Figure 8-1 Site Wide Alternative 1
- Figure 8-2 Site Wide Alternative 2
- Figure 8-3 Site Wide Alternative 3
- Figure 8-4 Site Wide Alternative 4
- Figure 8-5 Site Wide Alternative 5

## LIST OF ACRONYMS

1,1,-DCE	1,1,dichloroethene
AUL	activity and use limitations
bgs	below ground surface
CMR	Code of Massachusetts Regulations
COC	contaminant of concern
COPEC	contaminant of potential ecological concern
CSA	Comprehensive Site Assessment
cy	cubic yard
ECC	Eastern Channel Corridor
EPA	U.S. Environmental Protection Agency
ERC	Environmental Risk Characterization
FUDS	Formerly Used Defense Sites
HHCOC	human health contaminant of concern
HHRC	Human Health Risk Characterization
LDR	land disposal restriction
LTM	long-term monitoring
LOAEL	lowest observable adverse effect level
MassDEP	Massachusetts Department of Environmental Protection
MCP	Massachusetts Contingency Plan
MeHg	methyl mercury
mg/Kg	milligram per kilogram
MNA	monitored natural attenuation
MNR	monitored natural recovery
MUA	Marsh Uplands Area
NOAEL	no observable adverse effect level
OHM	oil and hazardous material
PAH	polycyclic aromatic hydrocarbon
PFLT	Paint Filter Liquids Test
POTW	publicly owned treatment works
PQL	practical quantitation limit
PRG	preliminary remediation goal
RAP	Remedial Action Plan
RBC	risk-based concentration
RCA	Risk Characterization Area

RCRA	Resource Conservation and Recovery Act
RO	remedial objective
SCCA	Southern Conservation Commission Area
SDA	Southern Disposal Area
SMU	sediment management unit
sf	square feet
S/S	solidification/stabilization
SWA	surface weighted average
TCE	trichloroethene
THg	total mercury
TtEC	Tetra Tech EC, Inc.
UCL	upper concentration limit
VOC	volatile organic compound

## **1.0 INTRODUCTION**

The Phase II Comprehensive Site Assessment (CSA) was completed and approved by Massachusetts Department of Environmental Protection (MassDEP) on August 16, 2006. This Phase III Identification, Evaluation and Selection of Comprehensive Remedial Action Alternatives (Phase III, 310 Code of Massachusetts Regulations [CMR] 40 0850) is being performed in accordance with the Massachusetts Contingency Plan (MCP) to develop and evaluate comprehensive remedial action alternatives for the Fireworks Site (the Site).

The Phase III for the Site involves the following activities:

- Development of remedial objectives (ROs);
- Development of risk-based screening preliminary remediation goals (PRGs) to eliminate or reduce the identified risk of harm to human health and the environment;
- Development of alternatives for remediation of contaminated media at the Site;
- Selection of the preferred alternative for remediation of the Site; and
- Preparation of a Remedial Action Plan (RAP).

### **1.1 BACKGROUND**

Historical activities at the Site (Figure 1-1; figures and tables are located at the end of this document) included the commercial manufacture of civilian fireworks and the research, development and manufacture of munitions and pyrotechnics for the United States Government over the approximate time period of 1907 to 1970. Lead, mercury, and some organic solvents, among other chemicals, were used in certain manufacturing processes and research and development activities during the facility's operational lifetime. MassDEP has conducted surface water, sediment, and fish tissue sampling for mercury, lead, and other metals in portions of the streams, ponds, and wetlands surrounding the Site and, based on this sampling, brought the Site into the MCP process. Tetra Tech EC, Inc. (TtEC) completed the CSA to characterize the nature and extent of the contamination in the surface soil, subsurface soil, soil gas, groundwater, surface water, and sediment within the Site boundaries (TtEC, 2005). Assessments of potential risk to human health, public welfare, safety and the environment also were completed as part of the CSA.

### **1.2 SUMMARY OF PHASE II CSA FINDINGS**

Mercury and methyl mercury were detected at significantly elevated levels in sediment in the Eastern Channel Corridor, the Lower Drinkwater River Corridor, Lily Pond, and Factory Pond, as well as in soil and groundwater in the Marsh Upland Area. The highest concentrations for

mercury in sediment were found in the easternmost reach of the Eastern Channel Corridor where the channel borders the North Area of No Historic Fireworks Use. The larger ponds at the Site tend to have lower, but more widespread concentrations of mercury in the sediment. Mercury detected in the soil and groundwater in the Marsh Upland Area, specifically in the Demolition Pit Area, suggests that there is likely a continuing source of mercury in the subsurface soil that is impacting local groundwater.

Lead was also detected at elevated levels in soil and some isolated locations in the groundwater across the Site where the concentrations exceed its upper concentration limit (UCL). Most detections of lead occurred in soil and groundwater in the Southern Disposal Area. Other metals were detected at elevated concentrations in soil, groundwater, and sediment across the Site, though to a lesser extent than mercury and lead.

Elevated volatile organic compound (VOC) concentrations in soils and groundwater were found in four areas of the Site:

- Upper North Area,
- Lower North Area,
- Southern Disposal Area, and
- Marsh Upland Area.

Trichloroethene and Freon TF were detected in the soils and groundwater in the Upper North Area adjacent to where the Eastern Channel Corridor runs along the northern edge of the Site. Freon TF also was detected in the groundwater near the old Building 80 in the Upper North Area. The deep overburden groundwater in the Lower North Area in the vicinity of the former Building 307 (near the Hanover Department of Public Works) has elevated levels of trichloroethene in groundwater. Soil and shallow groundwater contamination along the eastern edge of Factory Pond in the Southern Disposal Area consists of trichloroethene, Freon TF and chlorinated volatile degradation products.

The findings of the Phase II CSA (TtEC, 2005) indicate that there are areas of the Site that may present a significant risk to both human health and the environment from the presence of a number of contaminants, including metals and inorganics (mercury, methyl mercury, lead, copper, nickel, zinc, selenium, thallium, barium, arsenic, and chromium), and volatile organic compounds (1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, trichloroethene, vinyl chloride), and semivolatile organics (benzo[a]pyrene, dibenz[a,h]anthracene, and hexachlorobenzene). Risks above target levels (hazard index >1 and excess lifetime cancer risk >  $1 \times 10^{-5}$ ) were determined to be present for human health and environmental receptors from exposure to contaminants found in biota, soil, and sediment at the Site.

### **1.3 MASSDEP UPPER CONCENTRATION LIMIT EXCEEDANCES IN SOIL AND GROUNDWATER**

In the Phase II CSA, 15 soil and groundwater samples were found to exceed the MCP's published UCLs. As defined in 310 CMR 40.0996, UCLs are the concentrations of oil and hazardous materials (OHM) in soil or groundwater that, if exceeded under specific conditions, indicate the potential for "significant risk of harm to public welfare and the environment under future conditions." As such, sites that have UCL exceedances in soil or groundwater cannot achieve a Permanent Solution. Figure 1-2 shows the UCL exceedance locations. Table 1-1 lists the contaminants of concern (COC), environmental media, and COC concentration associated with these exceedances along with the COC UCLs.

Antimony was reported in soil above its UCL at one isolated location in the Upper North Area. Lead was detected above its UCL at a single soil location in the Central Commercial Area; however, this portion of the Site was redeveloped by others after this UCL exceedance was identified and this exceedance will not be addressed in this Phase III Report. Lead was detected above its UCL at four soil locations in the Southern Disposal Area. In the Cold Waste Area, UCL exceedances in soil were detected for antimony, barium, lead and zinc, all at a single sampling location in two soil samples. Mercury was detected above its UCL at five soil locations in the Marsh Upland Area.

UCL exceedances in groundwater were detected in one well and one piezometer (DP-MW1 and PZ-24) on the Site. At the Demolition Pit within the Marsh Upland Area, the groundwater mercury concentration exceeded the UCL at DP-MW1. In the Southern Disposal Area, there were groundwater UCL exceedances for lead and nickel at piezometer PZ-24. It was determined during the Phase IIA Investigation (FWENC, 1999) that the nickel exceedances in groundwater were attributable to nickel leaching from stainless steel drive points (used at the request of MassDEP). Therefore, the groundwater UCL exceedances for nickel will not be addressed as part of this Phase III Report. Remaining groundwater UCL exceedances are co-located with or downgradient of soil UCL exceedances for the same COCs.

### **1.4 SUMMARY OF PHASE II RISK CHARACTERIZATION**

As part of the Phase II CSA, a Risk Characterization was completed to assess the risks to human health, public welfare, safety, and the environment and to determine whether a level of "No Significant Risk" exists at the Site (TtEC, 2005). The Risk Characterization included a Human Health Risk Characterization (HHRC), found in Appendix A of the CSA, and a Stage II Environmental Risk Characterization (ERC), found in Appendix B of the CSA. The results of the Phase II Risk Characterization are summarized in Table 1-2. In the risk summaries presented in this section, COCs will be differentiated as to those identified in the HHRC (human health [HHCOCs]) and those identified in the ERC (contaminants of potential ecological concern

[COPECs]). After this summary section (in Section 2.0 and beyond), all COCs will be referred to collectively as simply the COCs.

It should be noted that this risk characterization summary is being included in this portion of the document for completeness. The detailed work is reported in the Phase II CSA approved by the MassDEP. The results of the risk characterization are used as the starting point for developing preliminary remedial objectives and remediation goals as described in Section 4. The development process further refines the risk levels into measurable remediation levels, and this work is detailed in Appendix A of this report. In some cases, HHCOCs and COPECs were modified based on Site-specific factors and cumulative risk. It is the remediation goals presented in Section 4 that will determine design clean up levels for soil and sediments targeted in Phase III.

To facilitate risk characterization activities, the Site was divided into risk characterization areas based on the Phase I and II sampling results, historical land use records, current ownership and activities, and projected future use. Subsequent to the initial division of the Site into eighteen risk characterization areas, the Site boundary was revised. This revision reduced the number of risk characterization areas to fourteen as there were four areas (the North, West, East, and Central Areas of No Historic Fireworks Use) that the Phase II CSA confirmed were not impacted by contamination from the former Fireworks activities. As such, these areas were removed from within the disposal site boundary. The resulting risk characterization areas shown on Figure 1-1 provided the framework for the subsequent Site management activities performed relative to the Site. These risk characterization area boundaries were used to the extent practicable during the Phase III evaluation.

#### **1.4.1 Assessment of Risks to Human Health**

The objective of the HHRC performed as part of the Phase II CSA was to characterize potential human health risks associated with exposure to soil, surface water, sediment, and groundwater. The HHRC consisted of a four-step process, involving:

1. Data evaluation;
2. Exposure assessment;
3. Dose-response assessment; and
4. Risk characterization.

Based on the conclusions of the HHRC, the significant potential risk scenarios in various areas of the Site are identified in Table 1-2. The receptors that were determined to be potentially at risk relative to incidental ingestion, dermal absorption, or inhalation of the Site soils in one or more of the Risk Characterization Areas were construction workers, utility workers, and recreational

users. Trespassers and fisherman were identified as being potentially at risk because of exposure to contaminated sediment, and fishermen may be at risk as a result of the ingestion of contaminated fish. Table 1-2 also identifies which chemical constituents posed the risks to human health for these exposure scenarios. Various metals and chlorinated organic compounds were the predominant risk drivers for soil; mercury, methyl mercury and some polycyclic aromatic hydrocarbons (PAHs) were the primary risk drivers in the sediment and mercury and methyl mercury were the primary risk drivers in fish tissue.

The Phase II CSA did not identify any risks to human health as a result of exposures to groundwater or surface water.

#### **1.4.2 Assessment of Environmental Risks**

The ERC performed as part of the Phase II CSA concluded that some environmental receptors associated with terrestrial, aquatic, and wetland habitats at the Site were potentially exposed to COPECs. A conceptual site and pathways analysis model was developed for evaluating the potential exposure of environmental receptors to Site-related contaminants. The primary pathways of exposure included direct contact with contaminated environmental media, dietary ingestion of contaminated prey, and incidental ingestion of contaminated abiotic media (i.e., during feeding or grooming). For higher trophic level receptors, bioaccumulation of certain COPECs, such as mercury and methyl mercury, will likely result in exposure via transfer within the local food chain. Aquatic communities (i.e., fish, plankton, benthic and pelagic invertebrates) are also potentially at risk from direct exposure to COPECs. The pathways of exposure to Site-related contaminants will be through direct contact with abiotic media, the consumption of contaminated prey (i.e., soil invertebrates, fish, terrestrial or aquatic invertebrates, and terrestrial or aquatic plants), and incidental exposure to abiotic environmental media.

The ERC applied a weight of evidence approach to the assessment of exposure and environmental risks to a range of environmental receptors representing 15 assessment endpoints. Assessment endpoints are discrete natural resource values or functions that are important to the local ecology or natural communities. The 15 assessment endpoints that were considered in the ERC (where applicable) are listed in Table 1-2 along with the specific Risk Characterization Areas in which these endpoints/species were indicated to be potentially at risk. The ERC used population and community level survey techniques as lines of evidence for the assessment endpoints that were evaluated. Modeled food chain intakes were used to characterize risks to upper trophic wildlife receptors. The MCP (MassDEP, 2006b) provides the following criteria

for the determination of risks to environmental assessment endpoints for the ERC process:

No Significant Risk of Harm

Indication of Potential for Biologically Significant Harm

Evidence of Biologically Significant Harm

Exceedance of a lowest observable adverse effect level (LOAEL) dosage can be considered as an indication of potential for biologically significant harm according to the MCP guidance for disposal site risk characterization (MassDEP, 1996). Table 1-2 identifies the assessment endpoints at risk or potential risk of biological harm with respect to the various Risk Characterization Areas from the ERC, and which constituents contribute to the risk.

Mercury is the primary COC in the aquatic habitats of the Site. The chemistry of mercury in the environment is complex given that the chemical form of mercury varies by environmental medium and the bioaccumulation potential of each form varies significantly. Methyl mercury (MeHg) and total mercury (THg) are both present at the Site. MeHg is the primary form bioaccumulated by biota. MeHg accounts for >98% of the mercury in aquatic biota (i.e., fish), and generally represents the most significant form of mercury contributing to risks to upper trophic levels of the aquatic food chain. Site-specific sediment data show that MeHg constitutes less than 1.5% of the THg present. The majority of the mercury present in the sediment is likely in inorganic forms (i.e., elemental Hg and mercuric salts) and, to a lesser degree, as complex organo-mercury compounds.

The Phase II CSA did not identify any risks to environmental receptors as a result of exposures to the surface water or groundwater at the Site.

### **1.4.3 Assessment of Risk to Safety**

The characterization of the risk of harm to safety involved evaluating the current and reasonably foreseeable conditions at the Site relative to their potential to cause physical injury. Examples of the types of conditions that could be considered to pose a threat of physical harm or bodily injury to people include:

The presence of rusted or corroded drums, open pits, lagoons, or other dangerous structures;

Any threat of fire or explosion, including the presence of explosive vapors resulting from a release of OHM; and

Any uncontained materials that exhibit corrosivity, reactivity, or flammability as described in 310 CMR 40.0347.

The Safety Evaluation in the Phase II CSA Risk Characterization for the Site (TtEC 2005) concluded that only the Cold Waste Area posed a significant potential risk of harm to safety. This finding was based both on the records of past operation that identified the Cold Waste Area

as the primary area designated for the disposal of non-energetic or previously de-energized ordnance-related items, and on the nature of the items that were found in this area during the Phase II Site investigation work. Conditions in this area could pose a potential threat of physical harm or bodily injury to people in the foreseeable future. This risk to safety is currently being managed by the maintenance of secure chain-link fencing that was installed around the perimeter of the Cold Waste Area. This fencing is periodically checked and is maintained to provide a barrier to prevent incidental or inadvertent access to the area and potential contact with any hazardous items that may be present there.

## **2.0 PHASE III EVALUATION PROCESS**

The first step in the process of identifying, evaluating, and selecting Site-wide remedial action alternatives is the development of Site-specific ROs. The ROs presented in this document describe the narrative requirements that any remedial actions that are implemented on the Site will need to meet to address risks to human health and the environmental receptors and to comply with regulatory requirements.

Once the ROs were established, the second step in this process was the development of Site-specific, numerical PRGs to support the evaluation of the effectiveness or performance of remedial alternatives. Such PRGs often define the concentrations of contaminants in the affected media that correspond to achieving the ROs.

For this Site, preliminary ROs were developed based on an overall Site-wide risk management approach. These Site-wide preliminary ROs are presented in Section 3.0. Media-specific preliminary ROs are presented in Section 4.1. The PRGs developed to be used in combination with these preliminary media-specific ROs are presented in Section 4.2. Given the size and complexity of the Site, it was anticipated that some ROs and PRGs would tend to act counter to one another and conflict in their desired outcome. Consequently, a fatal flaw analysis was conducted by collectively comparing the preliminary ROs to the PRGs and evaluating the impacts of each in the context of overall Site remediation. This analysis took into consideration such factors as the nature and extent of the disturbance to the Site to implement the remedy, the relative degree of risk reduction to be achieved, and the magnitude of the Site-specific background concentrations relative to the calculated PRGs. Following this fatal flaw evaluation, the preliminary ROs were revised. These proposed (revised) ROs are presented in Section 4.3.

Following the revision of the preliminary ROs, Site-specific alternatives for the remediation of the contaminated media were developed and evaluated. To assist in the development of Site-wide alternatives, the Site was subdivided into smaller areas, initially matching the Risk Characterization Areas developed in the Phase II CSA. Next, potentially applicable technologies for addressing each contaminated medium were identified and screened against a series of evaluation criteria. Finally, a number of risk characterization area-specific remedial alternatives were developed and combined to construct Site-wide remedial alternatives.

Evaluating candidate remedial alternatives involves four main steps as follows:

1. Developing and screening medium-specific remedial technologies and process options;
2. Assembling appropriate technologies into remedial alternatives for each Risk Characterization Area and assembling sets of alternatives for specific Characterization Areas into Site-wide alternatives for addressing the full set of the revised ROs;

3. Screening the candidate Site-wide remedial alternatives using MCP-specified evaluation criteria (i.e., conducting the comparative evaluation); and
4. Formulating recommendations regarding the preferred remedial alternative.

In the first step of the evaluation process, candidate technologies and process options for each medium were identified and screened. The initial screening was performed to determine if the technology is “reasonably likely to be feasible” based on whether the technology associated with the alternative is reasonably likely to achieve a Temporary or Permanent Solution (as defined in 310 CMR 40.0006) and whether individuals with the expertise needed to effectively implement the technology are available. Following this initial screening, feasible and reasonable technologies were assembled into remedial alternatives for each Risk Characterization Area, and then alternatives for Risk Characterization Areas were assembled into Site-wide remedial alternatives. After the Site-wide alternatives were assembled, they underwent a detailed comparative evaluation against a set of MCP-defined evaluation and regulatory criteria, which include:

1. Comparative effectiveness;
2. Comparative short-term and long-term reliability;
3. Comparative difficulty in implementing;
4. Comparative costs;
5. Comparative risks;
6. Comparative benefits;
7. Comparative timeliness in terms of eliminating any uncontrolled sources of oil and/or hazardous materials and achieving a level of No Significant Risk; and
8. Relative impact on non-pecuniary interests (such as aesthetic values).

The recommended remedial action alternative was selected based on the results of the detailed comparative evaluation. To the extent feasible, a Permanent Solution was selected over a Temporary Solution. Following selection of the alternative, the following feasibility evaluations were conducted:

1. Implementing a Permanent Solution, if a Temporary Solution is selected;
2. Reducing concentrations of constituents to achieve or approach background levels, unless a Class A-1 Response Action Outcome is selected; and
3. Reducing concentrations in soil and/or groundwater to at or below their UCLs.

When a selected alternative was unable to achieve the endpoints above, appropriate follow-up evaluations were conducted as needed. These follow-up evaluations are:

1. Technological feasibility, and
2. Benefit-Cost analysis for reaching background.

Once these evaluations were completed, this RAP was prepared to document the results of the Phase III analysis. The RAP describes in reasonable detail the processes that were used to develop and evaluate remedial alternatives and to support the selection of the preferred alternative. Figure 2-1 provides a flow chart of the Phase III process for this Site, including the steps and activities discussed above.

This Phase III complies with the Response Action Performance Standard defined in the MCP (310 CMR 40.0191 [1]-[3]). This includes:

Considering relevant policies and guidelines of MassDEP;

Using accurate and up-to-date methods, standards and practices, equipment and technologies which are appropriate, available and generally accepted by professional and trade communities conducting response actions in accordance with the MCP under similar circumstances; and

Using investigative practices which are scientifically defensible, and of a level of precision and accuracy commensurate with the intended use of the results of such investigations.

### **3.0 SITE-WIDE RISK MANAGEMENT APPROACH**

Based on the Phase II CSA, significant potential risks to human health and/or the environment are present at the Site. In order to determine what type of remedial response is necessary to address the identified risks, the ROs for the overall Site must first be defined. Given the size and complexity of this Site, the RO development process should begin by defining the overall risk management approach for the Site and the desired remediation outcomes. This Site-wide risk management strategy must not only meet the regulatory requirements of the MCP, but it should also consider the long-term objectives for the Site, including both the current and potential future uses of the upland portion of the Site, and for the associated aquatic resources. This strategy provides a basis for establishing ROs and subsequent PRGs.

The initial Site-wide ROs include:

- Implementing a Permanent Solution (310 CMR 40.0852 [2]);
- Achieving a level of No Significant Risk at the Site considering the OHM present, media contaminated, and Site characteristics (310 CMR 40.0853 [1]) by demonstrating that the chemical-specific, media-specific, and Risk Characterization Area-specific human health and environmentally-based clean-up goals have been achieved;
- Reducing, to the extent feasible, the concentrations of OHM in the environment to levels that achieve or approach background (310 CMR 40.0852 [4]);
- Reducing the levels of Site contaminants in soil and groundwater to below applicable UCLs (310 CMR 40.0860 [1][c]);
- Ensuring that there are no critical exposure pathways (310 CMR 40.0860 [d]);
- Minimizing the need for activity and use limitations (AULs); and
- Protecting the natural resources and conservation areas on the Site and minimizing the disruption of those areas during implementation of the selected remedial action alternative.

The initial ROs listed above define the goals of the overall Site-wide remediation approach. However, these objectives were too general to support the development of meaningful PRGs on which to base the evaluation and selection of remedial action alternatives, and certain of these initial ROs may not be feasible to achieve at this site. To be useful, these Site-wide ROs were further refined to establish media-specific ROs.

Section 4 of this Phase III document presents the more specific ROs for Site soil, groundwater, and sediment. During the Phase II Risk Characterization, no risks were identified with respect to surface water. Therefore, no further consideration will be given to this medium during the development and evaluation of media-specific remedial action alternatives, except as related to

the implementation of remedial actions for sediment. Additionally, no risks were identified for sediment in the Upper Drinkwater River Corridor. Therefore, the sediment in this Risk Characterization Area is not addressed in Phase III.

## **4.0 DEVELOPMENT OF PRELIMINARY REMEDIAL OBJECTIVES AND PRELIMINARY REMEDIATION GOALS**

ROs provide the foundation upon which remedial alternatives are based. ROs are generally developed after the determination has been made that significant risks to human health and/or the environment are present at a site. These risks, together with other federal, state, and local regulatory requirements, are considered as the ROs are defined.

ROs are required to support remedial action planning for the Site. The ROs are needed to clearly articulate the intent of any remedial actions that may be undertaken to address risks to human health and/or environmental receptors. PRGs are then developed to measure progress towards achieving the ROs. PRGs are the target COC concentrations in the affected media that correspond to the specific ROs. For example, if the RO is protection of adults and children from incidental ingestion of sediment during recreational activities, the PRG may be the concentrations of the COCs in these sediment that correspond to an acceptable projected risk level for this exposure route.

Establishment of ROs and associated PRGs will allow evaluation of the various remedial alternatives that are identified for the Site, relative to their ability to reduce risks to human health and environmental receptors to acceptable levels and their relative costs.

It is unlikely that all risks identified in the Phase II CSA can be eliminated by the remedial actions undertaken at this complex site due to a number of factors, including the numerous ecological assessment endpoints, the relatively low Site-specific background concentrations observed, widespread contaminant distribution, and the complex nature of mercury chemistry in sediment. Therefore, a risk reduction approach will be applied when evaluating performance of the candidate alternatives for the Site. Identified risks can be greatly reduced by selecting a remedial alternative that includes partial source removal and/or containment though there will likely be some low residual risks at this Site. The type and magnitude of the residual risks associated with each Site-wide remedial alternative are evaluated in Section 8.0.

### **4.1 PRELIMINARY REMEDIAL OBJECTIVES**

This section lists the preliminary ROs for each affected medium (soil, groundwater, and sediment) at the Site. These preliminary ROs were evaluated against the PRGs developed in Section 4.2 to assess the degree of compatibility and consistency, as mentioned in the fatal flaw analysis summarized in Section 2.0. Based on that evaluation, the preliminary ROs were revised. The revised ROs are presented in Section 4.3 and serve as the basis for this Phase III evaluation. Because the Phase II CSA concluded that there were no significant risks from surface water, ROs were not developed for surface water.

#### **4.1.1 Preliminary Remedial Objectives for Soil**

The preliminary ROs for soil are:

Reduce concentrations of COCs in soil to levels at or below UCLs.

Reduce or eliminate levels of COCs in soil that may be acting as a potential on-going source of sediment contamination to the water bodies (principally mercury).

Minimize or prevent exposure to COCs in soils that are sufficiently contaminated to pose unacceptable lifetime cancer or non-cancer risks to people using the Site.

Reduce, to the extent feasible, the concentrations of COCs in the soil to levels that achieve or approach background.

Reduce risks to acceptable levels for each of the environmental endpoints identified in the ERC as having potential risk of biological significant harm including:

- Insectivorous birds
- Insectivorous small mammals
- Soil invertebrates and microbial communities
- Terrestrial plants

#### **4.1.2 Preliminary Remedial Objectives for Groundwater**

The preliminary RO for groundwater is:

- Reduce concentrations of COCs in groundwater to levels at or below UCLs.

#### **4.1.3 Preliminary Remedial Objectives for Sediment**

The preliminary ROs for sediment are:

Reduce risks to acceptable levels for each of the environmental receptor groups identified in the ERC as having potential risk of biological significant harm including:

- Benthic communities
- Piscivorous fish
- Piscivorous birds
- Omnivorous waterfowl
- Herbivorous waterfowl
- Piscivorous mammals
- Omnivorous mammals
- Herbivorous mammals
- Aquatic reptiles

Reduce the concentrations of COCs, especially MeHg, in the tissues of fish and other prey species to levels that do not pose unacceptable risks to environmental endpoints.

Reduce or contain the mass of THg at the Site so as to minimize the potential transport of THg from low methylating environments to higher methylating environments at the Site.

Improve aquatic and wetland habitats on the Site to a state that will support the elimination of fish consumption advisories through a combination of mass removal/reduction/containment remedial measures that will reduce the bioavailability of mercury.

Reduce the accessible surface sediment THg concentrations to below the Site-specific human health PRG of 22.2 milligrams per kilogram (mg/Kg) to reduce potential risks to human health identified for wading fisherman in the Eastern Channel Corridor (ECC), Lower Drinkwater River Corridor, and Lily Pond/Upper Factory Pond Area and for wading trespassers in the ECC.

- Reduce, to the extent feasible, the concentrations of COCs in the sediment to levels that achieve or approach background.

## **4.2 PRELIMINARY REMEDIATION GOALS**

The primary focus of the RO development is the impact of the contaminated media on the populations and environmental receptors (i.e., endpoints) identified in the Risk Characterization. Although such ROs define the narrative requirements that any remedial actions undertaken to address these risks will need to meet, numerical PRGs also are required to support the evaluation of remedial alternatives for the Site. Numerical PRGs define the concentrations of COCs in the affected media that correspond to the ROs (i.e., that will be protective of people and environmental receptors at the Site). Details on the development of the PRGs are provided in Appendix A and a summary of this development is presented in Sections 4.2.1 and 4.2.2 below.

### **4.2.1 Human Health PRGs**

The calculation of human health-related PRGs involved first considering the chemical-specific risk contribution associated with each identified COC addressed in the HHRC. Decision rules were then established to identify the COCs that made a material contribution to the risk to the highlighted receptors. These “risk driver” COCs were operationally defined as the chemicals that individually contributed a potential carcinogenic risk contribution to a particular receptor greater than  $1 \times 10^{-6}$  or a potential non-carcinogenic hazard index contribution greater than 0.1. Using this conservative definition, this screening process identified the COCs for which PRGs were developed.

Table 4-1 presents the PRGs for soil at two depth intervals (0 to 3 feet below ground surface [bgs] and 0 to 6 feet bgs), and Table 4-2 presents the PRGs for accessible surficial sediment for recreational use. For each potentially exposed receptor, the tables show the risk-based concentrations (RBCs) that were back-calculated to meet the specified target risk goals for carcinogenic and non-carcinogenic health effect end points, as appropriate.

These tables also present the chemical-specific standards and concentration criteria that were used in the PRG derivation, including MassDEP-published background values for “natural” soil and the measured Site-specific background concentrations for sediment. The statistical mean and the maximum concentrations are presented for Site-specific background sediment concentrations.

To provide a context for considering the PRGs for soil, the MCP Method 1 Standards for soil, Site-specific background concentrations, and the MassDEP-published background values for soil containing fill are also provided. The most appropriate Method 1 Standards for soil and groundwater at this Site were judged to be those associated with the following classifications: S-2/GW-2, S-2/GW-3, S-3/GW-2, and S-3/GW-3. For soil, background samples collected at depth intervals consistent with the depth intervals used in the Phase II Risk Characterization (0 to 3 feet bgs and 0 to 6 feet bgs) were considered in this evaluation. These additional chemical-specific values were included to provide perspective on the most stringent RBCs and the PRGs that were developed.

The resulting human health PRGs will be used as remediation goals in the Phase III evaluation of remedial action alternatives for the Site. The soil PRGs are a combination of RBCs, MassDEP-published background concentrations, and practical quantitation limits (PQLs), whereas sediment PRGs are a combination of RBCs, Site-specific background concentrations, and PQLs. Details on the PRG development are presented in Appendix A.

#### **4.2.2 Environmental PRGs**

Environmental PRGs were developed using the results of both field studies and predictive modeling for the receptors and assessment endpoints associated with this Site. PRG development focused on the primary exposure routes and source media identified for each COC and assessment endpoint considered. Source media were sediment and surface soils for the assessment endpoints considered.

Under the MCP, exceedance of a no observable adverse effect level (NOAEL) alone does not constitute a basis for a finding of potential harm. Other lines of evidence must be considered as part of the weight of evidence approach. Exceedance of a LOAEL value may be a basis for a potential risk of harm. This value was used in the derivation of the corresponding PRGs.

Selection of the screening PRGs was based on identifying the lowest assessment endpoint-specific PRG calculated for each COC. For semi-aquatic and terrestrial wildlife receptors, the development process considered the lowest LOAEL-equivalent concentration, where available. This process adopted the LOAEL as the definitive effects concentration for endpoints having a determination as potential significant biological harm consistent with the MCP process. The screening PRG selection process did not consider background concentration as a basis for the

PRG. Table 4-1 provides the summary and proposed surface soil PRGs by COC for the terrestrial environmental receptors. Table 4-2 provides the summary and proposed sediment PRGs by COC for aquatic and semi-aquatic environmental receptors. Semiaquatic environmental receptors are defined as receptors that depend partially on the aquatic resource for protection or nutrition.

### **4.3 DEVELOPMENT OF PROPOSED REMEDIAL OBJECTIVES**

In this section, the PRGs proposed in Section 4.2 were reviewed relative to the preliminary ROs established in Section 4.1 to identify potential inconsistencies and mutually exclusive outcomes.

Results from the Phase II CSA showed that THg in sediment and MeHg in the upper trophic levels of the local food chain are environmental risk drivers and should be a primary focus of any sediment remediation strategy. In Section 4.1, a preliminary RO identified for sediment was to reduce risks to acceptable levels for each of the nine environmental endpoints identified in the ERC as having potential risk of biological significant harm. However, review of the sediment PRGs for each endpoint show that for two endpoints (piscivorous birds and piscivorous mammals), the corresponding THg PRGs (0.02 and 0.32 mg/Kg, respectively) are lower than the lowest measured sediment background concentration for THg (0.34 mg/Kg for the river) at the Site. The Phase II CSA concluded that a residual risk to both endpoints exists at the background concentration range. It would be impractical to remediate the THg concentration in the sediment to below background levels. Therefore, it is not feasible to fully protect the piscivorous bird and piscivorous mammal endpoints, even if background concentrations are achieved. The next lowest THg PRG above background for sediment is the herbivorous waterfowl (27 mg/Kg). However, the human health PRG for THg (22.2 mg/Kg) is lower than the THg PRG for herbivorous waterfowl in sediment, and therefore the human health PRG value for THg in sediments will be used as the criteria to determine whether this revised RO has been met.

Based on the complex chemistry of THg and MeHg in sediment and aquatic environments, reduction of MeHg in fish will likely take decades. Therefore, removal of the current fish consumption advisories, while recognized as an RO, will most likely be an RO to be achieved in the long term. Consequently, this RO was not a primary focus of the remediation alternatives selection process given the uncertainty in the timeframe for this recovery.

Two additional related preliminary ROs for sediment describe the desired future state of the Site. These additional preliminary sediment ROs (from Section 4.1) are as follows:

- Reduce the concentrations of COCs, especially MeHg, in the tissues of fish and other prey species to levels that do not pose unacceptable risks to environmental endpoints.
- Improve aquatic and wetland habitats on the Site to a state that will support the eventual elimination of fish consumption advisories through a combination of mass

removal/reduction/containment remedial measures that will reduce the bioavailability of mercury.

Although it would be desirable to achieve both of these objectives, differences/limitations due to the physical, biological, and chemical processes of mercury in sediment have the potential to significantly influence the feasibility and effectiveness of remedial actions focused on MeHg levels in fish. Developing a remediation strategy based on levels of MeHg in fish tissue will not only be difficult to design and implement, but determining the ultimate success of the remedy may be impractical to measure reliably. Therefore, while it is appropriate to develop ROs for the Site that reflect these desired future outcomes, it may not be realistic to expect that these two ROs will be achieved or can be tested and demonstrated in the shorter term. Instead, the remediation strategy for addressing these ROs will focus on the reduction of THg in those habitats, such as the benthic community, that contribute to increased MeHg levels in fish tissue. For example, remediation of contaminated sediment and the corresponding risk reduction to the benthic community will result in a corresponding risk reduction to wildlife by reducing the concentrations of COCs that bioaccumulate in the local food chain.

Based on the above discussion, the following sections list the revised ROs for each affected medium at the Site.

#### **4.3.1 Revised Remedial Objectives for Soil**

The revised ROs for soil are to:

Reduce the concentrations of COCs in soil to levels at or below their UCLs.

Reduce levels of COCs in soil that may be acting as a potential on-going source of sediment contamination to the water bodies (principally mercury).

Minimize exposure to COCs in soils that are sufficiently contaminated to pose unacceptable cancer or non-cancer risks to people using the Site.

Reduce, to the extent feasible, the concentrations of COCs in the soil to levels that achieve or approach background.

Reduce risks to acceptable levels for each of the environmental receptor groups identified in the ERC as having potential risk of biological significant harm including:

- Insectivorous birds
- Insectivorous small mammals
- Soil invertebrates and microbial communities
- Terrestrial plants

#### **4.3.2 Revised Remedial Objectives for Groundwater**

The revised RO for groundwater is to:

- Reduce concentrations of COCs in groundwater to levels at or below their UCLs to the extent feasible.

#### **4.3.3 Revised Remedial Objectives for Sediment**

The revised ROs for sediment are to:

Reduce risks to acceptable levels for each of the following seven environmental endpoints identified in the ERC as having potential risk of biological significant harm:

- Benthic communities
- Omnivorous waterfowl
- Herbivorous waterfowl
- Piscivorous fish
- Omnivorous mammal
- Herbivorous mammal
- Aquatic reptiles

Reduce/contain the mass of THg at the Site so as to minimize the potential transport of THg from low methylating environments to higher methylating environments.

Reduce risks to human health associated with direct contact with sediment during primary contact recreation (swimming or wading).

Reduce, to the extent feasible, the concentrations of COCs in the sediment to levels that achieve or approach background.

Reduce the concentrations of COCs, especially MeHg, in the tissues of fish and other prey species to levels that do not pose unacceptable risks to environmental endpoints.

Improve aquatic and wetland habitats on the Site to a state that will support the eventual elimination of fish consumption advisories through a combination of mass removal/reduction/containment remedial measures that will reduce the bioavailability of mercury.

## **5.0 DEVELOPMENT AND SCREENING OF REMEDIAL TECHNOLOGIES AND REMEDIAL ALTERNATIVES ASSEMBLY FOR SOIL**

Remedial alternatives were developed to address soil UCL exceedances (except as noted below) and soil identified as posing potential human health and/or ecological risks at the Site.

Soil UCL exceedances for the Site identified in Table 1-1 are shown in Figure 1-2. Remedial technologies to address these exceedances, with the exception of CL213, SCWD01015, and SCWD01153, are identified and screened below and technologies retained as feasible were assembled into remedial alternatives for soil.

The UCL exceedance in the Central Commercial Area (CL213) is in an area that has been redeveloped by others and will not be addressed in the Phase III (RAP) Report.

The UCL exceedances in the Cold Waste Area (SCWD01015 and SCWD01153) are in an area that will be addressed under the Formerly Used Defense Sites (FUDS) Program and will not be addressed in the Phase III (RAP) Report.

Additionally, technologies to address soil identified as posing potential human health and ecological risks (those soil areas having COC concentrations exceeding the human health and ecological PRGs presented in Table 4-1) which are not co-located with UCL exceedances have also been identified and screened. Technologies retained as feasible were assembled into remedial alternatives for soil.

### **5.1 IDENTIFICATION AND INITIAL SCREENING OF REMEDIAL TECHNOLOGIES**

An initial screening of remedial technologies for soil was conducted in accordance with 310 CMR 40.0856 to identify technologies that are reasonably likely to be feasible, based on hazardous material present at the Site, the media contaminated, and the Site characteristics. After initial screening, the remaining technologies were assembled into remedial action alternatives for soil. For the purposes of 310 CMR 40.0856, remedial action alternatives are reasonably likely to be feasible if:

1. The technologies to be employed by the alternative are reasonably likely to achieve a Permanent or Temporary Solution; and
2. Individuals with the expertise needed to effectively implement the technology(ies) would be available, regardless of arrangements for securing their services.

Table 5-1 details the initial screening of remedial technologies for Site soils in the Upper North Area, Southern Disposal Area, and Marsh Upland Area with UCL exceedances<sup>1</sup> and in areas with soils identified as posing potential human health and ecological risks which are not co-located with UCL exceedances (Potential Greenway Area, Southern Disposal Area, Southern Conservation Commission Area, Marsh Upland Area, and Floodplain Area).

The soil UCL exceedances for the Site, as identified in Table 1-1, are metals, specifically antimony, barium, lead, mercury and zinc. Additionally, in areas having soils identified as posing potential human health and ecological risks which are not co-located with UCL exceedances, the majority of risks are from metals. Therefore, based on oil and hazardous material present in the soil at the Site (e.g., metals), remedial technologies not applicable for metals were not put through the initial screening step. Such technologies include:

Bioventing and enhanced bioremediation. Both are in situ biological treatment technologies.

Chemical oxidation. This is an in situ chemical treatment technology.

Soil Vapor Extraction. This is an in situ physical treatment technology.

Ex situ biological treatment technologies including biopiles, composting, landfarming, and slurry phase biological treatment.

Dehalogenation. This is an ex situ chemical treatment technology.

- Ex situ thermal treatment technologies including pyrolysis, thermal desorption, and incineration.

Based on Site characteristics (the Cooperating Parties do not own any of the properties that constitute the Site and the small volume of soil with UCL exceedances [~1,600 cubic yards]), the following additional technologies were not put through the initial screening step:

- Phytoremediation;
- In situ thermal treatment technologies;
- In situ physical/chemical treatment technologies including soil flushing, solidification/stabilization, and electrokinetic separation; and

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<sup>1</sup> The UCL exceedances in the Cold Waste Area will be addressed under the FUDS Program.

- Ex situ physical/chemical treatment technologies including soil washing, separation, chemical extraction, chemical reduction/oxidation.

## 5.2 ASSEMBLY OF REMEDIAL ALTERNATIVES

Using the retained remedial technologies for soil from the initial screening in Section 5.1 above, remedial alternatives for each Risk Characterization Area were assembled. Tables 5-2 through 5-7 show the assembled alternatives for each Risk Characterization Area with soil UCL exceedances and/or identified potential human health or ecological risks associated with soil but not co-located with the UCL exceedances (Upper North Area, Potential Greenway Area, Southern Disposal Area, Southern Conservation Commission Area, Marsh Upland Area, and the Floodplain Area, respectively).

For each of the soil alternatives, the affected soil volume, the mass of primary COC(s) removed, and the human health and ecological risk reductions were calculated and are presented in the Soil Alternatives Summary Table, Table 5-8. Thiessen<sup>2</sup> (Voronoi) polygons were used to define individual areas of influence around each of the soil sample locations for these calculations. Polygons were adjusted to account for Site topography and lack of adjacent sample locations using best professional judgment.

Figures 5-1 through 5-14 show the estimated aerial extent of soil with UCL exceedances and/or soil identified as posing potential human health and ecological risks which are not co-located with UCL exceedances in the Upper North Area, Potential Greenway Area, Southern Disposal Area, Southern Conservation Commission Area, Marsh Upland Area, and the Floodplain Area using Thiessen polygons.

Detailed descriptions of each soil alternative are provided in Section 5.3.

The remedial alternatives for soil in these six Risk Characterization areas were then assembled into five Site-wide remedial alternatives (see Section 8) that include remedial alternatives for Site groundwater and sediment.

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<sup>2</sup> Thiessen polygons can be used to describe the area of influence of a point in a set of points. Each point within the set is connected to its nearest neighbor to form a triangulated irregular network. Bisecting each connecting line segment perpendicularly creates closed polygons (defined by the perpendicular bisectors) termed Thiessen polygons.

### **5.3 DETAILED SOIL ALTERNATIVE DESCRIPTIONS**

The following sections provide a detailed description of the soil alternatives for each Risk Characterization Area (RCA) and RCA-specific assumptions made during the development of remedial alternatives for each RCA. The general assumptions made for soil alternatives are as follows:

For all soil alternatives that include excavation of soil, it has been assumed that backfill of the excavation to match existing grade would be required.

Backfill material will be clean material from local sources. Backfill material will be tested to ensure COCs levels are less than the soil PRGs established for the Site prior to its use. Backfilling of an excavation is not considered capping and therefore does not require long-term monitoring.

Excavated material will be required to pass the Paint Filter Liquids Test (PFLT) prior to transport for off-site disposal and material will be stabilized/solidified if necessary to pass the PFLT.

For areas requiring long-term monitoring of soil COC concentrations, a 40-year monitoring period was assumed.

Pretreatment by filtration of any groundwater incidental to the excavation area and truck transport and disposal of water at an off-site, permitted publicly owned treatment works (POTW) is assumed.

#### **5.3.1 Upper North Area Soil Alternative Descriptions**

In the Upper North Area, there were no human health or ecological PRG exceedances. There is one soil UCL exceedance (for antimony) at sample location NSR 01 (Figure 5-1). To address this exceedance, three soil alternatives were developed for the Upper North Area soil as follows:

No Action – Soil Alternative UNA-1;

Limited Action – Soil Alternative UNA-2; and

- Removal of soil in the area of the UCL exceedance for antimony – Soil Alternative UNA-3.

##### **5.3.1.1 Soil Alternative UNA-1 – No Action**

The No Action alternative serves as a baseline for comparison of overall effectiveness of the other remedial alternatives. The No Action alternative would not involve implementation of any remedial activities to remove, treat, or contain the COCs in Site soil within this Risk Characterization Area. This alternative relies on natural attenuation processes alone to potentially reduce the concentrations of the COCs in Site soil to potentially attain the ROs, but does not include post-remediation monitoring to assess future COC concentrations. The Site soil

in this Risk Characterization Area would be allowed to remain in its current condition; no activities would be undertaken to change the current conditions and no monitoring would be implemented.

### **5.3.1.2 Soil Alternative UNA-2 – Limited Action**

The limited action alternative involves a combination of monitored natural attenuation (MNA) and non-engineering measures for the Site soil with UCL exceedances. Non-engineering measures would be implemented by the owner(s), Cooperating Parties, and/or regulatory agencies to reduce the potential of human receptors coming into contact with the soil in the area of the UCL exceedance.

Specifically, the components of this limited action alternative include:

Establishing a monitoring program to collect and analyze soil samples to track soil COC (antimony) concentrations over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period (or until such time as the antimony concentrations in the area fall below the corresponding UCL); and

- Implementing AULs for soil in the UCL exceedance area.

### **5.3.1.3 Soil Alternative UNA-3 – Excavation/Backfill with Off-Site Disposal**

This removal action alternative involves a combination of excavation, backfill of the area excavated, and off-site disposal of the excavated soil with (UNA-3B) or without (UNA-3A) solidification/stabilization of the excavated soil as necessary for transport. No long-term monitoring would be required as no further potential risk would exist within this Risk Characterization Area after excavation and off-site disposal of the contaminated soil from the UCL exceedance area. It was assumed that the excavated soil could be disposed of locally at a permitted, non-Resource Conservation and Recovery Act (RCRA) landfill. To ensure complete removal of soil with concentrations above the UCL for antimony, an excavation depth of 1 foot was assumed.

Specifically, the components of this complete removal alternative include:

Excavation of approximately 142 cubic yards (cy) of soil from around sample location NSR01;

Backfill of the excavated area with clean material;

Solidify or stabilize excavated soils prior to transport for disposal, if necessary; and

- Transport excavated materials by truck to a local, permitted disposal facility for disposal.

### **5.3.2 Potential Greenway Area Soil Alternative Descriptions**

In the Potential Greenway Area, there were no UCL exceedances or human health PRG exceedances. Mercury and thallium ecological PRG exceedances in surface soils exist within the Potential Greenway Area. To address these exceedances, four soil alternatives were developed for the Potential Greenway Area soil as follows:

No Action – Soil Alternative PGA-1;

Limited Action – Soil Alternative PGA-2;

Removal or Capping and Long-Term Monitoring (LTM) of Soil with Mercury Ecological PRG Exceedances – Soil Alternative PGA-3; and

- Removal or Capping and LTM of Soil with Mercury and Thallium Ecological PRG Exceedances – Soil Alternative PGA-4.

#### **5.3.2.1 Soil Alternative PGA-1 – No Action**

The No Action alternative serves as a baseline for comparison of overall effectiveness of the other remedial alternatives. See Section 5.3.1.1 for additional description of this alternative.

#### **5.3.2.2 Soil Alternative PGA-2 – Limited Action**

The limited action alternative involves MNA of the Site soil with the ecological PRG exceedances (Figure 5-2). Non-engineering measures would not be implemented because they are not effective in reducing the potential of ecological receptors coming into contact with the soil in the areas with ecological PRG exceedances.

Specifically, the components of this limited action alternative include:

- Establishing a monitoring program to collect and analyze soil samples to track soil COC (mercury and thallium) concentrations over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period (or until such time as the mercury and thallium concentrations in the area fall below the corresponding ecological PRGs).

#### **5.3.2.3 Soil Alternative PGA-3 – Excavation/Backfill with Off-Site Disposal or Capping and LTM of Areas with Ecological Mercury PRG Exceedances**

This alternative (Figure 5-3) involves a combination of excavation, backfill of the area excavated, and off-site disposal of the excavated soil with (PGA-3B) or without (PGA-3A) solidification/stabilization of the excavated soil as necessary for transport or engineered capping with long-term maintenance and monitoring of the capped area in areas with total mercury ecological PRG exceedances and MNA in areas with thallium ecological PRG exceedances. Non-engineering measures would not be implemented as they are not effective in reducing the

potential of ecological receptors coming into contact with the soil in the areas with ecological PRG exceedances (PGA-3C). It was assumed that the excavated soil could be disposed of locally at a permitted, non-RCRA landfill. To ensure complete removal of surface soil with concentrations above the ecological PRG for mercury, an excavation depth of 1 foot was assumed.

Specifically, the components of this partial removal or partial capping alternative include:

- Excavation of approximately 4,470 cy of soil (Alternatives PGA-3A and PGA-3B);
- Engineered capping of 120,701 square feet (sf) of soil (Alternative PGA-3C [same footprint as the excavations in Alternatives PGA-3A and PGA-3B]);
- Backfilling of the excavated areas with clean material from local sources (Alternatives PGA-3A and PGA-3B);
- Solidifying or stabilizing excavated soil prior to transport for disposal, if necessary (Alternative PGA-3B);
- Transporting excavated materials by truck to a local, permitted disposal facility for disposal (Alternatives PGA-3A and PGA-3B);
- Establishing a monitoring and maintenance program for the engineered cap (Alternative PGA-3C). The frequency of required monitoring and maintenance will be dependent upon the type of cap installed. For the purposes of this report, it has been assumed that the cap would require annual monitoring through a 40-year monitoring period and that maintenance would be required every 5 years.
- Establishing a monitoring program to collect and analyze soil samples to track soil thallium concentrations over time (Alternatives PGA-3A, PGA-3B, and PGA-3C). Monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period (or until such time as the thallium concentrations in the area fall below the corresponding ecological PRG).

#### **5.3.2.4 Soil Alternative PGA-4 – Excavation/Backfill with Off-Site Disposal or Capping and LTM of Areas with Ecological Mercury and Thallium PRG Exceedances**

This alternative (Figure 5-2) involves a combination of excavation, backfill of the area excavated, and off-site disposal of the excavated soil with (PGA-4B) or without (PGA 4A) solidification/stabilization of the excavated soil necessary for transport or engineered capping with long-term maintenance and monitoring of the capped area in areas with mercury and thallium ecological PRG exceedances (PGA-4C). It was assumed that the excavated soil could be disposed of locally at a permitted, non-RCRA landfill. To ensure complete removal of surface soil with concentrations above the ecological PRGs for mercury and thallium, an excavation depth of 1 foot was assumed.

Specifically, the components of this partial removal or partial capping alternative include:

- Excavation of approximately 10,601 cy of soil (Alternatives PGA-4A and PGA-4B);
- Engineered capping of 286,215 sf of soil (Alternative PGA-4C [same footprint as the excavations in Alternatives PGA-4A and PGA-4B]);
- Backfilling of the excavated areas with clean material from local sources (Alternatives PGA-4A and PGA-4B);
- Solidifying or stabilizing excavated soil prior to transport for disposal, if necessary (Alternative PGA-4B);
- Transporting excavated materials by truck to a local, permitted disposal facility for disposal (Alternatives PGA-4A and PGA-4B); and
- Establishing monitoring and maintenance program for the engineered cap (Alternative PGA-4C). The frequency of required monitoring and maintenance will be dependent upon the type of cap installed. For the purposes of this report, it has been assumed that the cap would require annual monitoring through a 40-year monitoring period and that maintenance would be required every 5 years.

### **5.3.3 Southern Disposal Area Soil Alternative Descriptions**

In the Southern Disposal Area, there were UCL exceedances for lead; human health PRG exceedances for chromium, 1,1-dichloroethene (1,1-DCE), trichloroethene (TCE), and lead; and ecological PRG exceedances for antimony, barium, chromium, copper, lead, mercury, and zinc. To address these exceedances, five soil alternatives were developed for the Southern Disposal Area soil as follows:

- No Action – Soil Alternative SDA-1;
- Limited Action – Soil Alternative SDA-2;
- Removal of Soil with UCL Exceedances – Soil Alternative SDA-3 (3A or 3B);
- Removal of Soil with UCL Exceedances and Removal or Capping and LTM of Soils with Highest Human Health Risks (1,1 DCE PRG Exceedances) – Soil Alternative SDA-4 (4A, 4B, or 4C); and
- Removal of Soil with UCL Exceedances and Removal or Capping and LTM of Soil with Human Health and Ecological PRG Exceedances – Soil Alternative SDA-5 (5A, 5B, or 5C).

#### **5.3.3.1 Soil Alternative SDA-1 – No Action**

The No Action alternative serves as a baseline for comparison of overall effectiveness of the other remedial alternatives. See Section 5.3.1.1 for additional description of this alternative.

### **5.3.3.2 Soil Alternative SDA-2 – Limited Action**

The limited action alternative involves a combination of MNA and non-engineering measures for the Site soil with UCL, ecological and human health exceedances. Non-engineering measures would be implemented by the owner(s), Cooperating Parties and/or regulatory agencies to reduce the potential of human receptors coming into contact with the soil in the area of the UCL and human health PRG exceedances. Although non-engineering measures are not effective in reducing the potential of ecological receptors coming into contact with the soil in the areas with ecological PRG exceedances, for the purposes of this report, the areas with only ecological PRG exceedances were not separated out for just MNA under this alternative (Figure 5-4).

Specifically, the components of this limited action alternative include:

Establishing a monitoring program to collect and analyze soil samples to track soil COC (lead, chromium, 1,1-DCE, TCE, antimony, barium, copper, mercury, and zinc) concentrations over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period (or until such time as the COC concentrations in the area fall below the corresponding UCL, human health PRG, or ecological PRG);

Implementing AULs for this area;

Installing and maintaining fencing and warning signs around the perimeter of the areas with UCL, ecological, and human health PRG exceedances; and

- Implementation of educational programs to inform future Site workers (utility and construction workers) and local recreational users engaged in potential soil disturbing activities of the health and safety considerations associated with COC-impacted soils. Site workers would receive pre-work briefings.

### **5.3.3.3 Soil Alternative SDA-3 – Excavation/Backfill with Off-Site Disposal of Areas with UCL Exceedances for Lead**

This removal action alternative involves a combination of excavation of soil with UCL exceedances for lead, backfill of the area excavated, and off-site disposal of the excavated soil with (SDA-3B) or without (SDA-3A) solidification/stabilization of the excavated soil as necessary for transportation. All soil with human health and ecological PRG exceedances not co-located with UCL exceedances would be subject to MNA and non-engineering measures. As previously discussed in Section 5.3.3.2 above, areas with just ecological PRG exceedances outside areas with UCL exceedances have not been separated out for just MNA under this alternative (Figure 5-5). It was assumed that the excavated soil could be disposed of locally at a permitted, non-RCRA landfill. To ensure complete removal of soil with concentrations above the UCL for lead, an excavation depth of 3 feet was assumed.

Specifically, the components of this partial removal alternative to address UCL exceedances for lead include:

- Excavation of approximately 855 cy of soil (Alternatives SDA-3A and SDA-3B);
- Backfilling of the excavated areas with clean material from local sources (Alternatives SDA-3A and SDA-3B);
- Solidifying or stabilizing excavated soil prior to transport for disposal, if necessary (Alternative SDA-3B);
- Transporting excavated materials by truck to a local, permitted disposal facility for disposal (Alternatives SDA-3A and SDA-3B);
- Establishing a monitoring program to collect and analyze soil samples to track soil COC (lead, chromium, 1,1-DCE, TCE, antimony, barium, copper, mercury, and zinc) concentrations over time. It is assumed that monitoring would occur once at 2 years, 5 years and, every 5 years after the year 5 monitoring through a 40-year monitoring period (or until such time as the COC concentrations in the area fall below the corresponding human health PRG or ecological PRG);
- Implementing AULs for this area for areas with human health PRG exceedances;
- Installing and maintaining fencing and warning signs around the perimeter of the areas with ecological and human health PRG exceedances; and
- Implementation of educational programs to inform future Site workers (utility and construction workers) and local recreational users engaged in potential soil disturbing activities of the health and safety considerations associated with COC-impacted soils. Site workers would receive pre-work briefings.

#### **5.3.3.4 Soil Alternative SDA-4 – Removal of Soil with UCL Exceedances and Removal or Capping and LTM of Soils with Highest Human Health Risks (1,1-DCE PRG Exceedances)**

This removal action alternative involves a combination of excavation of soil with UCL exceedances for lead, backfill of the area excavated, and off-site disposal of the excavated soil with (SDA-4B) or without (SDA-4A) solidification/stabilization of the excavated soil as necessary for transport and excavation/backfill/off-site disposal with or without solidification/stabilization as necessary for transport or engineered capping with long term monitoring and maintenance of capped areas with 1,1-DCE PRG exceedances (SDA-4C). 1,1-DCE PRG exceedances were identified for utility and construction workers as well as adult and child recreational users. The remaining area with human health and/or ecological PRG exceedances not co-located with UCL exceedances is the area around sample location SWBP17. This area would be subject to MNA only because there are only ecological PRG exceedances in

this area. It was assumed that the excavated soil could be disposed of locally at a permitted, non-RCRA landfill. Excavation depths vary from 0.5 foot to 3 feet in areas outside the UCL exceedance areas. To ensure complete removal of soil with concentrations above the UCL for lead, an excavation depth of 3 feet was assumed in these areas.

Specifically, the components of this partial removal alternative to address UCL exceedances for lead and the human health 1,1-DCE PRGs include:

- Excavation of approximately 855 cy of soil (Alternatives SDA-4A, SDA-4B, and SDA-4C) to address UCL exceedances;
- Excavation of an additional 4,472 cy of soil (Alternatives SDA-4A and SDA-4B) to address the 1,1-DCE human health PRG exceedances (Figure 5-6);
- Engineered capping of 44,188 sf of soils (Alternative SDA-4C (same footprint as the additional excavations in Alternatives SDA-4A and SDA-4B)) (Figure 5-7);
- Backfilling of the excavated areas with clean material from local sources (Alternatives SDA-4A, SDA-4B, and SDA-4C);
- Solidifying or stabilizing excavated soil prior to transport for disposal, if necessary (Alternative SDA-4B);
- Transporting excavated materials by truck to a local, permitted disposal facility for disposal (Alternatives SDA-4A, SDA-4B, and SDA-4C);
- Establishing a monitoring and maintenance program for the engineered cap (Alternative SDA-4C). The frequency of required monitoring and maintenance will be dependent upon the type of cap installed. For purposes of this report, it has been assumed that the cap would require annual monitoring through a 40-year monitoring period and that maintenance would be required every 5 years.
- Implementing AULs for the capped area (Alternative SDA-4C);
- Installing and maintaining fencing and warning signs around the perimeter of the capped areas (Alternative SDA-4C);
- Implementation of educational programs to inform future Site workers (utility and construction workers) engaged in potential cap disturbing activities of the health and safety considerations associated with COC-impacted soils (Alternative SDA-4C). Site workers would receive pre-work briefings; and
- Establishing a monitoring program in the area around sample location SWBP17 (Alternatives SDA-4A, SDA-4B, and SDA-4C) to collect and analyze surface soil samples to track soil COC (chromium and mercury) concentrations over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every five years after the year 5 monitoring through a 40-year monitoring period (or until such time as the COC concentrations in the area fall below the corresponding ecological PRG).

### **5.3.3.5 Soil Alternative SDA-5 – Removal of Soil with UCL Exceedances and Removal or Capping and LTM of Soil with Human Health and Ecological PRG Exceedances**

This removal action alternative involves a combination of excavation of soil with UCL exceedances for lead, backfill of the area excavated, and off-site disposal of the excavated soil with (SDA-5B) or without (SDA-5A) solidification/stabilization as necessary for transport or engineered capping with long term monitoring and maintenance of capped areas with human health or ecological PRG exceedances outside the areas with UCL exceedances (SDA-5C). It was assumed that the excavated soil could be disposed of locally at a permitted, non-RCRA landfill. Excavation depths vary from 0.5 foot to 3 feet in areas outside the UCL exceedance areas. To ensure complete removal of soil with concentrations above the UCL for lead, an excavation depth of 3 feet was assumed in these areas.

Specifically, the components of this alternative to remove UCL exceedances for lead and address human health and ecological PRG exceedances include:

- Excavation of approximately 855 cy of soil (Alternatives SDA-5A, SDA-5B, and SDA-5C) to address UCL exceedances;
- Excavation of an additional 509 cy of soil (Alternatives SDA-5A and SDA-5B) to address all human health and ecological PRG exceedances not co-located with UCL exceedances (Figure 5-4);
- Engineered capping of 50,954 sf of soils in Alternative SDA-5C to address human health and ecological PRG exceedances not co-located with UCL exceedances (same footprint as the additional excavations in Alternatives SDA-5A and SDA-5B) (Figure 5-8);
- Backfilling of the excavated areas with clean material from local sources (Alternatives SDA-5A, SDA-5B, and SDA-5C);
- Solidifying or stabilizing excavated soil prior to transport for disposal, if necessary (Alternative SDA-5B);
- Transporting excavated materials by truck to a local, permitted disposal facility for disposal (Alternatives SDA-5A, SDA-5B, and SDA-5C);
- Establishing a monitoring and maintenance program for the engineered cap installed (Alternative SDA-5C). The frequency of required monitoring and maintenance will be dependent upon the type of cap installed. For the purposes of this report, it has been assumed that the cap would require annual monitoring through a 40-year monitoring period and that maintenance would be required every 5 years.
- Implementing AULs for the capped area (Alternative SDA-5C);
- Installing and maintaining fencing and warning signs around the perimeter of the capped areas (Alternative SDA-5C); and

- Implementation of educational programs to inform future Site workers (utility and construction workers) engaged in potential cap disturbing activities of the health and safety considerations associated with COC-impacted soils in Alternative SDA-5C. Site workers would receive pre-work briefings.

### **5.3.4 Southern Conservation Commission Area Soil Alternative Descriptions**

In the Southern Conservation Commission Area (SCCA), there were no UCL exceedances or human health PRG exceedances. Mercury, chromium, copper, barium, and zinc ecological PRG exceedances in surface soils exist within the SCCA. To address these exceedances, four soil alternatives were developed for the SCCA as follows:

No Action – Soil Alternative SCCA-1;

Limited Action – Soil Alternative SCCA-2;

Removal or Capping and LTM of Surface Soils with Mercury Concentrations Greater Than or Equal to 1 mg/Kg – Soil Alternative SCCA-3 (3A, 3B or 3C); and

- Removal or Capping and LTM of Surface Soils with Ecological PRG Exceedances – Soil Alternative SCCA-4 (4A, 4B or 4C).

#### **5.3.4.1 Soil Alternative SCCA-1 – No Action**

The No Action alternative serves as a baseline for comparison of overall effectiveness of the other remedial alternatives. See Section 5.3.1.1 for additional description of this alternative.

#### **5.3.4.2 Soil Alternative SCCA-2 – Limited Action**

The limited action alternative involves MNA of the Site soil with the ecological PRG exceedances (Figure 5-9). Non-engineering measures would not be implemented because they are not effective in reducing the potential of ecological receptors coming into contact with the soil in the areas with ecological PRG exceedances.

Specifically, the components of this limited action alternative include:

- Establishing a monitoring program to collect and analyze surface soil samples to track soil COC (mercury, chromium, zinc, copper, barium, and zinc) concentrations over time. It is assumed that monitoring would occur once at 2 years, 5 years and, every 5 years after the year 5 monitoring through a 40-year monitoring period (or until such time as the COC concentrations in the area fall below the corresponding ecological PRGs).

### **5.3.4.3 Soil Alternative SCCA-3 – Excavation/Backfill with Off-Site Disposal or Capping and LTM of Areas with Mercury Concentrations in Surface Soils Greater than or Equal to 1 mg/Kg**

This alternative involves a combination of excavation, backfill of the area excavated, and off-site disposal of the excavated soil with (SCCA-3B) or without (SCCA-3A) solidification/stabilization of the excavated soil as necessary for transport or engineered capping with long term maintenance and monitoring of the capped area in areas with mercury concentrations greater than or equal to 1 mg/Kg and MNA in areas with ecological PRG exceedances not co-located with areas with mercury concentrations greater than or equal to 1 mg/Kg (SCCA-3C). Non-engineering measures would only be implemented in conjunction with capped areas to ensure the integrity of the cap as they are not effective in reducing the potential of ecological receptors coming into contact with the soil in the areas with ecological PRG exceedances (Figure 5-10). It was assumed that the excavated soil could be disposed of locally at a permitted, non-RCRA landfill. To ensure complete removal of surface soil with mercury concentrations equal to or greater than 1 mg/Kg, an excavation depth of 1 foot was assumed.

Specifically, the components of this partial removal or partial capping alternative include:

- Excavation of approximately 4,308 cy of soil (Alternatives SCCA-3A and SCCA-3B) in areas with mercury concentrations in surface soils greater than or equal to 1 mg/Kg;

- Engineered capping of 116,310 sf of soil (Alternative SCCA-3C) in areas with mercury concentrations in surface soils greater than or equal to 1 mg/Kg (same footprint as the excavations in Alternatives SCCA-3A and SCCA-3B);

- Backfilling of the excavated areas with clean material from local sources (Alternatives SCCA-3A and SCCA-3B);

- Solidifying or stabilizing excavated soil prior to transport for disposal, if necessary (Alternative SCCA-3B);

- Transporting excavated materials by truck to a local, permitted disposal facility for disposal (Alternatives SCCA-3A and SCCA-3B);

- Establishing a monitoring and maintenance program for the engineered cap installed (Alternative SCCA-3C). The frequency of required monitoring and maintenance will be dependent upon the type of cap installed. For the purposes of this report, it has been assumed that the cap would require annual monitoring through a 40-year monitoring period and that maintenance would be required every 5 years;

- Implementing AULs for the capped area (Alternative SCCA-3C);

- Installing and maintaining fencing and warning signs around the perimeter of the capped areas (Alternative SCCA-3C);

Implementation of educational programs to inform future Site workers (utility and construction workers) engaged in potential cap disturbing activities of the health and safety considerations associated with COC-impacted soils (Alternative SCCA-3C). Site workers would receive pre-work briefings; and

- Establishing a monitoring program to collect and analyze surface soil samples to track soil COC (mercury, chromium, zinc, copper, barium, and zinc) concentrations over time (Alternatives SCCA-3A, SCCA-3B, and SCCA-3C). It is assumed that monitoring of uncapped areas with surface soil ecological PRG exceedances would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period (or until such time as the COC concentrations in the area fall below the corresponding ecological PRG).

#### **5.3.4.4 Soil Alternative SCCA-4 – Excavation/Backfill with Off-Site Disposal or Capping and LTM of Areas with Ecological PRG Exceedances**

This alternative involves a combination of excavation, backfill of the area excavated, and off-site disposal of the excavated soil with (SCCA-4B) or without (SCCA-4A) solidification/stabilization of the excavated soil as necessary for transport or engineered capping with long term maintenance and monitoring of the capped area in areas with ecological PRG exceedances (SCCA-4C). It was assumed that the excavated soil could be disposed of locally at a permitted, non-RCRA landfill. To ensure complete removal of surface soil with concentrations above the corresponding ecological PRGs, an excavation depth of 1 foot was assumed.

Specifically, the components of this extensive removal or capping alternative include:

Excavation of approximately 34,827 cy of soil (Alternatives SCCA-4A and SCCA-4B) to address surface soil PRG exceedances (Figure 5-9);

Engineered capping of 940,875 sf of soil (Alternative SCCA-4C) to address surface soil PRG exceedances (same footprint as the excavations [Alternatives SCCA-4A and SCCA-4B]);

Backfilling of the excavated areas with clean material from local sources (Alternatives SCCA-4A and SCCA-4B);

Solidifying or stabilizing excavated soil prior to transport for disposal, if necessary (Alternative SCCA-4B);

Transporting excavated materials by truck to a local, permitted disposal facility for disposal (Alternatives SCCA-4A and SCCA-4B);

Establishing a monitoring and maintenance program for the engineered cap installed (Alternative SCCA-4C). The frequency of required monitoring and maintenance will be dependent upon the type of cap installed. For the purposes of this report, it has been

assumed that the cap would require annual monitoring through a 40-year monitoring period and that maintenance would be required every 5 years;

Implementing AULs for the capped area (Alternative SCCA-4C);

Installing and maintaining fencing and warning signs around the perimeter of the capped areas (Alternative SCCA-4C); and

- Implementation of educational programs to inform future Site workers (utility and construction workers) engaged in potential cap disturbing activities of the health and safety considerations associated with COC-impacted soils (Alternative SCCA-4C). Site workers would receive pre-work briefings.

### **5.3.5 Marsh Upland Area Soil Alternative Descriptions**

In the Marsh Upland Area, there are UCL exceedances for mercury, human health PRG exceedances for mercury, and ecological PRG exceedances for mercury, chromium, copper, and lead. To address these exceedances, four soil alternatives were developed for the Marsh Upland Area soil as follows:

No Action – Soil Alternative MUA-1;

Limited Action – Soil Alternative MUA-2;

Removal of Soil with UCL Exceedances – Soil Alternative MUA-3 (3A or 3B); and

- Removal of Soil with UCL Exceedances and Removal or Capping and LTM of Soil with Human Health and Ecological PRG Exceedances – Soil Alternative MUA-4 (4A, 4B, or 4C).

#### **5.3.5.1 Soil Alternative MUA-1 – No Action**

The No Action alternative serves as a baseline for comparison of overall effectiveness of the other remedial alternatives. See Section 5.3.1.1 for additional description of this alternative.

#### **5.3.5.2 Soil Alternative MUA-2 – Limited Action**

The limited action alternative involves a combination of MNA and non-engineering measures for the Site soil with UCL, ecological, and human health PRG exceedances. Non-engineering measures would be implemented by the owner(s), Cooperating Parties and/or regulatory agencies to reduce the potential of human receptors coming into contact with the soil in the area of the UCL and human health PRG exceedances (Figure 5-11). Although non-engineering measures are not effective in reducing the potential of ecological receptors coming into contact with the soil in the areas with ecological PRG exceedances, for the purposes of this report, the areas with only ecological PRG exceedances were not separated out for just MNA under this alternative.

Specifically, the components of this limited action alternative include:

Establishing a monitoring program to collect and analyze soil samples to track soil COC (mercury, chromium, copper, and lead) concentrations over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period (or until such time as the COC concentrations in the area fall below the corresponding UCL, human health PRG or ecological PRG);

Implementing AULs for the areas with UCL, ecological, and human health PRG exceedances;

Installing and maintaining fencing and warning signs around the perimeter of the areas with UCL, ecological, and human health PRG exceedances; and

- Implementation of educational programs to inform future Site workers (utility and construction workers) engaged in potential soil disturbing activities of the health and safety considerations associated with COC-impacted soils. Site workers would receive pre-work briefings.

#### **5.3.5.3 Soil Alternative MUA-3 – Excavation/Backfill with Off-Site Disposal in Areas with UCL Exceedances for Mercury**

This removal action alternative involves a combination of excavation of soil with UCL exceedances for mercury, backfill of the area excavated, and off-site disposal of the excavated soil with (MUA-3B) or without (MUA-3A) solidification/stabilization of the excavated soil as necessary for transport. All soil with human health and ecological PRG exceedances not co-located with UCL exceedances would be subject to MNA and non-engineering measures. As previously discussed in Section 5.3.3.2 above, areas with just ecological PRG exceedances outside areas with UCL exceedances have not been separated out for just MNA under this alternative (Figure 5-12). It was assumed that the excavated soil could be disposed of locally at a permitted, non-RCRA landfill. To ensure complete removal of soil with concentrations above the UCL for lead, excavation depths of 3 feet and 6 feet were assumed.

Specifically, the components of this partial removal alternative to address UCL exceedances for mercury include:

Excavation of approximately 353 cy of soil (Alternatives MUA-3A and MUA-3B) to address UCL exceedances for mercury;

Backfilling of the excavated areas with clean material from local sources (Alternatives MUA-3A and MUA-3B);

Solidifying or stabilizing excavated soil prior to transport for disposal (Alternative MUA-3B);

Transporting excavated materials by truck to a local, permitted disposal facility for disposal (Alternatives MUA-3A and MUA-3B);

Establishing a monitoring program to collect and analyze soil samples to track soil COC (mercury, chromium, copper, and lead) concentrations over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period (or until such time as the COC concentrations in the area fall below the corresponding human health PRG or ecological PRG) (Alternatives MUA-3A and MUA-3B);

Implementing AULs for areas with ecological and human health PRG exceedances not-co-located with UCL exceedances (Alternatives MUA-3A and MUA-3B) ;

Installing and maintaining fencing and warning signs around the perimeter of the areas with ecological and human health PRG exceedances not co-located with UCL exceedances (Alternatives MUA-3A and MUA-3B); and

- Implementation of educational programs to inform future Site workers (utility and construction workers) engaged in potential soil disturbing activities of the health and safety considerations associated with COC-impacted soils. Site workers would receive pre-work briefings (Alternatives MUA-3A and MUA-3B).

#### **5.3.5.4 Soil Alternative MUA-4 – Removal of Soil with UCL Exceedances and Removal or Capping and LTM of Soil with Human Health and Ecological PRG Exceedances**

This removal action alternative involves a combination of excavation of soil with UCL exceedances for mercury, backfill of the area excavated, and off-site disposal of the excavated soil with (MUA-4B) or without (MUA-4A) solidification/stabilization as necessary for transport or engineered capping with long-term monitoring and maintenance of capped areas with human health or ecological PRG exceedances outside the areas with UCL exceedances (MUA-4C). It was assumed that the excavated soil could be disposed of locally at a permitted, non-RCRA landfill. Excavation depth in areas outside the UCL exceedance areas was assumed to be 1 foot. To ensure complete removal of soil with concentrations above the UCL for lead, excavation depths of 3 feet and 6 feet were assumed.

Specifically, the components of this alternative to remove UCL exceedances for mercury and address human health and ecological PRG exceedances not co-located with the UCL exceedances include:

Excavation of approximately 353 cy of soil (Alternatives MUA-4A, MUA-4B, and MUA-4C) to address mercury UCL exceedances;

Excavation of an additional 867 cy of soil (Alternatives MUA-4A and MUA-4B) to address all human health and ecological PRG exceedances not co-located with UCL exceedances (Figure 5-11);

Engineered capping of 21,437 square feet (sf) of soils (Alternative MUA-4C) to address human health and ecological PRG exceedances not co-located with UCL exceedances (same footprint as the additional excavations [Alternatives MUA-4A and MUA-4B]) (Figure 5-13);

Backfilling of the excavated areas with clean material from local sources (Alternatives MUA-4A, MUA-4B, and MUA-4C);

Solidifying or stabilizing excavated soil prior to transport for disposal, if necessary (Alternative MUA-4B);

Transporting excavated materials by truck to a local, permitted disposal facility for disposal (Alternatives MUA-4A, MUA-4B, and MUA-4C);

Establishing a monitoring and maintenance program for the engineered cap (Alternative MUA-4C). The frequency of required monitoring and maintenance will be dependent upon the type of cap installed. For the purposes of this report, it has been assumed that the cap would require annual monitoring through a 40-year monitoring period and that maintenance would be required every five years;

Implementing AULs for the capped area (Alternative MUA-4C);

Installing and maintaining fencing and warning signs around the perimeter of the capped areas (Alternative MUA-4C); and

- Implementation of educational programs to inform future Site workers (utility and construction workers) engaged in potential cap disturbing activities of the health and safety considerations associated with COC-impacted soils (Alternative MUA-4C). Site workers would receive pre-work briefings.

### **5.3.6 Floodplain Area Soil Alternative Descriptions**

In the Floodplain Area, there were no UCL exceedances or human health PRG exceedances. One surface soil ecological lead PRG exceedance was detected. To address this exceedance, three soil alternatives were developed for the Floodplain Area soil as follows:

No Action – Soil Alternative FPA-1;

Limited Action – Soil Alternative FPA-2; and

- Removal of Soil with Lead Ecological PRG Exceedance – Soil Alternative FPA-3 (3A and 3B).

### **5.3.6.1 Soil Alternative FPA-1 – No Action**

The No Action alternative serves as a baseline for comparison of overall effectiveness of the other remedial alternatives. See Section 5.3.1.1 for additional description of this alternative.

### **5.3.6.2 Soil Alternative FPA-2 – Limited Action**

The limited action alternative involves MNA of soil with the ecological PRG exceedance for lead. Non-engineering measures would be not implemented as they are not effective in reducing the potential of ecological receptors coming into contact with the soil in the areas with ecological PRG exceedances (Figure 5-14).

Specifically, the components of this limited action alternative include:

- Establishing a monitoring program to collect and analyze surface soil samples to track soil COC (lead) concentrations over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period (or until such time as the lead concentration in the area falls below the corresponding ecological PRG).

### **5.3.6.3 Soil Alternative FPA-3 – Excavation/Backfill with Off-Site Disposal**

This removal action alternative involves a combination of excavation, backfill of the area excavated, and off-site disposal of the excavated soil with (FPA-3B) or without (FPA-3A) solidification/stabilization of the excavated soil as necessary for transport. No MNA would be required as no further potential risk would exist within the Floodplain Area after excavation and off-site disposal of the contaminated soil from the lead PRG exceedance area (Figure 5-14). It was assumed that the excavated soil could be disposed of locally at a permitted, non-RCRA landfill. To ensure complete removal of soil with concentrations above the ecological PRG for lead, an excavation depth of 0.5 foot was assumed.

Specifically, the components of this complete removal alternative include:

Excavation of approximately 211 cy of soil from around sample location FEMA 02 to address the lead PRG exceedance (Alternatives FPA-3A and FPA 3B);

Backfill of the excavated area with clean material from local sources (Alternatives FPA 3A and FPA 3B);

Solidifying or stabilizing excavated materials prior to transport for disposal, if necessary (FPA-3B); and

Transporting excavated materials by truck to a local, permitted disposal facility for disposal (Alternatives FPA-3A and FPA-3B).

## **6.0 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES FOR GROUNDWATER**

The two groundwater UCL exceedances for the Site identified during Phase II (PZ-24 and DPMW1) are listed in Table 1-1<sup>3</sup> and shown in Figure 1-2. There are no identified human health or environmental risks associated with groundwater at this Site (TtEC, 2005). Therefore, remedial alternatives developed for groundwater at the Site will only address UCL exceedances.

### **6.1 IDENTIFICATION AND INITIAL SCREENING OF REMEDIAL TECHNOLOGIES**

An initial screening of remedial technologies for groundwater was conducted in accordance with 310 CMR 40.0856 to identify technologies that are reasonably likely to be feasible, based on OHM present at the Site, the media contaminated, and the Site characteristics. After initial screening, the remaining technologies were assembled into remedial action alternatives for groundwater.

Table 6-1 details the initial screening of remedial technologies for Site groundwater in the Southern Disposal Area and Marsh Upland Area with UCL exceedances (Figure 1-2).

The groundwater UCL exceedances for the Site, as identified in Table 1-1, are metals, specifically lead and mercury. Therefore, based on OHM present in the groundwater at the Site (i.e., metals), remedial technologies not applicable for metals were not put through the initial screening step. Such technologies include:

In situ biological treatment technologies including enhanced bioremediation and phytoremediation;

In situ chemical treatment technologies including air sparging, bioslurping, chemical oxidation, dual phase extraction, thermal treatment, and in-well air stripping;

Bioreactors, an ex situ biological treatment technology;

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<sup>3</sup> As noted in Table 1-2, the groundwater UCL exceedances identified at PZ-24 in the Southern Disposal Area for nickel have been attributed to stainless steel well points installed at this location and will not be addressed in this RAP.

Air stripping and granulated activated carbon/liquid phase carbon absorption, and advanced oxidation processes. These are all ex situ physical/chemical treatment technologies that assume pumping and subsequent treatment; and

- Deep well injection, a containment technology.

Based on Site characteristics (the Cooperating Parties do not own any of the properties that constitute the Site and the limited number of groundwater UCL exceedances [two locations]), the following additional technologies were not put through the initial screening step:

Passive/reactive treatment walls;

Constructed wetlands, assuming pump and treat;

Ion exchange and precipitation/coagulation/flocculation, both physical/chemical ex situ treatment technologies; and

- Slurry walls and sheet piling, both containment technologies.

## **6.2 ASSEMBLY OF REMEDIAL ALTERNATIVES**

Using the retained remedial technologies for groundwater from the initial screening in Section 6.1 above, remedial alternatives for groundwater in the Southern Disposal Area and the Marsh Upland Area were assembled to address groundwater UCL exceedance for lead and mercury, respectively. Tables 6-2 and 6-3 show the assembled groundwater alternatives for the two locations with soil UCL exceedances, PZ-24 in the Southern Disposal Area and DPMW1 in Marsh Upland Area, respectively.

Detailed descriptions of each groundwater alternative are provided in Section 6.3.

The remedial alternatives for groundwater in these two locations were then assembled into the five Site-wide remedial alternatives (see Section 8) that include remedial alternatives for Site soil and sediment.

## **6.3 DETAILED GROUNDWATER ALTERNATIVE DESCRIPTIONS**

The following provides a detailed description of the groundwater alternatives and assumptions made during the development of remedial alternatives for each Risk Characterization Area.

### **6.3.1 Southern Disposal Area Groundwater Alternative Descriptions**

In the Southern Disposal Area, there are no identified risks to human health or ecological receptors based on groundwater conditions. There is one groundwater UCL exceedance for lead in the area of groundwater monitoring well PZ-24. To address this exceedance, four groundwater alternatives were developed for the Southern Disposal Area groundwater as follows:

No Action – Groundwater Alternative SDGW-1;

Limited Action – Groundwater Alternative SDGW-2;

Source Removal – Groundwater Alternative SDGW-3; and

- Extensive Source Removal – Groundwater Alternative SDGW-4.

#### **6.3.1.1 Groundwater Alternative SDGW-1 – No Action**

The No Action alternative serves as a baseline for comparison of overall effectiveness of the other remedial alternatives. The No Action alternative would not involve implementation of any remedial activities to remove, treat, or contain COCs in Site groundwater within this Risk Characterization Area. This alternative relies on natural attenuation processes alone to potentially reduce the concentrations of COCs in Site groundwater to potentially attain the ROs, but does not include post-remediation monitoring to assess future COC concentrations. The Site groundwater in the Southern Disposal Area would be allowed to remain in its current condition, and no activities would be undertaken to change the current conditions and no monitoring would be implemented.

#### **6.3.1.2 Groundwater Alternative SDGW-2 – Limited Action**

The limited action alternative involves a combination of monitored natural attenuation and institutional controls for groundwater with the UCL exceedance within the Southern Disposal Area. Non-engineering measures would be implemented by the owner(s), Cooperating Parties, and/or regulatory agencies to reduce the potential of human receptors coming into contact with the groundwater in the area of the UCL exceedance.

Specifically, the components of this limited action alternative include:

Establishing a monitoring program to collect and analyze groundwater samples at PZ-24 to track groundwater COC (lead) concentrations over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period (or until such time as the lead concentrations in the area fall below the corresponding UCL).

#### **6.3.1.3 Groundwater Alternative SDGW-3 – Source Removal**

This removal alternative assumes that elevated lead concentrations within the Southern Disposal Area soils are contributing to the lead UCL exceedance in groundwater and that removal of these source area soils would result in a corresponding reduction of lead in the groundwater. Under this alternative, soil in the Southern Disposal Area with lead concentrations exceeding the lead soil UCL would be excavated and disposed of off site (Figure 6-1). Any incidental groundwater in the excavations would be pre-treated, transported, and disposed of off site at a permitted POTW. Post-remediation monitoring of groundwater within the area of the groundwater UCL

exceedance for lead (at PZ-24) would be implemented. As previously discussed in Section 5.3.3.3, an excavation depth of 3 feet was assumed to ensure the complete removal of soil with concentrations above the UCL for lead.

Specifically, the components of this source removal option to address the groundwater UCL exceedance for lead include:

- Excavation of approximately 855 cy of soil;
- Backfilling of the excavated area with clean material;
- Pretreatment by filtration of any groundwater incidental to the excavation and truck transport and disposal of water at an off-site, permitted POTW;
- Transporting excavated materials by truck to a local, permitted disposal facility for disposal; and
- Establishing a monitoring program to collect and analyze groundwater samples at PZ-24 to track groundwater COC (lead) concentrations over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period (or until such time as the lead concentrations in the area fall below the corresponding UCL).

This alternative has the same excavation and backfill footprint as soil alternative SDA-3A.

#### **6.3.1.4 Groundwater Alternative SDGW-4 – Extensive Source Removal**

This removal alternative assumes that lead concentrations within the Southern Disposal Area soils are contributing to the lead UCL exceedance in groundwater. Under this alternative, soil in the Southern Disposal Area with lead concentrations exceeding the lead soil UCL and soil with lead human health and ecological PRG exceedances would be excavated and disposed of off site (Figure 6-2). Any incidental groundwater in the excavation would be pre-treated, transported, and disposed of off site at a permitted POTW. Post-remediation of groundwater within the area of the groundwater UCL exceedance for lead (at PZ-24) would be implemented. As previously discussed in Section 5.3.3.3, an excavation depth of 3 feet was assumed to ensure the complete removal of soil with concentrations above the UCL for lead. Excavation depths are assumed to be 0.5 foot within the soil polygons for SA-SS2 and SS-SS3 and 3 feet within the soil polygon for SFPDA02.

Specifically, the components of this extensive source removal option to address the groundwater UCL exceedance for lead include:

- Excavation of approximately 855 cy of soil in the areas where there are soil UCL exceedances for lead;

Excavation of an additional 2,809 cy of soil in areas not co-located with the soil UCL exceedances for lead where lead concentrations in soil exceed the human health and ecological PRGs for soil (soil polygons SA-SS2, SA-SS3, and SFPDA02).

Backfilling of the excavated areas with clean material;

Pretreatment by filtration of any groundwater incidental to the excavation and truck transport and disposal of water at an off-site, permitted POTW;

Transporting excavated materials by truck to a local, permitted disposal facility for disposal; and

Establishing a monitoring program to collect and analyze groundwater samples at PZ-24 to track groundwater COC (lead) concentrations over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period (or until such time as the lead concentrations in the area fall below the corresponding UCL).

### **6.3.2 Marsh Upland Area Groundwater Alternative Descriptions**

In the Marsh Upland Area, there are no identified risks to human health or ecological receptors based on groundwater conditions. There is one groundwater UCL exceedance for mercury in the area of groundwater monitoring well DP-MW1. To address this exceedance, four groundwater alternatives were developed for the Marsh Upland Area groundwater as follows:

No Action – Groundwater Alternative MUGW-1;

Limited Action – Groundwater Alternative MUGW-2;

Source Removal – Groundwater Alternative MUGW-3; and

- Extensive Source Removal – Groundwater Alternative MUGW-4.

#### **6.3.2.1 Groundwater Alternative MUGW-1 – No Action**

The No Action alternative serves as a baseline for comparison of overall effectiveness of the other remedial alternatives. See Section 6.3.1.1 for additional information regarding this alternative.

#### **6.3.2.2 Groundwater Alternative MUGW-2 – Limited Action**

The limited action alternative involves a combination of MNA and non-engineering measures for groundwater with the UCL exceedance within the Marsh Upland Area. Non-engineering measures would be implemented by the owner(s), Cooperating Parties, and/or regulatory agencies to reduce the potential of human receptors coming into contact with the groundwater in the area of the UCL exceedance.

Specifically, the components of this limited action alternative include:

Establishing a monitoring program to collect and analyze groundwater samples at DP-MW1 to track groundwater COC (mercury) concentrations over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period (or until such time as the mercury concentrations in the area fall below the corresponding UCL); and

### **6.3.2.3 Groundwater Alternative MUGW-3 – Source Removal**

This removal alternative assumes that mercury concentrations within the Marsh Upland Area soils are contributing to the mercury UCL exceedance in groundwater and that removal of these source area soils would result in a corresponding reduction of mercury in the groundwater. Under this alternative, soil in the Marsh Upland Area with mercury concentrations exceeding the mercury soil UCL would be excavated and disposed of off site (Figure 6-3). Any incidental groundwater in the excavations would be pre-treated, transported, and disposed of off site at a permitted POTW. Post-remediation monitoring of groundwater within the area of the groundwater UCL exceedance for mercury (at DP-MW1) would be implemented. As previously discussed in Section 5.3.5.3, excavation depths of 3 feet and 6 feet were assumed to ensure the complete removal of soil with concentrations above the UCL for mercury.

Specifically, the components of this source removal option to address the groundwater UCL exceedance for mercury include:

- Excavation of approximately 353 cy of soil;

- Backfilling of the excavated area with clean material;

- Pretreatment by filtration of any groundwater incidental to the excavation and truck transport and disposal of water at an off-site, permitted POTW;

- Transporting excavated materials by truck to a local, permitted disposal facility for disposal; and

- Establishing a monitoring program to collect and analyze groundwater samples at DP-MW1 to track groundwater COC (mercury) concentrations over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period (or until such time as the mercury concentrations in the area fall below the corresponding UCL).

This alternative has the same excavation and backfill footprint as soil alternative MUA-3A.

### **6.3.2.4 Groundwater Alternative MUGW-4 – Extensive Source Removal**

This removal alternative assumes that mercury concentrations within the Marsh Upland Area soils are contributing to the mercury UCL exceedance in groundwater. Under this alternative, soil with the Marsh Upland Area with mercury concentrations exceeding the mercury soil UCL and soil with mercury human health and ecological PRG exceedances would be excavated and disposed of

off site (Figure 6-4). Any incidental groundwater in the excavations would be pre-treated, transported and disposed of off-site at a permitted POTW. Post-remediation monitoring of groundwater within the area of the groundwater UCL exceedance for lead (at DP-MW1) would be implemented. As previously discussed in Section 5.3.5.3, excavation depths of 3 feet and 6 feet were assumed to ensure the complete removal of soil with concentrations above the UCL for mercury. Excavation depths are assumed to be 1 foot within the soil polygons for human health and ecological PRG exceedances for mercury.

Specifically, the components of this extensive source removal option to address the groundwater UCL exceedance for mercury include:

- Excavation of approximately 353 cy of soil in the areas where there are soil UCL exceedances for mercury;

- Excavation of an additional 516 cy of soil in areas not co-located with the soil UCL exceedances for mercury where mercury concentrations in soil exceed the human health and ecological PRGs for soil (soil polygons DPAL6, DPAL9, DPAL15, DPAL16, DPBL12, SDP03, SDP08, SDP09, and SDP10);

- Backfilling of the excavated areas with clean material;

- Pretreatment by filtration of any groundwater incidental to the excavation and truck transport and disposal of water at an off-site, permitted POTW;

- Transporting excavated materials by truck to a local, permitted disposal facility for disposal; and

- Establishing a monitoring program to collect and analyze groundwater samples at DP-MW1 to track groundwater COC (mercury) concentrations over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period (or until such time as the mercury concentrations in the area fall below the corresponding UCL).

## **7.0 DEVELOPMENT AND SCREENING OF REMEDIAL TECHNOLOGIES AND ASSEMBLY OF REMEDIAL ALTERNATIVES FOR SEDIMENT**

There are no UCLs for sediment and, as previously discussed in Section 4.3, the ecological risk-based mercury concentrations in sediment that would be protective of all identified ecological receptors are well below the Site background concentrations for mercury. Therefore, during the development and screening of remedial alternatives and assembly of remedial alternatives for sediment, a strategy will be followed that results in an overall, Site-wide reduction in the surface weighted average (SWA) total mercury concentration and that is protective of human health and most ecological endpoints with PRGs greater than background concentration (per revised ROs in Section 4.3.1.3).

Remedial technologies to reduce the SWA mercury concentration in Site sediment were identified and screened as discussed below and technologies retained as feasible were assembled into remedial alternatives for sediment.

### **7.1 IDENTIFICATION AND INITIAL SCREENING OF REMEDIAL TECHNOLOGIES**

An initial screening of remedial technologies for sediment was conducted in accordance with 310 CMR 40.0856 to identify technologies that are reasonably likely to be feasible, based on hazardous material present at the Site, the media contaminated, and the Site characteristics. After initial screening, the remaining technologies were assembled into remedial action alternatives for sediment.

Table 7-1 details the initial screening of remedial technologies for Site sediment.

The human health and ecological risks posed by Site sediments, as identified in Table 4-2, are related to metals (antimony, arsenic, beryllium, lead, mercury, methyl mercury, selenium, thallium and zinc), PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene), and VOCs (1,1-DCE, TCE and vinyl chloride). Therefore, based on hazardous materials present in the sediment at the Site (i.e., metals, PAHs, and VOCs), remedial technologies not applicable for these OHM were not put through the initial screening step. Also, technologies not applicable to sediments were not put through the initial screening. Such technologies include:

Bioventing and enhanced bioremediation. Both are in situ biological treatment technologies.

Chemical oxidation. This is an in situ chemical treatment technology.

Soil Vapor Extraction. This is an in situ physical treatment technology.

Ex situ biological treatment technologies including biopiles, composting, landfarming, and slurry phase biological treatment.

Dehalogenation. This is an ex situ chemical treatment technology.

- Ex situ thermal treatment technologies including pyrolysis, thermal desorption, and incineration.

Based on Site characteristics (the Cooperating Parties do not own any of the properties that constitute the Site, the presence of dams and weirs at or near the Site, and the presence of wetlands and conservation properties at the Site), the following additional technologies were not put through the initial screening step:

Phytoremediation after removal;

On-site upland disposal;

Nearshore disposal;

Confined aquatic disposal; and

- On-site beneficial reuse.

## **7.2 ASSEMBLY OF REMEDIAL ALTERNATIVES**

Using the retained remedial technologies for sediment from the initial screening in Section 7.1 above, remedial alternatives for Site sediments were assembled. Table 7-2 shows the assembled remedial alternatives for sediment (exclusive of the Marsh Upland Area sediment). Table 7-3 presents the assembled remedial alternatives for Marsh Upland Area sediment.

For each sediment alternative, the Site-wide total mercury post-remediation SWA, the mass of primary COC(s) removed, the affected sediment volume, and the human health and ecological risk reductions were calculated. Thiessen polygons were used to define individual areas of influence around each of the sediment sample locations for these calculations. Polygons were adjusted to account for Site bathymetry and topography and some polygons were merged using best professional judgment due to the close proximity of sampling locations. The resultant polygons were numbered as sediment management units (SMUs) for ease of reference. Figures 7-1 and 7-2 show the SMU numbering. The Site-wide total mercury SWA for each alternative was calculated using the post-remediation SWA for each SMU (see Tables 7-2 and 7-3). A detailed description of each sediment alternative is presented in Sections 7.3 and 7.4 below.

After the remedial alternatives for Site sediment were developed, these alternatives were then assembled into Site-wide remedial alternatives (see Section 8) that include remedial alternatives for Site soil and groundwater and the remainder of Site sediment.

### **7.3 DETAILED DESCRIPTION OF SEDIMENT ALTERNATIVES (EXCLUSIVE OF ALTERNATIVES FOR MARSH UPLAND AREA SEDIMENT)**

Some sediment within the Eastern Channel Corridor, the Lower Drinkwater River Corridor, Lily Pond/Upper Factory Pond, and Middle/Lower Factory Pond Risk Characterization Areas has mercury concentrations that exceed the human health and ecological PRGs (from Table 4-2) for total mercury. To address these exceedances, six remedial alternatives were developed for sediment in the Eastern Channel Corridor, the Lower Drinkwater River Corridor, Lily Pond/Upper Factory Pond and Middle/Lower Factory Pond as follows:

No Action – Sediment Alternative 1;

Limited Action – Sediment Alternative 2;

Removal in the Eastern Channel Corridor Only – Sediment Alternative 3;

Removal Such that Site-wide SWA Total Mercury Concentration Meets Human Health and Ecological PRGs for Total Mercury – Sediment Alternative 4;

Removal Such that Each Sediment Risk Characterization Area SWA Total Mercury Concentration Meets Human Health and Ecological PRGs for Total Mercury – Sediment Alternative 5; and

- Widespread Removal to Approach Site-Specific Background Total Mercury Concentration in Sediment – Sediment Alternative 6.

There were no human health or ecological PRG exceedances for sediment in the Upper Drinkwater River Corridor (SMUs 9, 10, and 11) and therefore the six remedial alternatives do not include actions in this sediment Risk Characterization Area.

The general assumptions made for sediment alternatives are as follows:

For all sediment alternatives that include excavation of sediment, it has been assumed that backfill of the excavation to match existing grade would be required.

Capping material will be clean material and will be tested to ensure COCs levels are less than the sediment PRGs established for the Site prior to its use.

Excavated/dredged material will be required to pass the PFLT prior to transport for off-site disposal, and excavated/dredged material will be stabilized/solidified if necessary to pass the PFLT.

For alternatives that include excavation of sediments from the Eastern Channel Corridor: The intent of removal actions is to remove **all** sediment within the Eastern Channel Corridor such that there is no remaining sediment in the channel and therefore no long term management of potential risks is required except potential risk associated with fish consumption.

For areas requiring long-term monitoring of sediment COC concentrations, a 40-year monitoring period was assumed.

In areas where excavation/dredging is required to meet the goal of a specific sediment alternative, capping of residual sediments will be required to minimize the potential for methylation of mercury (except in the ECC as noted above). Both bioturbation depth and cap thickness required to maintain an anoxic environment for remaining mercury-containing sediments will be considered during cap design.

For capped areas, a 40-year monitoring and maintenance period was assumed.

- In order to maintain the current hydraulic capacity of the Site, dredging is required in areas to be capped and the dredge depth should equal or exceed the cap thickness.

### **7.3.1 Sediment Alternative 1 – No Action**

The No Action alternative serves as a baseline for comparison of overall effectiveness of the other remedial alternatives. The No Action alternative would not involve implementation of any remedial activities to remove, treat, or contain COCs in Site sediment. This alternative relies on natural recovery processes alone to potentially reduce the concentrations of COCs in Site sediment to potentially attain the ROs, but does not include post-remediation monitoring to assess future COC concentrations. The Site sediment in the Eastern Channel Corridor, the Lower Drinkwater River Corridor, Lily Pond/Upper Factory Pond, and Middle/Lower Factory Pond would be allowed to remain in its current condition, and no activities would be undertaken to change the current conditions.

### **7.3.2 Sediment Alternative 2 – Limited Action**

This alternative involves a combination of monitored natural recovery (MNR)<sup>4</sup> for Site sediments in the Eastern Channel Corridor, the Lower Drinkwater River Corridor, Lily Pond/Upper Factory Pond and Middle/Lower Factory Pond and non-engineering measures for the Site. As previously stated, non-engineering measures generally include measures taken by the owner, Cooperating Parties, and/or regulatory agencies to reduce the potential of human

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<sup>4</sup> Generally, the term MNR is used for sediment recovery and MNA is used for groundwater and soil recovery.

receptors coming into contact with affected environmental media (in this case, contaminated sediment or biota affected by contaminated sediment).

The U.S. Environmental Protection Agency (EPA) defines monitored natural attenuation as the “reliance on natural attenuation processes (within the context of a carefully controlled and monitored Site cleanup approach) to achieve Site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods. The 'natural attenuation processes' that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants” (EPA, 1999).

MNR relies on natural processes to reduce the mobility and toxicity of contaminants in the sediment. The two primary natural processes are 1) the time dependent physical-chemical weathering and biological degradation of contaminants, reducing their toxicity; and 2) the natural deposition of unimpacted sediments over the contaminated sediments, thereby reducing the mobility and bioavailability of the COCs. Provided that ongoing sources of contamination are limited, the newly deposited sediments would eventually provide an isolation layer over the contaminated sediments. Regular monitoring would measure the rate and extent to which ongoing natural recovery processes are achieving the sediment ROs.

Specifically, the components of this limited action sediment alternative include:

Establishing a monitoring program to collect and analyze sediment and fish tissue samples to track sediment total mercury concentrations and mercury concentrations in fish tissue over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period;

Posting and maintaining signage regarding the area-wide fish consumption advisory along the banks of the Eastern Channel Corridor, the Upper Drinkwater River Corridor, Lower Drinkwater River Corridor, Lily Pond/Upper Factory Pond, and Middle/Lower Factory Pond. Signage would likely be posted at public access points to the river, channel, and ponds; and

- Implementing a hazard education program to inform future Site workers (e.g., construction and utility crews) and recreational users engaged in potential sediment disturbing activities of the health and safety considerations associated with COC-impacted sediments. Site workers would receive pre-work briefings.

### **7.3.3 Sediment Alternative 3 – Removal in the Eastern Channel Corridor Only**

This limited removal action alternative involves a combination of excavation, solidification/stabilization of the excavated material as necessary for transportation, off-site treatment as necessary to meet land disposal restrictions (LDRs), and disposal of the sediment excavated, and limited implementation of non-engineering measures (Figure 7-3). Limited removal will occur in SMUs 1 through 8 and removal depth is assumed to be 3 feet. The intent of this removal action is to remove all sediment within the Eastern Channel Corridor such that there is no remaining sediment in the channel and therefore no long term management of potential risks is required except potential risk associated with fish consumption. Monitored natural recovery would be required in SMUs 12 through 47 as the overall, post-removal SWA total mercury concentrations within the Lower Drinkwater River Corridor, Lily Pond/Upper Factory Pond, and Middle/Lower Factory Pond Risk Characterization Areas exceed the human health and ecological PRGs for total mercury in sediment.

Specifically, the components of this limited removal action alternative for sediment include:

- Excavation of approximately 11,731 cy of sediment from within SMUs 1 through 8;
- Solidification/stabilization of excavated material as necessary for transportation;
- Transportation of excavated material by truck and rail to a RCRA-permitted treatment and disposal facility for treatment as necessary to meet LDRs (due to the mercury concentration in the excavated sediment) and disposal;
- Establishing a monitoring program to collect and analyze sediment and fish tissue samples to track sediment total mercury concentrations and mercury concentrations in fish tissue over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period;
- Posting and maintaining signage regarding the area-wide fish consumption advisory along the banks of the Eastern Channel Corridor, the Upper Drinkwater River Corridor, Lily Pond/Upper Factory Pond, and Middle/Lower Factory Pond. Signage would likely be posted at public access points to the river, channel, and ponds; and
- Implementing a hazard education program to inform future Site workers (e.g., construction and utility crews) and recreational users engaged in potential sediment disturbing activities of the health and safety considerations associated with COC-impacted sediments. Site workers would receive pre-work briefings.

### **7.3.4 Sediment Alternative 4 – Removal Such that Site-wide SWA Total Mercury Concentration Meets Human Health and Ecological PRGs for Total Mercury**

This limited removal action alternative involves a combination of excavation, solidification/stabilization of the excavated material as necessary for transportation, capping of a portion

of the area excavated, off-site treatment (as necessary to meet LDRs) and disposal of the sediment excavated, long-term monitoring and maintenance of the sediment cap, and limited implementation of non-engineering measures (Figure 7-4) to reduce the Site-wide total mercury concentration in sediments to meet human health and ecological PRGs for total mercury. Removal/dredging will occur in SMUs 1 through 8, 12 through 15, 17 through 19, 22, and 23 and removal depth is assumed to be 3 feet. The intent of the removal action in SMUs 1 through 8 is to remove all sediment within the Eastern Channel Corridor such that there is no remaining sediment in the channel, and therefore no long-term management of potential risks is required except potential risk associated with fish consumption. Monitored natural recovery of sediment would be required in SMUs 33 through 47 as the overall, post-removal and capping SWA total mercury concentrations within the Middle/Lower Factory Pond Risk Characterization Area would still exceed the human health and ecological PRGs for total mercury in sediment.

Specifically, the components of this limited removal action alternative for sediment include:

- Excavation of approximately 41,945 cy of sediment from within SMUs 1 through 8, 12 through 15, 17 through 19, 22, and 23;
- Isolation capping of approximately 271,919 sf of sediment in SMUs 12 through 15, 17 through 19, 22, and 23;
- Solidification/stabilization of excavated material as necessary for transportation;
- Transportation of excavated material by truck and rail to a RCRA-permitted treatment and disposal facility for treatment as necessary to meet LDRs due to the mercury concentration of the excavated sediment and disposal;
- Establishment of monitoring and maintenance program for the isolation cap installed in SMUs 12 through 15, 17 through 19, 22, and 23. The frequency of required maintenance and monitoring will be dependent upon the type of cap installed. For the purposes of this report, it has been assumed that the cap would require annual monitoring through a 40-year monitoring period and that maintenance would be required every 5 years;
- Installation and maintenance of signs around the perimeter of the Lower Drinkwater River Corridor, and Lily Pond regarding the presence of the sediment cap;
- Establishing a monitoring program to collect and analyze sediment and fish tissue samples to track sediment total mercury concentrations and mercury concentrations in fish tissue over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period;
- Posting and maintaining signage regarding the area-wide fish consumption advisory along the banks of the Eastern Channel Corridor, the Upper Drinkwater River Corridor, the Lower Drinkwater River Corridor, Lily Pond/Upper Factory Pond, and Middle/Lower

Factory Pond. Signage would likely be posted at public access points to the river, channel and ponds; and

- Implementing a hazard education program to inform future Site workers (e.g., construction and utility crews) and recreational users engaged in potential sediment disturbing activities of the health and safety considerations associated with COC-impacted sediments. Site workers would receive pre-work briefings.

### **7.3.5 Sediment Alternative 5 – Removal Such that Each Sediment Risk Characterization Area SWA Total Mercury Concentration Meets Human Health and Ecological PRGs for Total Mercury**

This more extensive removal action alternative involves a combination of excavation/dredging, solidification/stabilization of the excavated material as necessary for transportation, capping of the majority of the area excavated/dredged, off-site disposal of the sediment excavated/dredged, long-term monitoring and maintenance of the sediment cap, and limited implementation of non-engineering measures (Figure 7-5) to reduce the SWA total mercury concentration in sediments in each sediment Risk Characterization Area to meet human health and ecological PRGs for total mercury. Removal/dredging will occur in SMUs 1 through 8, 12 through 15, 17 through 19, 22, 23, 46, and 47 and removal depth is assumed to be 3 feet. The intent of the removal action in SMUs 1 through 8 is to remove all sediment within the Eastern Channel Corridor such that there is no remaining sediment in the channel and therefore no long-term management of potential risks is required except potential risk associated with fish consumption. Monitored natural recovery would not be required as the post-removal and capping SWA total mercury concentrations within each sediment Risk Characterization Area would not exceed the human health and ecological PRGs for total mercury in sediment.

Specifically, the components of this removal action alternative for sediment include:

Excavation of approximately 57,810 cy of sediment from within SMUs 1 through 8, 12 through 15, 17 through 19, 22, 23, 46, and 47;

Isolation capping of approximately 414,705 sf (9.52 acres) of sediment in SMUs 12 through 15, 17 through 19, 22, 23, 46, and 47;

Solidification/stabilization of excavated material as necessary for transportation;

Transportation of excavated material by truck and rail to a RCRA permitted treatment and disposal facility for treatment as necessary to meet LDRs due to the mercury concentration of the excavated sediment and disposal;

Establishment of monitoring and maintenance program for the isolation cap installed in SMUs 12 through 15, 17 through 19, 22, 23, 46, and 47. The frequency of required maintenance and monitoring will be dependent upon the type of cap installed. For the purposes of this

report, it has been assumed that the cap would require annual monitoring through a 40-year monitoring period and that maintenance would be required every 5 years;

Installation and maintenance of signs around the perimeter of the Lower Drinkwater River Corridor, Lily Pond, and Lower Factory Pond Area regarding the presence of the sediment cap;

Establishing a monitoring program to collect and analyze fish tissue samples to track mercury concentrations in fish tissue over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period;

- Posting and maintaining signage regarding the area-wide fish consumption advisory along the banks of the Eastern Channel Corridor, the Upper Drinkwater River Corridor, the Lower Drinkwater River Corridor, Lily Pond/Upper Factory Pond, and Middle/Lower Factory Pond. Signage would likely be posted at public access points to the river, channel and ponds.

### **7.3.6 Sediment Alternative 6 – Widespread Removal to Approach Site-Specific Background Total Mercury Concentration in Sediment**

This extensive widespread removal action alternative involves a combination of excavation/dredging, solidification/stabilization of the excavated material as necessary for transportation, capping of the majority of the area excavated/dredged, off-site treatment (as necessary to meet LDRs) and disposal of the sediment excavated, long-term monitoring and maintenance of the sediment cap, and limited implementation of non-engineering measures to manage residual potential human health risks associated with fish consumption (Figure 7-6).

The goal of this alternative is to reduce the overall Site-wide SWA total mercury concentration in sediments to approach Site sediment background concentration of 0.62 mg/Kg.

Removal/dredging will occur in SMUs 1 through 8, 12 through 15, 17 through 19, 22 through 31, 33 through 38, and 42 through 47 and removal depth is assumed to be 3 feet. Monitored natural recovery of sediments would not be required as the post-removal and capping SWA total mercury concentrations within each sediment Risk Characterization Area would not exceed the human health and ecological PRGs for total mercury in sediment.

Specifically, the components of this extensive removal action alternative for sediment include:

Excavation of approximately 253,482 cy of sediment from within SMUs 1 through 8, 12 through 15, 17 through 19, 22 through 31, 33 through 38, and 42 through 47;

Isolation capping of approximately 2,175,756 sf (49.95 acres) of sediment in SMUs 12 through 15, 17 through 19, 22 through 31, 33 through 38, and 42 through 47;

Solidification/stabilization of excavated/dredged material as necessary for transportation;

Transportation of excavated material by truck and rail to a RCRA permitted treatment and disposal facility for treatment as necessary to meet LDRs due to the mercury concentration of the excavated/dredged sediment and disposal;

Establishment of monitoring and maintenance program for the isolation cap installed in SMUs 12 through 15, 17 through 19, 22 through 31, 33 through 38, and 42 through 47. The frequency of required maintenance and monitoring will be dependent upon the type of cap installed. For the purposes of this report, it has been assumed that the cap would require annual monitoring through a 40-year monitoring period and that maintenance would be required every 5 years;

Installation and maintenance of signs around the perimeter of the Lower Drinkwater River Corridor, Lily Pond/Upper Factory Pond, and Middle/Lower Factory Pond Area regarding the presence of the sediment cap;

Establishing a monitoring program to collect and analyze fish tissue samples to track mercury concentrations in fish tissue over time. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period;

- Posting and maintaining signage regarding the area-wide fish consumption advisory along the banks of the Eastern Channel Corridor, the Upper Drinkwater River Corridor, the Lower Drinkwater River Corridor, Lily Pond/Upper Factory Pond, and Middle/Lower Factory Pond. Signage would likely be posted at public access points to the river, channel, and ponds.

#### **7.4 DETAILED DESCRIPTION OF SEDIMENT ALTERNATIVES FOR MARSH UPLAND AREA SEDIMENT**

Some sediment within the Marsh Upland Sediment Area has mercury concentrations that exceed the human health and ecological PRGs (from Table 4-2) for total mercury. To address these exceedances, five sediment alternatives were developed for the Marsh Upland Area sediment as follows:

No Action – Marsh Upland Sediment Alternative 1;

Limited Action – Marsh Upland Sediment Alternative 2;

Spot Removal – Marsh Upland Sediment Alternative 3;

Limited Thin Capping – Marsh Upland Sediment Alternative 4; and

- Widespread Removal – Marsh Upland Sediment Alternative 5.

Detailed descriptions of these five alternatives are presented in Sections 7.4.1 through 7.4.5 below.

#### **7.4.1 Marsh Upland Area Sediment Alternative 1 – No Action**

The No Action alternative serves as a baseline for comparison of overall effectiveness of the other remedial alternatives. See Section 7.3.1 for additional details of this alternative.

#### **7.4.2 Marsh Upland Area Sediment Alternative 2 – Limited Action**

The limited action alternative involves monitored natural recovery of the Marsh Upland Sediment Area sediments with human health and ecological PRG exceedances for mercury. Non-engineering measures would be implemented by the owner(s), Cooperating Parties, and/or regulatory agencies to reduce the potential of human receptors coming into contact with sediment containing total mercury concentrations exceeding the human health PRG for mercury in sediment.

Specifically, the components of this limited action alternative for Marsh Upland Area sediment include:

Establishing a monitoring program to collect and analyze sediment samples to track sediment total mercury concentrations over time within SMUs MUA 2, MUA 3, MUA 11, and MUA 13. It is assumed that monitoring would occur once at 2 years, 5 years, and every 5 years after the year 5 monitoring through a 40-year monitoring period;

Installing and maintaining warning signs around the perimeter of the Marsh Upland Sediment Area identifying potential human health risks associated with Marsh Upland Sediment Area sediments; and

- Informing future Site workers (e.g., construction and utility crews) engaged in potential sediment disturbing activities of the health and safety considerations associated with COC-impacted sediments. Site workers would receive pre-work briefings.

#### **7.4.3 Marsh Upland Area Sediment Alternative 3 – Spot Removal**

This limited removal action alternative involves a combination of excavation, solidification/stabilization of the excavated material as necessary for transportation, off-site treatment to meet LDRs (due to the mercury concentration of the excavated area) and disposal of the sediment excavated, and limited implementation of non-engineering measures (Figure 7-7). Limited removal will occur in the MUA SMU that has the highest concentration of total mercury (this material has a total mercury concentration of 283 mg/Kg) and removal depth is assumed to be 3 feet. It is assumed that post-dredge capping will not be required for this limited removal alternative.

Specifically, the components of this limited removal action alternative for Marsh Upland Area sediment include:

Excavation of approximately 410 cy of sediment from within SMU MUA 2;

Stabilization/solidification of excavated material as necessary for transportation;

Transportation of excavated material by truck and rail to a RCRA permitted treatment and disposal facility for treatment to meet LDRs (due to total mercury concentration in excavated material) and disposal; and

- Installation and maintenance of signs around the perimeter of the Marsh Upland Sediment Area regarding the potential human health risks associated with the presence of COC-impacted sediments.

#### **7.4.4 Marsh Upland Area Sediment Alternative 4 – Limited Thin Capping**

This limited thin capping action alternative involves a combination of thin capping, post-capping long-term monitoring of sediment COC concentrations, and limited implementation of non-engineering measures (Figure 7-8). Limited thin capping will occur in the MUA SMUs with the two highest concentrations of total mercury, SMUs MUA 2 and MUA 13, and the thin cap thickness is assumed to be 1 foot.

Specifically, the components of this limited thin capping alternative for Marsh Upland Area sediment include:

Thin capping of approximately 8,877 sf of sediment (capping over SMUs MUA 2 and MUA 13);

Establishment of a monitoring program for the capped area. For the purposes of this report, it has been assumed that the capped area would require annual monitoring through a 40-year monitoring period; and

- Installation and maintenance of signs around the perimeter of the Marsh Upland Sediment Area regarding the potential human health risks associated with the presence of COC-impacted sediments as sediment mercury concentrations in MUA SMUs MUA 2, MUA 3, MUA 11, and MUA 13 are above the human health PRG.

#### **7.4.5 Marsh Upland Area Sediment Alternative 5 – Widespread Removal**

This extensive removal action alternative involves a combination of excavation, solidification/stabilization of the excavated material as necessary for transportation, and off-site treatment to meet LDRs and disposal of the sediment excavated (Figure 7-9).

Excavation/removal will occur in the MUA SMUs such that the overall total mercury SWA for the MUA Sediment Area approaches the Site-specific background concentration (0.62 mg/Kg total mercury). Excavation of MUA SMUs MUA 2, MUA 3, MUA 7, MUA 8, MUA 11, MUA 12, MUA 13, and MUA 14 would be performed and removal depth is assumed to be 3 feet. It is assumed that the total mercury in remaining sediments would not exceed the human health and

ecological PRGs and that capping is not required. No long-term sediment monitoring would be required because the overall, post-removal and capping SWA total mercury concentration within the Marsh Upland Sediment Area will be below the human health and ecological PRGs for total mercury.

Specifically, the components of this limited removal action alternative for Marsh Upland Area sediment include:

- Excavation of approximately 3,736 cy of sediment from within SMUs MUA 2, MUA 3, MUA 7, MUA 8, MUA 11, MUA 12, MUA 13, and MUA 14;

- Solidification/stabilization of excavated material as necessary for disposal (due to total mercury concentration in excavated material); and

- Transportation of excavated material by truck and rail to a RCRA-permitted treatment and disposal facility for treatment as necessary to meet LDRs due to the mercury concentrations in the excavated sediment and disposal.

## **8.0 ASSEMBLY AND COMPARATIVE ANALYSIS OF SITE-WIDE REMEDIAL ALTERNATIVES**

The media and risk characterization-specific alternatives developed for soil, groundwater, and sediment were assembled into Site-wide remedial alternatives. A total of five Site-wide alternatives were assembled for further evaluation in the detailed comparative analysis presented in Section 8.5 below. Each of the alternatives consists of retained general response actions, process options, and remedial technologies discussed in Sections 5, 6, and 7. Table 8-1 provides a listing of the retained general response actions, process options, and remedial technologies for soil, groundwater, and sediment used to assemble site-wide alternatives.

### **8.1 SITE-WIDE ALTERNATIVES**

The five Site-wide remedial alternatives developed to address the soil, groundwater, and sediment ROs for the Site were assembled. Table 8-2 presents the individual soil, groundwater, and sediment alternatives that make up each Site-wide alternative. A brief description of each of the remedial alternatives developed to address Site ROs is presented below.

#### **8.1.1 Alternative 1 – Monitoring and Non-Engineering Measures**

This alternative includes MNA for Site soil and groundwater, MNR for Site sediments, a monitoring program to collect and analyze mercury in fish tissue, and non-engineering measures that include AULs, fencing, warning signs, and educational programs (Figure 8-1). A list of the specific soil, sediment, and groundwater alternatives that make up Site-wide Alternative 1 are provided in Table 8-2. Site-wide Alternative 1 is a Temporary Solution. The overall estimated cost of this alternative is approximately \$1.8 million. Tables B-1A and B-1B provide the details of the cost estimate for this Site-wide alternative.

#### **8.1.2 Alternative 2 – Targeted Removal to Address Soil and Groundwater UCLs and ECC Sediments**

This alternative includes sediment removal in the Eastern Channel Corridor, soil removal and backfilling to address soil and groundwater UCLs, MNA for Site soil and groundwater, MNR for Site sediments, a monitoring program to collect and analyze mercury in fish tissue, and non-engineering measures including AULs, fencing, warning signs, and educational programs (Figure 8-2). A list of the specific soil, sediment, and groundwater alternatives that make up Site-wide Alternative 2 are provided in Table 8-2. Site-wide Alternative 2 is a Temporary Solution. The overall estimated cost of this alternative is approximately \$11.4 million. Tables B-2A and B-2B provide the details of the cost estimate for this Site-wide alternative.

### **8.1.3 Alternative 3 – Targeted Removal to Address Soil and Groundwater UCLs and Limited Removal of Sediments to Meet Human Health and Ecological THg PRGs (Overall Sediment SWA < 22.2 mg/Kg THg)**

Alternative 3 includes enough sediment removal and sediment capping such that the overall (Site-wide) SWA will meet human health and ecological PRGs for THg, soil removal and backfill to address soil and groundwater UCLs, a long-term monitoring and maintenance program for the sediment cap, MNR for Site sediment, MNA for Site soil and groundwater, a monitoring program to collect and analyze mercury in fish, and non-engineering measures including AULs, fencing, warning signs, and educational programs (Figure 8-3). A list of the specific soil, sediment, and groundwater alternatives that make up Site-wide Alternative 3 are provided in Table 8-2. Site-wide Alternative 3 is a Permanent Solution. The overall estimated cost of this alternative is approximately \$36.4 million. Tables B-3A and B-3B provide the details of the cost estimate for this Site-wide alternative.

### **8.1.4 Alternative 4 – Targeted Removal to Address Soil and Groundwater UCLs, Intermediate Range Soil Removal to Address Human Health and Ecological Risks not Co-located with UCL Exceedances and Limited Removal of Sediments to Meet Human Health and Ecological THg PRGs in Each Sediment RCA (Sediment SWA < 22.2 mg/Kg THg in Each Sediment RCA)**

Alternative 4 includes enough sediment removal and sediment capping such that the SWA in each sediment RCA will meet human health and ecological PRGs for THg, soil removal and backfill to address soil and groundwater UCL exceedances and soil and groundwater human health and ecological PRG exceedances, a long-term monitoring and maintenance program for sediment capping, MNR for the Site sediment, MNA for the Site soil and groundwater, a monitoring program to collect and analyze mercury in fish, and non-engineering measures including AULs, fencing, warning signs, and educational programs (Figure 8-4). A list of the specific soil, sediment, and groundwater alternatives that make up Site-wide Alternative 4 are provided in Table 8-2. Site-wide Alternative 4 is a Permanent Solution. The overall estimated cost of this alternative is approximately \$45.6 million. Tables B-4A and B-4B provide the details of the cost estimate for this Site-wide alternative.

### **8.1.5 Alternative 5 – “Approaching Background”**

Alternative 5 will include sediment removal and capping such that the SWA for THg is approaching the background concentration of 0.62 mg/Kg, soil removal and backfill to address soil and groundwater UCL exceedances and soil and groundwater human health and ecological PRG exceedances, a long-term monitoring and maintenance program for the sediment cap, a long-term monitoring program for the Site groundwater, a monitoring program to collect and

analyze mercury in fish, and non-engineering measures including AULs, educational programs, fencing, and warning signs (Figure 8-5). A list of the specific soil, sediment, and groundwater alternatives that make up Site-wide Alternative 5 are provided in Table 8-2. Site-wide Alternative 5 is a Permanent Solution. The overall estimated cost of this alternative is approximately \$158.4 million. Tables B-5A and B-5B provide the details of the cost estimate for this Site-wide alternative.

## **8.2 REGULATORY REQUIREMENTS**

Table 8-3 presents a summary of applicable regulatory requirements. Because the Site contains a significant amount of water bodies and wetlands, impacts to these areas, to varying degrees, are anticipated for four of the five Site-wide alternatives (Alternatives 2 through 5). As such, the following permits will likely be required for these alternatives.

### **8.2.1 Chapter 91 Waterways Permit**

A Mass. Gen. Laws Chapter 91 Waterways permit is necessary to protect the public interest in water bodies by ensuring that proposed projects do not unreasonably interfere with navigation and the rights of the public or adjacent waterfront property. This permit may be required for this Site because of the dredging activities and placement of subaqueous cap material within a “Great Pond” (which is defined as any pond that contains more than 10 acres in its natural state). Given the nature of the dredging activity, only a permit (filed on form BRP WW01), not a license, will be required. MassDEP will be consulted to determine whether Factory Pond should be designated as a Great Pond given the presence of the dam. If MassDEP determines that it is not a Great Pond, Chapter 91 will not apply.

### **8.2.2 401 Water Quality Certification for Dredging Activities**

Section 401 of the Clean Water Act provides the state with the authority to review projects that result in a discharge to state waters, including excavating and filling in wetlands to ensure that the project will comply with state water quality standards and other appropriate requirements. The alternatives for this Site would require a 401 Water Quality Certification for Dredging Activities (Form BRP WW07) as well as a 401 Water Quality Certification for Fill and Excavation Projects in Waters and Wetlands (Form BRP WW11). For both of these certifications, the activities would fall under the “major projects” category which, for dredging, is defined as projects involving dredging of 5,000 cy or greater; and for fill and excavation is defined as projects involving a cumulative loss of more than 5,000 square feet of bordering and isolated vegetated wetland and land under water.

### **8.2.3 Massachusetts Wetlands Protection Act and Local By-laws**

The Wetlands Protection Act regulates work conducted within coastal and inland wetland areas and associated buffer zones, referred to as Resource Areas. The Towns of Hanover and Hanson each has a by-law protecting additional wetland resources. Resource Areas on this Site include Bordering Vegetated Wetlands, Banks, Land Under Water Bodies, and Land Subject to Flooding. For the alternatives that involve work within and adjacent to these Resource Areas, a Notice of Intent will be filed with the Conservation Commissions in the towns of Hanover and Hanson. Following their review, an Order of Conditions will then be issued to authorize and regulate the work activities. The local by-laws for each town will also need to be reviewed to determine whether other by-laws apply in addition to wetlands.

### **8.3 DESCRIPTION OF EVALUATION CRITERIA**

The assembled Site-wide alternatives were evaluated using the following eight criteria per 310 CMR 40.0858:

1. Comparative effectiveness;
2. Comparative short-term and long-term reliability;
3. Comparative difficulty in implementing;
4. Comparative costs;
5. Comparative risks;
6. Comparative benefits;
7. Comparative timeliness in terms of eliminating any uncontrolled sources of oil and/or hazardous materials and achieving a level of No Significant Risk; and
8. Relative impact on non-pecuniary interests (such as aesthetic values).

### **8.4 DETAILED COMPARATIVE EVALUATION OF REMEDIAL ACTION ALTERNATIVES**

A detailed comparative analysis was performed of the five Site-wide alternatives. Using the detailed evaluation criteria from 310 CMR 40.0858 as summarized in Section 8.3 above, each of the Site-wide alternatives was scored for each sub-criterion in the eight evaluation categories using a numerical ranking from 0 to 100 with 100 representing a very favorable (good) ranking related to the specific criteria and 0 representing a very unfavorable (poor) ranking. These numerical values were assigned using a combination of calculated volumes, areas, remedial costs, and professional judgment based on previous sediment remediation experience. Table 8-4 provides the summary of the detailed evaluation of the Site-wide alternatives. Subsequently, the

sub-criteria ranking in each evaluation category (each of the eight evaluation categories were equally weighted) were averaged for each Site-wide alternative and these averages summed to calculate a numerical score for each Site-wide alternative. The overall rankings for each of the alternatives are presented in Table 8-5.

## **8.5 RECOMMENDED REMEDIAL ACTION ALTERNATIVE**

The comparative evaluation of the five Site-wide alternatives ranked Alternative 3 as the alternative with the best (highest) ranking. Therefore, Site-wide Alternative 3 was selected as the recommended remedial action alternative for the Site because it achieves a level of No Significant Risk at a far lesser cost and less impact to the natural resources on the Site than Site-wide Alternatives 4 and 5.

## **8.6 FEASIBILITY EVALUATIONS**

Under 310 CMR 40.0860, the following feasibility evaluations must be conducted after selection of a remedial action alternative:

1. Evaluating the feasibility of implementing a Permanent Solution;
2. Evaluating the feasibility of reducing the concentrations of OHM in the environment to levels that achieve or approach background;
3. Evaluating the feasibility of reducing the concentrations of OHM in soil at a disposal site to levels at or below applicable soil UCLs; and
4. Evaluating the feasibility of eliminating, preventing, or mitigating critical exposure pathway(s).

310 CMR 40.0860(5) further states that a remedial action alternative that would achieve the above conditions “shall be considered feasible” unless:

1. The alternative is not technologically feasible;
2. The costs of conducting, or the risks resulting from, the alternative would not be justified by the benefits as determined by a benefit-cost analysis;
3. Individuals with the expertise needed to effectively implement the alternative would not be available, regardless of arrangements for securing their services;
4. The alternative would necessitate land disposal other than at the site itself and no off-site facility is available in the Commonwealth or in other states that is in full compliance with all applicable federal and state regulatory requirements; or

5. An alternative is selected for a portion of a disposal site for which the source of the oil and/or hazardous material is not located on, and the elimination or control of that source cannot be achieved at that portion of the disposal site.

The recommended Site-wide Alternative (Alternative 3) reduces the concentrations of constituents in soil to levels below UCLs and eliminates critical exposure pathway(s). However, Alternative 3 does not reduce the concentrations of constituents to achieve or approach background levels. In addition, since the concentrations in groundwater are above applicable UCLs, a Class A Response Action Outcome cannot be achieved until the concentrations in groundwater are reduced below UCLs. Currently, only a Class C Response Action Outcome (Temporary Solution) can be achieved. For these reasons, a feasibility evaluation pursuant to 310 CMR 40.0860 was completed and is summarized below.

### **8.6.1 Technological Feasibility**

The three technological feasibility criteria used for evaluation for Site-wide Alternative 3 are the criteria contained in 310 CMR 40.0860 (6). A remedial action alternative is considered feasible unless:

Existing technology or reasonable modifications to existing technology cannot remediate the oil and hazardous material present to the extent necessary to attain a level of No Significant Risk or to levels that approach or achieve background;

The reliability of the identified alternative has not been sufficiently proven at other sites or through pilot tests and a substantial uncertainty exists as to whether it will effectively reduce risk; or

The identified alternative cannot comply with or be modified to comply with applicable regulatory requirements.

The selected alternative would meet the site-specific PRGs that are above Site background concentrations upon completion of the remedy and would achieve a level of No Significant Risk. There are two locations identified on the Site where groundwater concentrations exceed UCLs. In both areas, these elevated groundwater concentrations are a direct result of source area contamination in the soil immediately upgradient of these areas. Although active groundwater treatment could be implemented on this Site to reduce the concentrations to below UCLs, the alternative addresses the identified UCL groundwater exceedances through source removal of soil, including the soil above UCLs, and long-term monitoring of groundwater. Since the Phase II CSA identified no human health or ecological risks associated with groundwater, the substantial costs associated with implementation of active groundwater remediation are not warranted.

The removal, capping, and long-term monitoring and maintenance techniques are all proven techniques for soil, sediment, and groundwater remediation. This alternative, when fully designed and implemented, can comply with the applicable regulatory requirements discussed in Section 8.2 above.

### **8.6.2 Benefit-Cost Analysis**

The second feasibility evaluation required by 310 CMR 40.0860 is the benefit-cost analysis. Pursuant to 310 CMR 40.0860 (7), the benefits of implementing a remedial action alternative to achieve a Permanent Solution or Temporary Solution and the benefits, when performing a Permanent Solution, of reducing the concentrations of OHM in the environment at the disposal site to levels that achieve or approach background or reducing the concentrations of oil and hazardous material in soil at the disposal site to levels at or below applicable soil UCLs shall justify the related costs unless:

The incremental cost of conducting the remedial action alternative is substantial and disproportionate to the incremental benefit of risk reduction, environmental restoration, and monetary and non-pecuniary values;

The risk of harm to health, safety, public welfare, or the environment posed by the implementation of the alternative cannot be adequately controlled; or

The alternative would destroy more than 5,000 square feet of wetlands or wildlife habitat, or would otherwise result in a substantial deleterious impact to the environment and:

Other feasible Temporary or Permanent Solutions exist;

The oil and/or hazardous materials, if any, that have come to be located in such resources do not bio-accumulate and are not likely to migrate; and

The damage to such resources resulting from the implementation of the alternative would be permanent and irreparable.

For comparison purposes, both Site-wide Alternative 3 and Site-wide Alternative 5 have been evaluated using the following criteria, because in Alternative 5, concentrations of COCs are reduced to background.

The overall cost of Alternative 3 is approximately \$36.4 million (M) whereas Alternative 5 has a cost of approximately \$158.4M, representing an incremental cost difference of approximately \$122M. To evaluate the relative reduction in risk, TtEC considered how each alternative would impact the number of human health and ecological receptors currently at risk, on both an area-weighted and non-area-weighted basis. Specifically, TtEC evaluated the reduction in the number of receptors at risk for each alternative. Table 8-6 provides a summary of that evaluation.

From this evaluation, both Alternative 3 and Alternative 5 had no human health receptors at risk. For ecological risks under Alternative 3, the number of ecological receptors not at risk on an

area-weighted basis was 39 percent for soil (50 percent non area-weighted) and 60 percent for sediment (74 percent non area-weighted). Under Alternative 5, the number of ecological receptors not at risk on an area-weighted basis was 49 percent for soil (95 percent non area-weighted) and 75 percent for sediment (82 percent non-area-weighted). This represents an incremental risk benefit for Alternative 5 of 10 percent for soil and 15 percent for sediment over Alternative 3. The incremental cost difference of \$122M for Alternative 5 is substantial and disproportionate to the incremental reduction of risk for this alternative and thus does not justify its selection.

With regard to protection of nonpecuniary interest, such as aesthetic values and wetland and wildlife habitat, implementation of Alternative 5 (“approaching background”) would result in a significant and extensive impact/destruction of habitat across the majority of the Site (82.74 acres would be disturbed under Site-wide Alternative 5). Although both alternatives would result in the loss of greater than 5,000 square feet of wetlands or wildlife habitat, Alternative 5 would involve substantially greater impacts and loss of habitat over Alternative 3 (only 8.86 acres would be disturbed under Site-wide Alternative 3) and would require significant efforts relative to environmental restoration.

Based on the feasibility evaluation and benefit-cost analysis above, Site-wide Alternative 3 is the recommended remedial action alternative for the Site. This alternative is protective of human health and the environment (meets Site-specific PRGs), reduces COC concentrations in soil to levels at or below applicable UCLs, substantially reduces both human health and ecological risks from their present levels, and the costs, when compared with Alternative 5, are proportionate to the benefits of implementing this remedial action alternative.

## **8.7 STEPS TO ACHIEVE A PERMANENT SOLUTION**

The MCP in 310 CMR 40.0861(1)(h) requires that if the selected remedy is a Temporary Solution, the RAP must provide a description of “definitive and enterprising steps to identify and develop an alternative that is a likely Permanent Solution and a schedule for implementation of such steps.”

As indicated in section 8.2 above, the only limiting factor to not being able to achieve a Permanent Solution at this time is the presence of OHM in isolated areas above applicable groundwater UCLs, specifically, lead in the Southern Disposal Area and mercury in the Marsh Uplands Area. In each area, the groundwater UCL exceedance is localized and attributable specifically to the presence of lead (in the SDA) and mercury (in the MUA) in the overburden soils directly above and upgradient of the groundwater UCL exceedance. The selected remedial alternative includes excavation of the source area soils in the SDA and MUA and monitoring of the groundwater to demonstrate that once the soils are removed, the groundwater will likely attenuate to levels below applicable UCLs (which may already have occurred). The removal of

these source area soils will be one of the first steps in the Phase IV Remedial Implementation Plan to be developed for the Site.

## **9.0 COMPLETION STATEMENT**

The Phase III RAP was conducted in accordance with the pertinent provisions of the MCP and the Phase III performance standards described in 310 CMR 40.0853. This Phase III RAP describes and documents the information, reasoning and results used to identify and evaluate remedial action alternatives is sufficient detail to support the selection of a proposed remedial action alternative. It is the opinion of the LSP-of-Record that the proposed remedial action alternative documented in this Phase III is a Temporary Solution and that “definitive and enterprising steps” have been provided to identify and develop an alternative that is a likely Permanent Solution.

## 10.0 REFERENCES

- EPA (U.S. Environmental Protection Agency). 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. OSWER Directive 9200.4-17P. EPA Office of Solid Waste and Emergency Response. Washington, D.C. April 1999.
- FWENC (Foster Wheeler Environmental Corporation). 1999. Phase IIA Groundwater Investigation Data Report, Fireworks I (Former National Fireworks Facility) Hanover, Massachusetts, Tier IA Permit # 100223. May 1999.
- MassDEP (Massachusetts Department of Environmental Protection). 1996. Massachusetts Contingency Plan (MCP). Guidance for Disposal Site Risk Characterization. Chapter 9: Method 3 Environmental Risk Characterization. Interim Final Policy, BWSC/ORS-95-141. CMR: 40.0900. 1996.
- MassDEP. 2002. Technical Update: Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soil. May 2002.
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- TtEC (Tetra Tech EC, Inc.). 2005. Draft Comprehensive Site Assessment Environmental Risk Characterization Report, Fireworks (Former Fireworks Facility) Hanover, Massachusetts, Tier IA Permit #100223. May 2005.