REVISED PHASE III

REMEDIAL ACTION PLAN

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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LIST OF ACRONYMS

1,1,-DCE	1,1,dichloroethene
ac	acres
AUL	activity and use limitation
AWQC	ambient water quality criteria
bgs	below ground surface
BMP	Best Management Practice
BOE	Basis of Estimate
BRP	Bureau of Resource Protection
BVW	bordering vegetated wetland
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethene
CMR	Code of Massachusetts Regulations
COC	contaminant of concern
COPEC	contaminant of potential ecological concern
CSA	Comprehensive Site Assessment
CWA	Cold Waste Area
CY	cubic yard
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
DEIR	Draft Environmental Impact Report
DoD	U.S. Department of Defense
DPW	Department of Public Works
ECC	Eastern Channel Corridor
EIR	Environmental Impact Report
ELCR	Excess Lifetime Cancer Risk
ENF	Environmental Notification Form
EoEEA	Executive Office of Energy and Environmental Affairs
EPA	U.S. Environmental Protection Agency
ERC	Environmental Risk Characterization
FEIR	Final Environmental Impact Report
FUDS	formerly-used defense sites
FWENC	Foster Wheeler Environmental Corporation
GAC	granular activated carbon
GHG	greenhouse gas
HE	high explosives
HHCOC	human health contaminant of concern

HHRC	Human Health Risk Characterization
HI	Hazard Index
LDR	Land Disposal Restriction
LDRC	Lower Drinkwater River Corridor
LOAEL	lowest observed adverse effect level
LNA	Lower North Area
LP/UFP	Lily Pond/Upper Factory Pond
LSP	Licensed Site Professional
LTM	long-term monitoring
M	million
MCP	Massachusetts Contingency Plan
MassDEP	Massachusetts Department of Environmental Protection
MassDMF	Division of Marine Fisheries
MeHg	methyl mercury
MEPA	Massachusetts Environmental Policy Act
mg/Kg	milligram per kilogram
MGL	Massachusetts General Law
M/LFP	Middle/Lower Factory Pond
MNA	monitored natural attenuation
MNR	monitored natural recovery
MUA	Marsh Upland Area
NOAEC	no observable adverse effect concentration
NOAEL	no observable adverse effect level
NOI	Notice of Intent
NOR	Notice of Responsibility
NPDES	National Pollutant Discharge Elimination System
NHRP	National Register of Historic Places
OHM	oil and hazardous materials
PAH	polycyclic aromatic hydrocarbon
PFLT	Paint Filter Liquids Test
PGA	Potential Greenway Area
PGP	Programmatic General Permit (Massachusetts)
POTW	Publicly-owned Treatment Works
PQL	practical quantitation limit
PRG	preliminary remediation goal
RAP	Remedial Action Plan
RAPS	Response Action Performance Standards
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
S/S	solidification/stabilization
SDA	Southern Disposal Area
SVOC	semi-volatile organic compound
SWA	Site-wide alternative
SWPPP	Stormwater Pollution Prevention Plan
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
Site	Fireworks Site
THg	total mercury
trans-1,2-DCE	trans-1,2-dichloroethene
TtEC	Tetra Tech EC, Inc.
UCL	upper concentration limit
UNA	Upper North Area
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound
WPA	Wetlands Protection Act
WQC	Water Quality Certification

1.0 INTRODUCTION

The Phase II Comprehensive Site Assessment (CSA) was completed and approved by the Massachusetts Department of Environmental Protection (MassDEP) on August 16, 2006. This Revised Phase III Identification, Evaluation and Selection of Comprehensive Remedial Action Alternatives (Phase III, 310 Code of Massachusetts Regulations (CMR) 40.0850) (hereafter referred to as the Remedial Action Plan (RAP)) 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). An initial Phase III RAP was submitted to the MassDEP on November 12, 2007 and was presented to the Site stakeholders at a public meeting held at the Hanover Town Hall on February 27, 2007 (TtEC, 2007). This Revised Phase III RAP incorporates new sampling and field investigation results collected in the Fall of 2008 and in February of 2009. These Phase III supplemental sampling activities were described and reported in the Phase III Supplemental Data Report (TtEC, 2009). The Phase III evaluation activities for the Site included the following:

- Development of Site-wide and area-specific remedial objectives (ROs);
- Development of Site-wide risk-based preliminary remediation goals (PRGs) designed to eliminate or reduce the significant potential human health and environmental risks identified during the CSA;
- Development of remedial action alternatives for the clean-up of the contaminated media at the Site (i.e., sediment, soil, and groundwater);
- Selection of a recommended remedial alternative for the Site; and
- Preparation of the RAP.

1.1 BACKGROUND

Historical activities at the Site (shown in Figure 1-1) included the commercial manufacture of civilian fireworks and research, development and manufacture of munitions and pyrotechnics for the United States Government during the years between 1907 and 1970 (Note: All referenced figures and tables are located at the end of this document). Lead, mercury, and some organic solvents (among other chemicals) were used in these manufacturing processes and research and development activities during the facility's operational lifetime. The MassDEP has conducted surface water, sediment, and fish tissue sampling for mercury, lead, and other metals in portions of the streams, ponds, and wetlands associated with the Site. Based on this sampling, the MassDEP issued notifications and brought the Site into the MCP process. Tetra Tech EC, Inc. (TtEC) completed the Phase II CSA, which characterized the nature and extent of the oil and hazardous materials (OHM) contamination in the surface soil, subsurface soil, soil gas, groundwater, surface water, and sediment within the Site boundaries (TtEC, 2005). Assessments of the potential risk to human health, environment, safety and the public welfare also were performed as part of the Phase II 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 (ECC), the Lower Drinkwater River Corridor (LDRC), Lily Pond, and Factory Pond, as well as in the soil and underlying groundwater in the Marsh Upland Area (MUA) (refer to Figure 1-1). The highest concentrations for mercury in sediment were found in the northeastern reach of the ECC.

Mercury concentrations were lower but more widespread in the sediment of the larger ponds at the Site. Mercury detected in the soil and groundwater in the MUA, specifically in the former 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 these constituents' upper concentration limit (UCL) as specified in the MCP. Most detections of lead occurred in soil and groundwater in the Southern Disposal Area (SDA). Other metals were detected at elevated concentrations in soil, groundwater, and sediment across the Site (including in the Cold Waste Area (CWA)), 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:

1) Upper North Area (UNA);
2) Lower North Area (LNA);
3) SDA; and the
4) MUA.

Trichloroethene and Freon TF were detected in the soils and groundwater in the UNA adjacent to where the ECC runs along the northern edge of the Site. Freon TF also was detected in the groundwater near the former Building 80 in the UNA. The deep overburden groundwater in the LNA in the vicinity of the former Building 307 (near the Town of Hanover Department of Public Works) was found to have elevated levels of trichloroethene in groundwater. Soil and shallow groundwater contamination along the eastern edge of Factory Pond in the SDA contained trichloroethene, Freon TF and chlorinated VOC degradation products.

The findings of the Phase II CSA (TtEC, 2005) indicated that there are areas of the Site that may present a "significant risk" to human health and/or the environment due to the presence of certain metals and inorganics (e.g., mercury, methyl mercury, lead, copper, nickel, zinc, selenium, thallium, barium, arsenic, and chromium), VOCs (e.g., benzene, 1,1-dichoroethene, cis-1,2-dichloroethene, trans-1,2-dichoroethene, trichloroethene, vinyl chloride), and semi-volatile organic compounds (SVOCs) (e.g., benzo(a)pyrene, dibenzo(a,h)anthracene, and hexachlorobenzene). Projected risks (relative to exposure to contaminants found in biota, soil, and sediment) at the Site for current and potential future site users were determined to be present above human health target levels (Hazard Index (HI) >1 and Excess Lifetime Cancer Risk (ELCR) > $1x10^{-5}$) and above ecological protection criteria.

1.3 UPPER CONCENTRATION LIMIT EXCEEDANCES IN SOIL AND GROUNDWATER

In the Phase II CSA, 15 soil and groundwater samples were found to exceed the MCP UCLs. As defined in 310 CMR 40.0996, UCLs are the concentrations of 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 under the MCP. Figure 1-2 shows the locations of the identified UCL exceedances at the Site. Table 1-1 lists the contaminants of concern (COC), the impacted environmental medium, the COC concentration associated with these exceedances, and the corresponding UCL values.

Antimony was reported in soil above its UCL at one isolated location in the UNA near the bank of the ECC. Lead was detected above its UCL at a single soil location in the Central Commercial Area (CCA). This portion of the Site was subsequently redeveloped by the landowner after this UCL exceedance was identified. As a practical result, this exceedance has been disturbed and covered by paving and an industrial process. As such, it is not addressed in this Revised Phase III RAP. Lead was detected above its UCL at four soil locations in the SDA. In the CWA, 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 MUA.

UCL exceedances in groundwater were detected in one well (DP-MW1) and one piezometer (PZ-24) at the Site. At the former Demolition Pit location within the MUA, the concentration of mercury in groundwater exceeded the UCL at DP-MW1. In the SDA, there were groundwater UCL exceedances for lead and nickel at piezometer PZ-24. During the Phase IIA Investigation (FWENC, 1999) it was determined that nickel exceedances in the groundwater were attributable to nickel leaching from stainless steel drive points used in the characterization. Therefore, these groundwater UCL exceedances for nickel are not addressed in this Revised Phase III RAP. The remaining groundwater UCL exceedances were found to be co-located with, or downgradient of, the 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, the environment, safety, and the public welfare, 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), (presented in Appendix A of the CSA) and a Stage II Environmental Risk Characterization (ERC), (presented 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 are differentiated as to those identified in the HHRC (i.e., human health (COCs)) and those identified in the ERC (i.e., contaminants of potential ecological concern (COPECs)). After this summary discussion, all COCs for the Site will be referred to collectively in the remainder of this document as simply the "COCs."

This Risk Characterization summary, presented below, is being included in this RAP to provide background on the identification of ROs and PRG development that was conducted for this RAP. The detailed presentation of the evaluation is reported in the Phase II CSA that was approved by the MassDEP. The results of the Risk Characterization were used as the starting point for developing preliminary remedial objectives and preliminary remediation goals as described in Section 4.

To facilitate Risk Characterization activities, the Site was divided into a number of Risk Characterization Areas (RCAs) based on the Phase I and II sampling results, the historical land use records, current property ownership and land use, and projected future land use. Subsequent to the initial division of the Site into 18 RCAs, the Site boundary was revised. This revision reduced the number of RCAs to 14, 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 operations. As such, these four areas were removed from within the disposal site boundary. The RCAs shown on Figure 1-1 provided the framework for evaluating subsequent Site assessment and management activities. These RCA boundaries were also used, to the extent practicable, during the Phase III evaluations.

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 for each RCA, including:

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

Based on the conclusions of the HHRC, the potential "significant risk" scenarios identified for the various RCAs are highlighted 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 RCAs were construction workers, utility workers, and people who may use the Site for recreational outdoor activities. Trespassers and fisherman also 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 the COCs that contribute to the risks associated with these receptors and exposure pathways. Various metals and chlorinated organic compounds were the predominant risk drivers for soil; total mercury (THg), methyl mercury (MeHg) 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 significant risks to human health as a result of exposures to the groundwater or surface water at the Site.

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 exposed to COPECs. A conceptual site model was developed for evaluating the possible exposure of environmental receptors to Site-related contaminants via various transport and food chain pathways. The primary pathways of exposure to ecological receptors included direct contact with contaminated environmental media (e.g., soils or sediment), dietary ingestion of contaminated prey, and incidental ingestion of contaminated abiotic media during feeding or grooming. For higher trophic level receptors, bioaccumulation of certain COPECs (such as THg and MeHg) will likely result in exposure via transfer within the local food chain. Aquatic communities such as, fish, plankton, benthic, and pelagic invertebrates are also potentially at risk from direct exposure to COPECs. The pathways of exposure to Site-related contaminants are through direct contact with abiotic media, the consumption of contaminated prey (such as 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 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 RCAs 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 the upper trophic wildlife receptors. The MCP (MassDEP, 1999) provides the following criteria for the determination of risks to environmental assessment endpoints in an ERC:

- No Significant Risk of Harm;
- Indication of Potential for Biologically Significant Harm; and
- 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 for each RCA and which COCs are associated with 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. MeHg and THg are both present at the Site. MeHg is the primary form of mercury that is bioaccumulated by biota. MeHg accounts for >98 percent of the mercury in fish and other aquatic biota, 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 percent of the THg present. The majority of the mercury present in the sediment is likely to be in inorganic forms (i.e., 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 (TtEC, 2005) concluded that only the CWA posed a significant potential risk of harm to safety. This finding was based both on the records of past operation that identified the CWA as the primary area designated for the disposal of non-energetic or previously de-energized munitions-related items, and on the nature of the items that were found in this area during the Phase II field 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 CWA. 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.

1.4.4 Assessment of Risk to Public Welfare

The characterization of the risk of harm to public welfare performed for the Phase II CSA involved a comparison of soil and groundwater concentrations at the Site to published MCP UCLs. UCLs are defined under 310 CMR 40.0996 as the concentrations of 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. The Phase II CSA identified 15 soil and groundwater samples exceeding these UCLs. The locations of the soil UCL exceedances and the highlighted COCs were:

- UNA – antimony;
- MUA – mercury;
- SDA – lead; and
- CWA – antimony, barium, lead, and zinc.

The locations of the groundwater UCL exceedances and the highlighted COCs were:

- MUA – mercury; and
- SDA – lead.

The assessment of risk to public welfare found that antimony, barium, lead, mercury and zinc could all pose a potential risk of harm to public welfare within the specified media and locations, noted above. The Phase II Site investigation did not identify any nuisance conditions, odors or unilateral restrictions imposed on the Site that could pose a potential threat of harm to public welfare in the foreseeable future.

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 remedial objectives (ROs). The ROs presented in this document describe the narrative requirements that any collection of remedial actions that are implemented on the Site will need to meet to address risks to human health, the environment, safety, or public welfare receptors or to comply with regulatory requirements. Once the ROs were established for the Site, numerical preliminary remediation goals (PRGs) to support the evaluation of the effectiveness of the remedial alternatives with respect to protectiveness were developed. These define the concentrations of contaminants in the affected media (e.g., sediment or soil) that correspond to achieving the ROs.

For this Site, preliminary ROs were developed based on an overall Site-wide risk management approach. The Site-wide ROs are presented in Section 3.0. Preliminary media-specific ROs are presented in Section 4.1. The PRGs that were 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 Fireworks Site, it was anticipated that some ROs would suggest remedial responses that 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 required 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 revised ROs are presented in Section 4.3.

Using these revised ROs and the applicable regulatory requirements, 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 (RCAs) developed in the Phase II Comprehensive Site Assessment (CSA). Next, potentially applicable technologies for addressing each contaminated medium were identified and screened against a series of evaluation criteria. Finally, a number of RCA-specific remedial action alternatives were developed and combined to construct Site-wide remedial action alternatives.

Evaluating candidate remedial action alternatives involved the following four main steps:

1) Developing and screening remedial technologies and process options specific to each impacted environmental medium;
2) Assembling appropriate technologies into remedial action alternatives for each RCA and assembling sets of alternatives for specific areas into Site-wide alternatives for addressing the full set of the revised ROs;
3) Screening the candidate Site-wide remedial action alternatives using Massachusetts Contingency Plan (MCP)-specified evaluation criteria (i.e., conducting the comparative evaluation); and
4) Formulating a recommendation regarding the preferred remedial action 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 Code of Massachusetts Regulations (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 action alternatives for each RCA, and then the alternatives for the RCAs were assembled into a set of Site-wide remedial action alternatives. Thereafter, these alternatives underwent a detailed comparative evaluation against a set of MCP-defined evaluation and regulatory criteria, which included:

- Comparative effectiveness;
- Comparative short-term and long-term reliability;
- Comparative difficulty in implementation;
- Comparative costs;
- Comparative risks;
- Comparative benefits;
- Comparative timeliness in terms of eliminating any uncontrolled sources of oil and hazardous materials (OHM) and achieving a level of "No Significant Risk;" and
- Comparative 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. Following the selection of the recommended remedial action alternative, the following feasibility evaluations were conducted:

- Implementing a Permanent Solution, if a Temporary Solution was originally selected;
- Reducing concentrations of constituents to achieve or "approach background" levels (as defined in the MCP) (MassDEP, 2004), unless a Class A-1 Response Action Outcome is selected; and
- Reducing concentrations in soil and groundwater to below their upper concentration limits (UCLs).

If the recommended remedial action alternative was not projected to achieve the noted endpoints, further evaluations were conducted, as required. These evaluations were:

- Technological feasibility; and
- Benefit-cost analysis for reaching background.

This Revised Phase III Remedial Action Plan (RAP) was prepared to document the results of these Phase III evaluations performed for the Site. The Revised RAP describes in reasonable detail the processes that were used to develop and evaluate the remedial action 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 Revised Phase III RAP complies with the Response Action Performance Standards (RAPS) defined in the MCP (310 CMR 40.0191 [1]-[3]) and the evaluations it documents. This includes:

- Considering relevant policies and guidelines of the Massachusetts Department of Environmental Protection (MassDEP);

- Using accurate and up-to-date methods, standards and practices, equipment and technologies that 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 findings of the Phase II Comprehensive Site Assessment (CSA), significant risks to human health and/or the environment were found to be potentially associated with conditions at the Site. In order to determine what type of remedial response is appropriate and necessary to address the identified risks, the remedial objectives (ROs) for the overall Site must first be defined. Given the size and complexity of the Site, the RO development process began by defining the overall risk management approach for the Site and the general nature of the desired remediation and site management outcomes. This Site-wide risk management strategy had to meet the regulatory requirements of the Massachusetts Contingency Plan (MCP), but 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 the associated aquatic resources. This strategy provided the basis for establishing more site-specific ROs and subsequent preliminary remediation goals (PRGs).

The initial Site-wide ROs identified for the Site were:

- Implementing a Permanent Solution (310 Code of Massachusetts Regulations (CMR) 40.0852 [2]);
- Reducing the levels of Site contaminants in soil and groundwater to below applicable upper concentration limits (UCLs) (310 CMR 40.0860 [1][c]);
- Ensuring that there are no critical exposure pathways (310 CMR 40.0860 [d]);
- Achieving a level of “No Significant Risk” at the Site considering the oil and hazardous materials (OHM) present, the media that are contaminated and impacted, and the Site characteristics (310 CMR 40.0853 [1]) by demonstrating that the chemical-specific, media-specific, and Risk Characterization Area (RCA)-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]);
- Minimizing the need for activity and use limitations (AULs); and
- Protecting the natural resources and conservation areas at the Site and minimizing the disruption of those areas during implementation of the selected remedial action alternative.

These ROs define the goals of the overall Site-wide remediation approach. However, a few of 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 Revised Phase III RAP presents the more specific ROs for the soil, groundwater, and sediment of the Site. During the Phase II Risk Characterization, no significant risks were identified with respect to surface water. Therefore, no further consideration was given to this medium during the development and evaluation of medium-specific remedial action alternatives, except as related to the implementation of remedial action alternatives for associated sediment or the adjacent soils. Additionally, no significant risks were identified for sediment in the Upper Drinkwater River Corridor. Therefore, the sediment in this RCA was not addressed in this Revised Phase III RAP.

4.0 DEVELOPMENT OF PRELIMINARY REMEDIAL OBJECTIVES AND PRELIMINARY REMEDIATION GOALS

Remedial objectives (ROs) provide the foundation upon which remedial alternatives are based. ROs are generally developed after a determination has been made that significant risks to human health and/or the environment are present at a site. The elimination or reduction of these highlighted potential risks and compliance with applicable federal, state, and local regulatory requirements are considered in defining the ROs.

ROs are required to clearly articulate the intent of any remedial actions. Quantitative preliminary remediation goals (PRGs) are then developed to allow the measurement of progress towards achieving the ROs. PRGs are the target chemicals of concern (COC) concentrations in the affected media that correspond to the condition when a specific RO is considered to be achieved. For example, if an RO is the protection of adults and children from incidental ingestion of sediment during recreational activities, then the associated PRGs would be the concentrations of the COCs in the exposed sediment that are projected to create a level of risk for these receptors via this exposure route that is below an acceptable threshold limit.

Establishing ROs and their associated PRGs allows the evaluation of the ability of the candidate remedial action alternatives to reduce risks to human health and environmental receptors to acceptable levels, comply with regulatory requirements, and be cost effective.

All of the risks identified in the Phase II Comprehensive Site Assessment (CSA) will probably not be eliminated by the remedial actions that will be undertaken at the Site due to a number of factors. These factors include the numerous ecological assessment endpoints that were evaluated, the relatively low Site-specific background concentrations for some of the key chemical constituents present, widespread contaminant distributions, and the complex nature of mercury chemistry in aquatic systems. Therefore, a risk reduction approach will be applied when evaluating the performance of the candidate remedial action alternatives for the Site. Identified risks can be greatly reduced by selecting a remedial action alternative that includes full or partial source removal and/or containment. However, there will likely be some low level residual risks at this Site following the implementation of the recommended alternative. The type and magnitude of the residual risks associated with each Site-wide remedial alternative are evaluated and discussed in Section 8.0.

4.1 PRELIMINARY REMEDIAL OBJECTIVES

This section lists the preliminary ROs for each impacted environmental medium (i.e., 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 across and consistency between them as a collective set using the fatal flaw analysis summarized in Section 2.0. Based on that evaluation, the preliminary ROs were revised. The revised ROs, presented in Section 4.3, serve as the basis for the Phase III evaluations. Since the Phase II CSA concluded that there were no significant risks from surface water, ROs were not required for surface water.

4.1.1 Preliminary Remedial Objectives for Soil

The preliminary ROs for soil are to:

- Reduce the concentrations of COCs in soil to levels at or below upper concentration limits (UCLs);

- Reduce the concentrations or quantity of COCs in soil that may act as a potential on-going source of sediment contamination to the water bodies and aquatic environments (principally mercury);
- Minimize or prevent exposure to COCs in soils that are sufficiently contaminated to pose an unacceptable potential lifetime cancer or non-cancer risk to people using the Site;
- Minimize or prevent exposure to COCs in soil that are sufficiently contaminated to pose an unacceptable level of potential risk of biological significant harm to each of the environmental endpoints identified in the Environmental Risk Characterization (ERC), including:
  - Insectivorous birds;
  - Insectivorous small mammals;
  - Soil invertebrates and microbial communities; and
  - Terrestrial plants.
- Reduce, to the extent feasible, the concentrations of COCs in the soil to levels that achieve or approach background.

4.1.2 Preliminary Remedial Objectives for Groundwater

The preliminary RO for groundwater is to reduce the concentrations of COCs (i.e., lead and mercury) in groundwater to levels at or below the applicable UCLs.

4.1.3 Preliminary Remedial Objectives for Sediment

The preliminary ROs for sediment are to:

- Minimize or prevent exposure to COCs in sediment that are sufficiently contaminated to pose an unacceptable level of potential risk of biological significant harm to each of the environmental receptor groups identified in the ERC, including:
  - Benthic communities;
  - Piscivorous fish;
  - Piscivorous birds;
  - Omnivorous waterfowl;
  - Herbivorous waterfowl;
  - Piscivorous mammals;
  - Omnivorous mammals;
  - Herbivorous mammals; and
  - Aquatic reptiles.
- Reduce the concentrations of COCs (especially methyl mercury (MeHg)) in the tissues of fish and other prey species to levels that do not pose unacceptable potential risks to people and environmental endpoints.
- Reduce or contain (isolate) the mass of total mercury at the Site to minimize the potential transport of total mercury from areas that inhabit mercury methylation to areas that promote mercury methylation.

- Improve the aquatic and wetland habitats at the Site to a state that will eventually support the elimination of the Site-related fish consumption advisory through a combination of remedial measures that will reduce the bioavailability of mercury.
- Reduce total mercury concentrations in the accessible surface sediment to below the Site-specific human health PRG of 22.2 milligrams per kilogram (mg/Kg) to reduce potential risks to wading fishermen in the Eastern Channel Corridor (ECC), Lower Drinkwater River Corridor (LDRC), and the Lily Pond/Upper Factory Pond (LP/UFP) Area, and for trespassers wading 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 to reduce the impact of the contaminated media on the human populations and environmental receptors (i.e., endpoints) identified in the Phase II CSA 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 candidate remedial alternatives. Numerical PRGs define the concentrations of COCs in the affected media that correspond to the achievement of 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 assessed in the Human Health Risk Characterization (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 practically defined as the chemicals that individually contributed a potential Excess Lifetime Cancer Risk (ELCR) contribution to a particular receptor greater than 1×10^{-6} or a potential non-carcinogenic Hazard Index (HI) contribution greater than 0.1. Using this definition, COCs were identified for which PRGs were developed.

Table 4-1 presents the human health-related 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 human health-related 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 individual chemical target risk goals for carcinogenic and non-carcinogenic health effect end points, as applicable.

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

To provide a context for considering the human health-related PRGs for soil, the Massachusetts Contingency Plan (MCP) Method 1 Standards for soil, the Site-specific background concentrations, and the MassDEP-published background values for soil containing fill also are provided. The most appropriate Method 1 Standards for soil and groundwater at this Site are 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, the background samples collected at depth intervals consistent with the depth intervals evaluated in the Phase II Risk

Characterization (0 to 3 feet bgs and 0 to 6 feet bgs) were considered in the development of the PRGs. The resulting human health-related PRGs were used as the remediation goals in the Phase III evaluation of remedial action alternatives for the Site. The human health-related soil PRGs are a combination of RBCs, MassDEP-published background concentrations, and practical quantitation limits (PQLs), whereas the human health-related sediment PRGs are a combination of RBCs, Site-specific background concentrations, and PQLs. Details of the PRG development are presented in Appendix A.

4.2.2 Environmental PRGs

The environmental PRGs were developed using the results of both field studies and predictive modeling for the receptors and assessment endpoints that were evaluated in the Stage II ERC performed for this Site. The environmental PRG development focused on the primary exposure routes and source media identified for each COC or assessment endpoint combination considered. The environmental source media were the sediment and surface soils for the assessment endpoints associated with significant risks in the ERC.

Under the MCP, exceedance of a no observable adverse effect level (NOAEL) alone does not constitute a basis for a finding of potential environmental harm. Other lines of evidence must be considered as part of a weight-of-evidence evaluation. Exceedance of a lowest observed adverse effect level (LOAEL) value may; however, support a finding of potential risk of environmental harm. Consequently, this value was used in the development of the corresponding PRGs.

The environmental PRGs were selected by identifying the lowest assessment endpoint-specific PRG calculated for each COC. For semi-aquatic and terrestrial wildlife receptors, the selected environmental PRG was the lowest available LOAEL or LOAEL-equivalent concentration, consistent with MCP guidance. Semi-aquatic environmental receptors are defined as receptors that depend partially on the aquatic habitat or resource for protection or nutrition. The environmental PRGs did not consider the background concentration as a basis for the PRG. Table 4-1 presents the environmental PRGs for the surface soil by COC for the terrestrial environmental receptors. Table 4-2 presents the environmental PRGs for sediment by COC for aquatic and semi-aquatic environmental receptors.

4.3 DEVELOPMENT OF PROPOSED REMEDIAL OBJECTIVES

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

Results from the Phase II CSA showed that total mercury (THg) in sediment and methyl mercury (MeHg) in the upper trophic levels of the local food chain are the key 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 THg concentration. It is 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 the background THg concentration for sediment is the herbivorous waterfowl (27 mg/Kg). However, the human health THg PRG of (22.2 mg/Kg) is lower than the THg PRG for herbivorous waterfowl in sediment. Therefore, the human health PRG value for THg in sediments was used as the criterion to determine whether this revised RO had been met.

Two preliminary ROs for sediment from Section 4.1 describe the desired future state of the Site:

- Reduce the concentrations of COCs (especially MeHg) in the tissues of fish and other prey species to levels that do not pose unacceptable potential risks to environmental endpoints; and
- Improve aquatic and wetland habitats on the Site to a state that will eventually support the eventual elimination of the Site-specific fish consumption advisory 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 and biological systems have the potential to significantly influence the feasibility and effectiveness of remedial actions focused on MeHg levels in fish. Given the complex chemistry and biology of the fate of THg and MeHg in sediment and aquatic organisms, a significant reduction in the average MeHg concentration in a population of fish will likely take some time. Developing a remediation strategy keyed to levels of MeHg in fish tissue would 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 demonstrated through testing in the short-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 potential 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 potential 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; and
  - 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.

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; and
  - Aquatic reptiles.
- 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.
- Reduce potential 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 potential risks to environmental endpoints.
- Improve aquatic and wetland habitats on the Site to a state that will support the eventual elimination of the Site-specific fish consumption advisory 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 ASSEMBLY OF REMEDIAL ALTERNATIVES FOR SOIL

Remedial alternatives were developed for soil to address soil upper concentration limits (UCL) exceedances and soil identified as posing a significant potential human health and/or ecological risk at the Site. Soil UCL exceedances for the Site are listed in Table 1-1 and the locations of these exceedances are shown in Figure 1-2. The UCL exceedance that was previously identified in the Central Commercial Area of the Site at the location identified as CL213 was in an area that has since been disturbed, covered, and redeveloped by the property owner. Access to this soil and potential exposure has been eliminated and further assessment or response relative to this exceedance is not warranted. As such, this soil UCL exceedance was not addressed further in this Revised Phase III Remedial Action Plan (RAP). Technologies that can be used to address the soil that has been characterized as potentially posing a significant human health and/or ecological risk (i.e., those areas having chemical of concern (COC) concentrations exceeding the Site-specific human health and ecological preliminary remediation goals (PRGs) presented in Table 4-1) have been identified and screened. Remedial technologies to address these UCL and PRG exceedances have been identified and screened below, and technologies that were retained as feasible were assembled into remedial action alternatives for soil.

5.1 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

An initial screening of remedial technologies for soil was conducted in accordance with 310 Code of Massachusetts Regulations (CMR) 40.0856 to identify technologies that are reasonably likely to be feasible, based on the oil and hazardous materials (OHM) present at the Site, the Site soils that are contaminated, and the characteristics of the Site. After this 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 technologies would be available, regardless of arrangements for securing their services.

Table 5-1 details the initial screening of the candidate remedial technologies for the Site soils with UCL exceedances (i.e., in the Upper North Area (UNA), Southern Disposal Area (SDA), and Marsh Upland Area (MUA)), and the soils that have been identified as potentially posing a significant risk to human health and/or the environment (i.e., the Potential Greenway Area (PGA), SDA, Southern Conservation Commission Area (SCCA), MUA, and Cold Waste Area (CWA)).

The soil UCL exceedances are for metals, specifically antimony, barium, lead, mercury, nickel, and zinc. In addition, the majority of the potential risks to human health or ecological receptors identified for soil in areas that were not co-located with the UCL exceedances also were associated with the metals in the soil. Therefore, based on the soil contaminants present at the Site, remedial technologies that were not applicable to addressing metals were not put through the initial screening step. These technologies include:

- Bioventing and enhanced bioremediation (both are in-situ biological treatment technologies);
- Chemical Oxidation (an in-situ chemical treatment technology);
- Soil Vapor Extraction (an in-situ physical treatment technology);

- Ex-Situ Biological Treatment technologies (including biopiles, composting, landfarming, and slurry phase biological treatment);
- Dehalogenation (an ex-situ chemical treatment technology); and
- Ex-Situ Thermal Treatment technologies (including pyrolysis, thermal desorption, and incineration).

In consideration of the Site characteristics and circumstances (e.g., the Cooperating Parties do not own any of the properties that constitute the Site), the following larger-scale/process-intensive remedial technologies were not considered to be practical and were not subject to 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
- Ex-Situ Physical/Chemical Treatment technologies (including soil washing, separation, chemical extraction, chemical reduction/oxidation).

In addition, in areas where both capping and excavation were feasible, excavation was usually chosen as the preferred technology because the Cooperating Parties do not own any of the properties that constitute the Site and this would eliminate the need for long-term inspection and maintenance.

5.2 ASSEMBLY OF REMEDIAL ALTERNATIVES

Remedial alternatives for each Risk Characterization Area (RCA) were assembled using the retained remedial technologies for soil from the initial screening. Tables 5-2 through 5-7 show the assembled alternatives for each RCA (i.e., the UNA, PGA, SDA, SCCA, MUA, and CWA, respectively). The alternatives were configured to address soil with contaminant concentrations that exceeded UCLs, soil associated with identified potential human health and/or ecological risks, and soil with concentrations of COCs that do not approach background concentrations. For the purposes of this Revised Phase III RAP and consistent with the Massachusetts Contingency Plan (MCP), "approaching background" was defined as the lower of the S-1/GW-2 and S-1/GW-3 standards as specified in 310 CMR 40.0900 (MassDEP, 2004) (Note that the groundwater at the Site is not classified as GW-1).

For each of the soil alternatives, the affected soil volume, the mass of primary chemicals of concern (COCs) removed, and the reductions to the projected human health and ecological risks were calculated. A selection of these results is presented in Table 5-8. Thiessen polygons were used to define individual areas of influence around each of the soil sample locations within the overall soil sampling network for use in these calculations. Each sample location was connected to its nearest neighbor to form an irregular triangulated network. Bisecting each line segment that connects the adjacent sampling location perpendicularly creates the closed polygons. The automatically-derived polygons were then adjusted to account for Site topography, local physical features, and the possible lack of adjacent sample locations using best professional judgment. Figures 5-1 through 5-19 show the estimated aerial extent of soil with UCL exceedances and/or soil identified as posing potential human health and ecological risks in the UNA, PGA, SDA, SCCA, MUA, and the CWA using these Thiessen polygons.

Detailed descriptions of each soil alternative are provided in Section 5.3. The remedial alternatives for soil in these six RCAs were then assembled into five Site-wide remedial alternatives (see Section 8) which also include remedial alternatives to address the Site groundwater and sediment.

5.3 DETAILED SOIL ALTERNATIVE DESCRIPTIONS

The following sections provide a detailed description of the soil alternatives developed for each RCA and the RCA-specific assumptions made during the development of the remedial alternatives for that area. The general assumptions made for all of the soil alternatives were:

- 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 COC levels are less than the soil preliminary remediation goals (PRGs) established for the Site prior to its use. Backfilling an excavation is not considered to be "capping" and, therefore, does not require long-term monitoring.
- Excavated soil will be required to pass the Paint Filter Liquids Test (PFLT) prior to transport for off-site disposal and material will be solidified or stabilized (if necessary) to pass the PFLT.
- For areas requiring long-term monitoring of soil COC concentrations, a 30-year monitoring period was assumed.
- Treatment of any groundwater incidental to the excavation area is assumed to be by filtration and granular activated carbon (GAC), with subsequent discharge on-site via a permitted outfall.

5.3.1 Upper North Area Soil Alternative Descriptions

No human health or ecological PRG exceedances were identified for the UNA. There was one soil UCL exceedance for antimony at sample location NSR01 (see Figure 5-1) located on the northern bank of the Eastern Channel Corridor (ECC). Due to its close proximity to the ECC, this UCL exceedance will be addressed as part of the sediment alternative for the ECC. To address the remaining remedial objectives for soil, three soil alternatives were developed for the UNA including:

- No Action – Soil Alternative UNA-1;
- Limited Action – Soil Alternative UNA-2; and
- Removal of Soil to Approach Background – 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 the overall effectiveness of the other remedial alternatives. The No Action alternative includes no remedial activities to remove, treat or contain the COCs in the soil within this RCA. This alternative relies on natural attenuation processes alone to reduce the concentrations of the COCs in the soil and to potentially attain the remedial objectives (ROs), but does not include monitoring to document future COC concentrations.

5.3.1.2 Soil Alternative UNA-2 – Limited Action

The Limited Action alternative is presented in Figure 5-1 and involves a combination of monitored natural attenuation (MNA) and non-engineering measures for the soil with UCL exceedances. The U.S.

Environmental Protection Agency (EPA) defines MNA 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).

Non-engineering measures would be implemented by the owner(s), Cooperating Parties, local government, and/or regulatory agencies to reduce the likelihood that people would come 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 the soil COC (antimony) concentrations over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five monitoring through a 30-year monitoring period (or until such time as the antimony concentrations in the area fall below the corresponding UCL).

5.3.1.3 Soil Alternative UNA-3 – Removal of Soil to Approach Background

This Removal Action alternative is presented in Figure 5-2 and involves a combination of excavation, backfilling the excavated area, and off-site disposal of the excavated soil. No long-term monitoring would be required as no further potential risk would exist within this RCA following the implementation of this alternative. Soil would be excavated to concentrations approaching background and the excavated material would be disposed of off-site. It was assumed that the excavated soil could be disposed of locally at a permitted, non-hazardous waste landfill. To ensure complete removal of soil with concentrations above background, excavation depths of 1, 2 or 6 feet at seven locations were determined to be required as shown in Figure 5-2.

Specifically, the components of this Removal Action alternative include:

- Excavation of approximately 26,807 cubic yards (CY) of soil to approach background (Note: There were no human health or ecological PRG exceedances in this RCA);
- Backfill of the excavated area with clean material; and
- Transport of the excavated materials by truck to a local, permitted facility for disposal.

5.3.2 Potential Greenway Area Soil Alternative Descriptions

No UCL exceedances or human health PRG exceedances were identified for the PGA. However, exceedances of the mercury, thallium, and hexachlorobenzene ecological PRGs for surface soils were identified. To address these exceedances, four soil alternatives were developed for the PGA including:

- No Action – Soil Alternative PGA-1;
- Limited Action – Soil Alternative PGA-2;

- Removal of Soil to Eliminate Ecological PRG Exceedances for Mercury – Soil Alternative PGA-3; and
- Removal of Soil to Eliminate All Ecological PRG Exceedances and Approach Background – 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 the overall effectiveness of the other remedial alternatives. The No Action alternative includes no remedial activities to remove, treat, or contain the COCs in the soil within this RCA. This alternative relies on natural attenuation processes alone to reduce the concentrations of the COCs in the soil and to potentially attain the ROs, but does not include monitoring to document future COC concentrations.

5.3.2.2 Soil Alternative PGA-2 – Limited Action

The Limited Action alternative is presented in Figure 5-3 and involves MNA of the soil with the ecological PRG exceedances. Non-engineering measures would not be implemented because they would not be effective in reducing the potential of ecological receptors coming into contact with the soil in theses areas.

Specifically, this Limited Action alternative includes:

- Establishing a monitoring program to collect and analyze soil samples to track the soil COC (mercury, thallium, and hexachlorobenzene) concentrations over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five monitoring through a 30-year monitoring period (or until such time as the mercury, thallium, and hexachlorobenzene concentrations in the area fall below the corresponding ecological PRGs).

5.3.2.3 Soil Alternative PGA-3 – Removal of Soil to Eliminate Ecological PRG Exceedances for Mercury

This Removal Action alternative is presented in Figure 5-4 and involves a combination of excavation, backfilling the excavated area, and off-site disposal of the excavated soil. The surface soil would be excavated to eliminate all exceedances of the ecological PRG for mercury and the excavated material would be disposed of off-site. It was assumed that the excavated soil could be disposed of locally at a permitted, non-hazardous waste landfill. Excavation to 1 foot below the ground surface at two locations was determined to be required as shown in Figure 5-4.

Specifically, the components of this Removal Action alternative include:

- Excavation of approximately 656 CY of soil;
- Backfilling the excavated areas with clean material from local sources;
- Transport of the excavated materials by truck to a permitted facility for disposal; and
- Long term monitoring of the remaining ecological PRG exceedances.

5.3.2.4 Soil Alternative PGA-4 – Removal of Soil to Eliminate all Ecological PRG Exceedances and Approach Background

This Removal Action alternative is presented in Figure 5-5 and involves a combination of excavation, backfilling the excavated area, and off-site disposal of the excavated soil. No long-term monitoring would be required as no further potential risk would exist within this RCA following the implementation of the alternative. Soil would be excavated to result in constituent levels that approach background, and the excavated material would be disposed of off-site. It was assumed that the excavated soil could be disposed of locally at a permitted, non-hazardous waste landfill. Excavation to 1 foot below the ground surface at three locations was determined to be required as shown in Figure 5-5.

Specifically, the components of this Removal Action alternative include:

- Excavation of approximately 1,020 CY of soil;
- Backfilling the excavated areas with clean material from local sources;
- Transporting excavated materials by truck to a local, permitted facility for disposal; and
- Establishing a monitoring program to collect and analyze soil samples to track soil concentrations over time. Monitoring would occur once at two years, five years, and every five years after the year five monitoring through a 30-year monitoring period (or until such time as the COC concentrations in the area reach levels approaching background).

5.3.3 Southern Disposal Area Soil Alternative Descriptions

In the SDA, there were soil UCL exceedances for lead, and human health and ecological PRG exceedances in soil for 1,1-dichloroethene (1,1-DCE), trichloroethene (TCE), vinyl chloride, hexachlorobenzene, antimony, barium, cadmium, chromium, copper, lead, mercury, thallium, and zinc. To address these exceedances, five soil alternatives were developed for the SDA:

- No Action – Soil Alternative SDA-1;
- Limited Action – Soil Alternative SDA-2;
- Removal of Soil to Eliminate UCL Exceedances for Lead – Soil Alternative SDA-3 (3A or 3B);
- Removal of Soil to Eliminate Exceedances of UCLs and Human Health and Ecological PRGs – Soil Alternative SDA-4 (4A or 4B); and
- Removal of Soil to Approach Background – Soil Alternative SDA-5 (5A or 5B).

5.3.3.1 Soil Alternative SDA-1 – No Action

The No Action alternative serves as a baseline for comparison of the overall effectiveness of the other remedial alternatives. The No Action alternative includes no remedial activities to remove, treat, or contain the COCs in the soil within this RCA. This alternative relies on natural attenuation processes alone aimed to reduce the concentrations of the COCs in the soil and to potentially attain the ROs, but does not include monitoring to document future COC concentrations.

5.3.3.2 Soil Alternative SDA-2 – Limited Action

The Limited Action alternative is presented in Figure 5-6 and involves a combination of MNA and non-engineering measures for the areas with soil that exceeds UCLs or human health or ecological PRGs. Non-engineering measures would be implemented by the owner(s), Cooperating Parties, local government, and/or regulatory agencies to reduce the likelihood that people would come into contact with the soil with UCL and human health PRG exceedances. Non-engineering measures would not be effective in reducing the potential for ecological receptors to come into contact with the soil in the areas with ecological PRG exceedances. However, for the purposes of this evaluation, any area with only ecological PRG exceedances was 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 multiple soil COC concentrations over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five monitoring through a 30-year monitoring period (or until such time as the concentrations of each COC in the area fall below its corresponding UCL, human health PRG, or ecological PRG);
- Implementing an appropriate activity and use limitation (AUL) for this area;
- Installing and/or maintaining fencing and warning signs around the perimeter of the areas with UCL, ecological and human health PRG exceedances; and
- Implementing 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 – Removal of Soil to Eliminate UCL Exceedances for Lead and Co-Located Human Health and Ecological PRGs

This Removal Action alternative is presented in Figure 5-7 and involves a combination of excavation of soil with UCL exceedances for lead and co-located human health and ecological PRGs, backfilling the excavated area, 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 and disposal. All soil with human health or ecological PRG exceedances that are not co-located with the UCL exceedances would be subject to MNA and non-engineering measures. As previously noted, areas with only ecological PRG exceedances located outside of the areas with UCL exceedances have not been separated out for just MNA under this alternative. It was assumed that the excavated soil could be disposed of at a permitted, hazardous waste landfill or a local non-hazardous waste landfill. To ensure the complete removal of soil with concentrations above the UCL for lead, excavation depths of 2 or 3 feet at three locations were determined to be required.

Specifically, the components of this Removal Action alternative include:

- Excavation of approximately 726 CY of soil (Alternatives SDA-3A and SDA-3B);
- Backfilling 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 permitted facility for disposal (Alternatives SDA-3A and SDA-3B);
- Establishing a monitoring program to collect and analyze soil samples to track soil COC concentrations over time. It is assumed that monitoring would occur once at two years, five years and, every five years after the year five monitoring through a 30-year monitoring period (or until

such time as the COC concentrations in the area fall below the corresponding human health and ecological PRGs);

- Implementing and appropriate AUL for this area;
- Installing and maintaining fencing and warning signs around the perimeter of the areas with ecological and human health PRG exceedances; and
- Implementing 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 to Eliminate Exceedances of UCLs and Human Health and Ecological PRGs

This Removal Action alternative is presented in Figure 5-8 and involves a combination of excavation of soil with exceedances of the UCL for lead and the human health and ecological PRGs, backfilling the excavated area, 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 disposal. No long-term monitoring would be required as no further potential risk would exist within this RCA following implementation of the alternative. It was assumed that the excavated soil could be disposed of at a permitted, hazardous waste landfill or a local non-hazardous waste landfill. Excavation depths of 1 or 6 feet at 11 locations within the RCA were required to meet the PRGs.

Specifically, the components of this Removal Action alternative include:

- Excavation of approximately 6,648 CY of soil (Alternatives SDA-4A, SDA-4B, and SDA 4C);
- Backfilling the excavated areas with clean material from local sources (Alternatives SDA-4A or SDA-4B);
- Solidifying or stabilizing excavated soil prior to transport for disposal, if necessary (Alternative SDA-4B); and
- Transporting excavated materials by truck to a permitted facility for disposal (Alternatives SDA-4A or SDA-4B).

5.3.3.5 Soil Alternative SDA-5 – Removal of Soil to Approach Background

This Removal Action alternative is presented in Figure 5-9 and involves a combination of excavation of soil to levels approaching background, backfilling the excavated area, and off-site disposal of the excavated soil with (SDA-5B) or without (SDA-5A) solidification/stabilization as necessary for transport and disposal. It was assumed that the excavated soil could be disposed of at a permitted, hazardous waste landfill or a local non-hazardous waste landfill. Excavation depths of 1, 3, or 6 feet in 15 locations within the RCA were required to achieve background conditions.

Specifically, the components of this Removal Action alternative include:

- Excavation of approximately 7,520 CY of soil (Alternatives SDA-5A and SDA-5B);
- Backfilling the excavated areas with clean material from local sources (Alternatives SDA-5A and SDA-5B);

- Solidifying or stabilizing excavated soil prior to transport for disposal, if necessary (Alternative SDA-5B); and
- Transporting excavated materials by truck to a permitted facility for disposal (Alternatives SDA-5A and SDA-5B).

5.3.4 Southern Conservation Commission Area Soil Alternative Descriptions

No UCL exceedances or human health PRG exceedances were identified for the SCCA. However, exceedances of the mercury, antimony, lead, copper, barium, thallium, and zinc ecological PRGs in the surface soils were identified. To address these exceedances, five soil alternatives were developed for the SCCA including:

- No Action – Soil Alternative SCCA-1;
- Limited Action – Soil Alternative SCCA-2;
- Removal of Soil to Eliminate Ecological PRG Exceedances for Mercury and Lead– Soil Alternative SCCA-3 (3A or 3B);
- Removal of Soil to Eliminate All Ecological PRG Exceedances – Soil Alternative SCCA-4 (4A or 4B); and
- Removal of Soil to Approach Background – Soil Alternative SCCA-5 (5A, or 5B).

5.3.4.1 Soil Alternative SCCA-1 – No Action

The No Action alternative serves as a baseline for comparison of the overall effectiveness of the other remedial alternatives. The No Action alternative includes no remedial activities to remove, treat, or contain the COCs in Site soil within this RCA. This alternative relies on natural attenuation processes alone to reduce the concentrations of the COCs in the soil and to potentially attain the ROs, but does not include monitoring to document future COC concentrations.

5.3.4.2 Soil Alternative SCCA-2 – Limited Action

The Limited Action alternative is presented in Figure 5-10 and involves MNA of the soil with the ecological PRG exceedances. Non-engineering measures would not be implemented because they would not be effective in reducing the potential of ecological receptors coming into contact with the soil in theses areas.

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 two years, five years and, every five years after the year five monitoring through a 30-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 – Removal of Soil to Eliminate Ecological PRG Exceedances for Mercury and Lead

This Removal Action alternative is presented in Figure 5-11 and involves a combination of excavation, backfilling the excavated area, 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 and disposal. The surface soil would be excavated to eliminate all exceedances of the ecological PRG for mercury and lead. It was assumed that the excavated soil could be disposed of locally at a permitted, non-hazardous waste landfill. Excavation to 1 foot below the ground surface at four locations within the RCA was determined to be required as shown in Figure 5-11.

Specifically, the components of this Removal Action alternative include:

- Excavation of approximately 5,231 CY of soil (Alternatives SCCA-3A and SCCA-3B);
- Backfilling 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 permitted facility for disposal (Alternatives SCCA-3A and SCCA-3B); and
- Long term monitoring of the remaining ecological PRG exceedances.

5.3.4.4 Soil Alternative SCCA-4 – Removal of Soil to Eliminate All Ecological PRG Exceedances

This Removal Action alternative is presented in Figure 5-12 and involves a combination of excavation, backfilling of the excavated area, 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 and disposal. The surface soil would be excavated to eliminate all exceedances of the ecological PRGs for any contaminant. No long-term monitoring would be required as no further potential risk would exist within this RCA following the implementation of this alternative. It was assumed that the excavated soil could be disposed of locally at a permitted, non-hazardous waste landfill. Excavation to 1 foot below the ground surface at six locations was determined to be required as shown in Figure 5-12.

Specifically, the components of this Removal Action alternative include:

- Excavation of approximately 6,976 CY of soil (Alternatives SCCA-4A and SCCA-4B);
- Backfilling 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); and
- Transporting excavated materials by truck to a permitted facility for disposal (Alternatives SCCA-4A and SCCA-4B).

5.3.4.5 Soil Alternative SCCA-5 – Removal of Soil to Approach Background

This Removal Action alternative is presented in Figure 5-13 and involves a combination of excavation, backfilling the excavated area, and off-site disposal of the excavated soil with (SCCA-5B) or without (SCCA-5A) solidification/stabilization of the excavated soil as necessary for transport and disposal. No long-term monitoring would be required as no further potential risk would exist within this RCA following the implementation of this alternative. Soil would be excavated to concentrations approaching background and the excavated material would be disposed of off-site. It was assumed that the excavated soil could be disposed of locally at a permitted, non-hazardous waste landfill. Excavation to up to 3 feet below the ground surface at nine locations within the RCA was determined to be required as shown in Figure 5-13.

Specifically, the components of this Removal Action alternative include:

- Excavation of approximately 18,527 CY of soil (Alternatives SCCA-5A and SCCA-5B);
- Backfilling the excavated areas with clean material from local sources (Alternatives SCCA-5A and SCCA-5B);
- Solidifying or stabilizing excavated soil prior to transport for disposal, if necessary (Alternative SCCA-5B); and
- Transporting excavated materials by truck to a local, permitted facility for disposal (Alternatives SCCA-5A and SCCA-5B).

5.3.5 Marsh Upland Area Soil Alternative Descriptions

In the MUA, there were UCL exceedances for mercury, and human health and ecological PRG exceedances in soil for mercury, antimony, and copper. To address these exceedances, five soil alternatives were developed for the MUA:

- No Action – Soil Alternative MUA-1;
- Limited Action – Soil Alternative MUA-2;
- Removal of Soil to Eliminate UCL Exceedances for Mercury – Soil Alternative MUA-3 (3A or 3B);
- Removal of Soil to Eliminate Exceedances of UCLs and Human Health and Ecological PRGs – Soil Alternative MUA-4 (4A or 4B); and
- Removal of Soil to Approach Background – Soil Alternative MUA-5 (5A or 5B).

5.3.5.1 Soil Alternative MUA-1 – No Action

The No Action alternative serves as a baseline for comparison of the overall effectiveness of the other remedial alternatives. The No Action alternative includes no remedial activities to remove, treat, or contain the COCs in the soil within this RCA. This alternative relies on natural attenuation processes alone to reduce the concentrations of the COCs in the soil and to potentially attain the ROs, but does not include monitoring to document future COC concentrations.

5.3.5.1 Soil Alternative MUA-2 – Limited Action

The Limited Action alternative is presented in Figure 5-14 and involves a combination of MNA and non-engineering measures for the areas with soil that exceeds UCLs or human health or ecological PRGs. Non-engineering measures would be implemented by the owner(s), Cooperating Parties, local government, and/or regulatory agencies to reduce the likelihood that people would come into contact with the soil in the area of the UCL and human health PRG exceedances. Although non-engineering measures would not be effective in reducing the potential for ecological receptors to come into contact with the soil in the areas with ecological PRG exceedances, for the purposes of this evaluation, any area with only ecological PRG exceedances was 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, antimony, and copper) concentrations over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five monitoring through a 30-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 an appropriate AUL for this area;
- Installing and maintaining fencing and warning signs around the perimeter of the areas with UCL, human health, and ecological PRG exceedances; and
- Implementing 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.

5.3.5.2 Soil Alternative MUA-3 – Removal of Soil to Eliminate UCL Exceedances for Mercury and Co-Located Human Health and Ecological PRGs

This Removal Action alternative is presented in Figure 5-15 and involves a combination of excavation of soil with UCL exceedances for mercury and co-located human health and ecological PRGs, backfilling the excavated area, 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 and disposal. 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, areas with just ecological PRG exceedances outside the areas with UCL exceedances have not been separated out for just MNA under this alternative. It was assumed that the excavated soil could be disposed of at a permitted, hazardous waste landfill or a local non-hazardous waste landfill. To ensure complete removal of soil with concentrations above the UCL for lead, excavation depths of 1 to 6 feet were assumed in eight locations within the RCA.

Specifically, the components of this Removal Action alternative include:

- Excavation of approximately 325 CY of soil (Alternatives MUA-3A and MUA-3B);
- Backfilling 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 permitted disposal facility (Alternatives MUA-3A and MUA-3B);
- Establishing a monitoring program to collect and analyze soil samples to track soil COC (mercury, antimony, and copper) concentrations over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five monitoring through a 30-year monitoring period (or until such time as the COC concentrations in the area fall below the corresponding human health or ecological PRG) (Alternatives MUA-3A and MUA-3B);
- Implementing an appropriate AUL for this area;

- Installing and maintaining fencing and warning signs around the perimeter of the areas with ecological and human health PRG exceedances (Alternatives MUA-3A and MUA-3B); and
- Implementing 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).

5.3.5.3 Soil Alternative MUA-4 – Removal of Soil to Eliminate Exceedances of UCLs and Human Health and Ecological PRGs

This Removal Action alternative is presented in Figure 5-16 and involves a combination of excavation of soil with UCL exceedances for mercury and exceedances of human health or ecological PRGs, backfilling the excavated area, and off-site disposal of the excavated soil with (MUA-4B) or without (MUA-4A) solidification/stabilization as necessary for transport and disposal. It was assumed that the excavated soil could be disposed of at a permitted, hazardous waste landfill or a local non-hazardous waste landfill. To ensure complete removal of soil with concentrations above the PRGs, excavation depths of 1 to 6 feet at 18 locations within the RCA were identified as required.

Specifically, the components of this Removal Action alternative include:

- Excavation of approximately 1,876 CY of soil (Alternatives MUA-4A and MUA-4B);
- Backfilling the excavated areas with clean material from local sources (Alternatives MUA-4A and MUA-4B);
- Solidifying or stabilizing excavated soil prior to transport for disposal, if necessary (Alternative MUA-4B); and
- Transporting excavated materials by truck to a local, permitted facility for disposal (Alternatives MUA-4A and MUA-4B).

5.3.5.4 Soil Alternative MUA-5 – Removal of Soil to Approach Background

This Removal Action alternative is presented in Figure 5-17 and involves a combination of excavation of soil to levels approaching background, backfilling the area excavated, and off-site disposal of the excavated soil with (MUA-5B) or without (MUA-5A) solidification/stabilization as necessary for transport and disposal. It was assumed that the excavated soil could be disposed of at a permitted, hazardous waste landfill or a local non-hazardous waste landfill. To ensure complete removal of soil with concentrations above background, excavation depths of 1 to 6 feet at 18 locations within the RCA were identified as required.

Specifically, the components of this Removal Action alternative include:

- Excavation of approximately 2,067 CY of soil (Alternatives MUA-5A and MUA-5B);
- Backfilling the excavated areas with clean material from local sources (Alternatives MUA-5A and MUA-5B);
- Solidifying or stabilizing excavated soil prior to transport for disposal, if necessary (Alternative MUA-5B); and

- Transporting excavated materials by truck to a permitted facility for disposal (Alternatives MUA-5A and MUA-5B).

5.3.6 Cold Waste Soil Alternative Descriptions

In the CWA, there were UCL exceedances for antimony, barium, zinc, and lead, as well as human health and ecological PRG exceedances. There is also the potential presence of energetic munitions debris in the soil of the CWA. To address these exceedances, and the potential presence of energetic munitions, three soil alternatives were developed for the CWA including:

- No Action – Soil Alternative CWA-1;
- Limited Action – Soil Alternative CWA-2; and
- Removal of Soil with UCL, Human Health and Ecological PRG Exceedances, Potential Munitions Debris, and to Approach Background – Soil Alternative CWA-3 (3A and 3B)

5.3.6.1 Soil Alternative CWA-1 – No Action

The No Action alternative serves as a baseline for comparison of the overall effectiveness of the other remedial alternatives. The No Action alternative includes no remedial activities to remove, treat, or contain the COCs or potential munitions debris in the soil within this RCA. This alternative relies on natural attenuation processes alone to reduce the concentrations of the COCs in the soil and to potentially attain the ROs, but does not include monitoring to document future COC concentrations.

5.3.6.2 Soil Alternative CWA-2 – Limited Action

The Limited Action alternative is presented in Figure 5-18 and involves a combination of MNA and non-engineering measures for the areas with soil that exceeds UCLs or human health or ecological PRGs. Non-engineering measures would be implemented by the owner(s), Cooperating Parties, local government, and/or regulatory agencies to reduce the likelihood that people would come into contact with the soil or munitions debris in the area of the UCL and human health PRG exceedances. Although non-engineering measures would not be effective in reducing the potential for ecological receptors to come into contact with the soil in the areas with ecological PRG exceedances, for the purposes of this evaluation, any area with only ecological PRG exceedances was not separated out for just MNA under this alternative.

Specifically, the components of this Limited Action alternative are:

- Establishing a monitoring program to collect and analyze surface soil samples to track soil COC (antimony, barium, zinc, and lead) concentrations over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five monitoring through a 30-year monitoring period (or until such time as the COC concentrations in the area fall below their corresponding UCLs and PRGs).
- Implementing an appropriate AUL for this area;
- Installing and maintaining fencing and warning signs around the perimeter of the areas with UCL, human health, and ecological PRG exceedances and potential energetic munitions debris; and
- Implementing 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 and potential energetic munitions debris. Site workers would receive pre-work briefings.

5.3.6.3 Soil Alternative CWA-3 – Removal of Soil with UCL, Human Health and Ecological PRG Exceedances, Potential Munitions Debris, and to Approach Background

This Removal Action alternative is presented in Figure 5-19 and involves a combination of excavation, backfilling the excavated area, and off-site disposal of the excavated soil with (CWA-3B) or without (CWA-3A) solidification/stabilization of the excavated soil as necessary for transport and disposal. In addition, the excavated soil will be screened and sifted to remove any potential energetic munitions debris that may be present. No long-term monitoring would be required as no further potential toxic or explosive risk would remain in relation to the CWA following the implementation of this alternative. It was assumed that the excavated soil would be segregated and disposed of at a permitted non-hazardous or hazardous waste landfill. Excavation of 1 or 3 feet below the ground surface at five locations within the RCA was determined to be required.

Specifically, the components of this Removal Action alternative include:

- Excavation of approximately 1,054 CY of soil (Alternatives CWA-3A and CWA-3B);
- Backfilling the excavated areas with clean material from local sources (Alternatives CWA-3A and CWA-3B);
- Solidifying or stabilizing excavated materials prior to transport for disposal, if necessary (CWA-3B); and
- Transporting excavated materials by truck to a permitted facility for disposal (Alternatives CWA-3A and CWA-3B).

6.0 DEVELOPMENT AND SCREENING OF REMEDIAL TECHNOLOGIES AND ASSEMBLY OF REMEDIAL ALTERNATIVES FOR GROUNDWATER

The two groundwater upper concentration limit (UCL) exceedances for the Site identified during the Phase II and Phase III investigations (at PZ-24 and DPMW1) are listed in Table 1-1 and shown in Figure 1-2. No significant human health or environmental risks were identified in relation to exposure to the groundwater at this Site (TtEC, 2005). Therefore, the remedial action alternatives developed for groundwater at the Site only needed to address the UCL exceedances in order to meet the remedial objective (RO).

6.1 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

An initial screening of remedial technologies for groundwater was conducted in accordance with 310 Code of Massachusetts Regulations (CMR) 40.0856 to identify technologies that are reasonably likely to be feasible, based on oil and hazardous materials (OHM) present at the Site and the Site characteristics. After an initial screening, the remaining technologies were assembled into remedial action alternatives for groundwater. Table 6-1 details the initial screening of remedial technologies for the Site groundwater in the Southern Disposal Area (SDA) and Marsh Upland Area (MUA) where the UCL exceedances were observed.

The groundwater UCL exceedances, as identified in Table 1-1, were for metals, lead and mercury. Therefore, remedial technologies that were not applicable to these constituents were not put through the initial screening step. Such technologies included:

- 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);
- Air Stripping and GAC/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).

In consideration of the Site characteristics and circumstances (e.g., the Cooperating Parties of the Joint Defense Group do not own any of the properties that constitute the Site and the limited number (two) of groundwater UCL exceedances that exist), the following additional technologies were not subject to 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 groundwater remedial technologies retained from the initial screening, remedial action alternatives for groundwater in the SDA and MUA were assembled to address the UCL exceedances for lead and mercury, respectively. Tables 6-2 and 6-3 show the assembled groundwater remedial action alternatives for the two Risk Characterization Areas (RCAs) that exhibited groundwater UCL exceedances; PZ-24 in the SDA and DP-MW1 in the MUA, respectively. Detailed descriptions of each groundwater remedial action alternative are provided in Section 6.3. Selected remedial action alternatives for groundwater at these two locations were then incorporated into the five Site-wide remedial action alternatives (see Section 8) along with remedial action alternatives for the impacted soil and sediment.

6.3 DETAILED GROUNDWATER ALTERNATIVE DESCRIPTIONS

The following provides a detailed description of the groundwater remedial action alternatives and associated assumptions for each RCA with UCL exceedances.

6.3.1 Southern Disposal Area Groundwater Alternative Descriptions

There were no significant risks to human health or ecological receptors identified in relation to exposure to groundwater in the SDA. However, there is one groundwater UCL exceedance for lead at peizometer PZ-24. To address this exceedance, four groundwater remedial action alternatives were developed for the SDA including:

- 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 the baseline for comparison of the overall effectiveness of the other remedial action alternatives. The No Action alternative would not involve the implementation of any remedial activities to remove, treat, or contain the lead in the groundwater beneath the SDA. This alternative relies solely on natural attenuation processes to potentially reduce the concentrations of lead in the groundwater to the point where the UCL is no longer exceeded. This alternative also does not include any monitoring to assess future lead concentrations in the groundwater.

6.3.1.2 Groundwater Alternative SDGW-2 – Limited Action

The Limited Action alternative involves a combination of monitored natural attenuation (MNA) and the implementation of non-engineering institutional controls relative to the groundwater beneath the SDA. Non-engineering measures would be implemented by the owner(s), Cooperating Parties, local government, and/or regulatory agencies to reduce the potential for people to come into contact with the groundwater in the area of the UCL exceedance.

Specifically, the components for this Limited Action alternative include:

- Establishing a monitoring program to collect and analyze groundwater samples at PZ-24 to track the concentrations of lead over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five monitoring event through a 30-year monitoring period (or until such time as the lead concentration in the area falls below its UCL).

6.3.1.3 Groundwater Alternative SDGW-3 – Source Removal

This Removal Action is presented in Figure 6-1 and assumes that elevated lead concentrations within the SDA soils are contributing to the lead UCL exceedance in groundwater in this area. Thus, removal of these source area soils would result in a corresponding reduction of lead in the local groundwater. Under this alternative, soil in the SDA with lead concentrations exceeding the soil UCL for lead would be excavated and disposed of off-site. Any groundwater pooling up in the excavations would be collected, treated, and discharged at the Site via a permitted outfall. Post-excavation monitoring of the groundwater at the area of the groundwater UCL exceedance for lead at PZ-24 would then be implemented. An excavation depth of 2 or 3 feet would be necessary at three locations within the RCA to ensure the complete removal of soil with concentrations above the soil UCL for lead.

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

- Excavation of approximately 726 CY of soil (Note: this alternative has the same excavation and backfill footprint as soil alternative SDA-3);
- Backfilling the excavated area with clean material;
- Treatment of any groundwater pooled in the excavation and any water separated from soil by filtration and granular activated carbon (GAC) and discharge on-site at a permitted outfall;
- Transporting excavated soil by truck to a suitable, permitted disposal facility; and
- Establishing a monitoring program to collect and analyze groundwater samples at PZ-24 to track groundwater lead concentrations over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five monitoring through a 30-year monitoring period (or until such time as the lead concentrations fall below the corresponding UCL).

6.3.1.4 Groundwater Alternative SDGW-4 – Extensive Source Removal

This more extensive Removal Action is presented in Figure 6-2 and again assumes that lead concentrations within the SDA soils are contributing to the lead UCL exceedance in the groundwater. Under this alternative, soil in the SDA with lead concentrations exceeding the soil UCL for lead and any soil with human health or ecological PRG exceedances for lead would be excavated and disposed of off-site. Any groundwater pooling up in the excavation would be collected, treated, and discharged at the Site via a permitted outfall. Post-excavation monitoring of the groundwater at the area of the groundwater UCL exceedance for lead at PZ-24 would then be implemented. An excavation depth of 2 to 3 feet would be necessary at 12 locations within the RCA to ensure the complete removal of soil with concentrations above the soil UCL or the human health or ecological preliminary remediation goals (PRGs) for lead.

Specifically, the components of this more extensive source removal option to address the groundwater UCL, human health, or ecological PRG exceedances for lead include:

- Excavation of approximately 6,648 CY of soil in the subareas where there is a soil UCL exceedance for lead or where the lead concentrations in soil exceed the human health or ecological PRGs for soil (Note: this alternative has the same excavation and backfill footprint as soil alternative SDA-4);

- Backfilling the excavated areas with clean material;
- Treatment of any groundwater pooled in the excavation and any water separated from soil by filtration and GAC and discharge on-site at a permitted outfall;
- Transporting excavated soil by truck to a suitable, permitted disposal facility; and
- Establishing a monitoring program to collect and analyze groundwater samples at PZ-24 to track groundwater lead concentrations over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five monitoring event through a 30-year monitoring period (or until such time as the lead concentrations fall below the corresponding UCL).

6.3.2 Marsh Upland Area Groundwater Alternative Descriptions

There were no significant risks to human health or ecological receptors identified in relation to exposure to groundwater in the MUA. However, there is one groundwater UCL exceedance for mercury at monitoring well DP-MW1. To address this exceedance, four groundwater remedial action alternatives were developed for the MUA including:

- 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 the baseline for comparison of the overall effectiveness of the other remedial action alternatives. The No Action alternative would not involve the implementation of any remedial activities to remove, treat, or contain the mercury in the groundwater beneath the MUA. This alternative relies solely on natural attenuation processes to potentially reduce the concentrations of mercury in the groundwater to the point where the UCL is no longer exceeded. This alternative also does not include any monitoring to assess future mercury concentrations in the groundwater.

6.3.2.2 Groundwater Alternative MUGW-2 – Limited Action.

The Limited Action alternative involves a combination of MNA and the implementation of non-engineering institutional controls relative to the groundwater beneath the MUA. Non-engineering measures would be implemented by the owner(s), Cooperating Parties, local government, and/or regulatory agencies to reduce the potential for people to come into contact with the groundwater from 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 concentrations of mercury over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five event monitoring through a 30-year monitoring period (or until such time as the mercury concentration in the area falls below its UCL).

6.3.2.3 Groundwater Alternative MUGW-3 – Source Removal

This Removal Action alternative is presented in Figure 6-3 and assumes that elevated mercury concentrations within the MUA soils are contributing to the mercury UCL exceedance in groundwater in this area. Thus, removal of these source area soils would result in a corresponding reduction of mercury in the local groundwater. Under this alternative, soil in the MUA with mercury concentrations exceeding the mercury soil UCL would be excavated and disposed of off-site. Any groundwater pooling up in the excavations would be collected, treated, and discharged at the Site via a permitted outfall. Post-excavation monitoring of the groundwater at the area of the groundwater UCL exceedance for mercury at DP-MW1 would then be implemented. Excavation depths between 3 and 6 feet would be necessary at eight locations within the RCA to ensure the complete removal of soil with concentrations above the soil UCL for mercury.

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

- Excavation of approximately 325 CY of soil (Note: this alternative has the same excavation and backfill footprint as soil alternative MUA-3);
- Backfilling the excavated area with clean material;
- Treatment of any groundwater pooled in the excavation and any water separated from soil by filtration and GAC and discharge on-site at a permitted outfall;
- Transporting excavated soil by truck to a suitable, permitted disposal facility; and
- Establishing a monitoring program to collect and analyze groundwater samples at DP-MW1 to track groundwater mercury concentrations over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five monitoring through a 30-year monitoring period (or until such time as the mercury concentrations fall below the corresponding UCL).

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

6.3.2.4 Groundwater Alternative MUGW-4 – Extensive Source Removal

This Removal Action Alternative is presented in Figure 6-4 and again assumes that mercury concentrations within the MUA soils are contributing to the mercury UCL exceedance in the groundwater. Under this alternative, however, the soil in the MUA with mercury concentrations exceeding the soil UCL for mercury or any soil with human health or ecological PRG exceedances for mercury would be excavated and disposed of off-site. Any groundwater pooling up in the excavation would be collected, treated, and discharged at the Site via a permitted outfall. Post-excavation monitoring of the groundwater at the area of the groundwater UCL exceedance for mercury at DP-MW1 would then be implemented. Excavation depths from 3 to 6 feet would be necessary at 18 locations within the RCA to ensure the complete removal of soil with concentrations above the soil UCL or the human health or ecological PRGs for mercury.

Specifically, the components of this more extensive source removal option to address the groundwater UCL or the human health or ecological PRG exceedances for mercury include:

- Excavation of approximately 1,876 CY of soil in the subareas where there is a soil UCL exceedance for mercury or where the mercury concentration in the soil exceeds the human health or ecological PRGs for soil (Note: this alternative has the same excavation and backfill footprint as soil alternative MUA-4);
- Backfilling the excavated areas with clean material;
- Treatment of any groundwater pooled in the excavation and any water separated from soil by filtration and GAC and discharge on-site at a permitted outfall;
- Transporting excavated soil by truck to a suitable, permitted disposal facility; and
- Establishing a monitoring program to collect and analyze groundwater samples at DP-MW1 to track groundwater mercury concentrations over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five monitoring through a 30-year monitoring period (or until such time as the mercury concentrations fall below the corresponding UCL).

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

The Massachusetts Department of Environmental Protection (MassDEP) has not established upper concentration limits (UCLs) for sediment and, as previously discussed, the risk-based ecological preliminary remediation goal (PRG) for mercury in sediment that would be protective of all identified ecological receptors at the Site is well below the measured Site-specific background concentrations for mercury in sediment. Therefore, during the development and screening of remedial technologies and the assembly of remedial alternatives for sediment, a strategy was followed that resulted in a reduction in the surface weighted average concentration of total mercury in sediment. This reduced level is protective of human health and ecological endpoints with PRGs greater than the background concentration (as defined by the revised remedial objectives (ROs)). Alternatives were defined to achieve this level of mercury reduction on both a Site-wide basis (i.e., across the complete set of streams and ponds) and also for the individual stream segments and ponds identified as Risk Characterization Areas (RCAs). Remedial technologies to reduce the surface weighted average total mercury concentration in sediment were identified and screened, and technologies that were retained as feasible were assembled into remedial alternatives for sediment.

7.1 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

An initial screening of remedial technologies for sediment was conducted in accordance with 310 Code of Massachusetts Regulations (CMR) 40.0856 to identify technologies that are reasonably likely to be feasible, based on the oil and hazardous materials (OHM) present at the Site, the Site sediments that are contaminated, and the characteristics of the Site. After this initial screening, the remaining technologies were assembled into remedial action alternatives for sediment. 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 technologies would be available, regardless of arrangements for securing their services.

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

The human health and ecological risks posed by the Site sediments, as identified in Table 4-2, are related to metals (antimony, arsenic, beryllium, lead, total mercury (THg), methyl mercury (MeHg), selenium, thallium, and zinc), polycyclic aromatic hydrocarbons (PAHs) (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene), and volatile organic compounds (VOCs) (i.e., 1,1,-dichloroethene (1,1-DCE), trichloroethene (TCE) and vinyl chloride). Therefore, remedial technologies that were not applicable to address metals, PAHs, or VOCs were not put through the initial screening step. Also, technologies that were not, in general, applicable to sediments were not subject to the initial screening. These technologies include:

- Bioventing and Enhanced Bioremediation (both are in-situ biological treatment technologies);
- Chemical Oxidation (an in-situ chemical treatment technology);
- Soil Vapor Extraction (an in-situ physical treatment technology);

- Ex-Situ Biological Treatment technologies (including biopiles, composting, landfarming, and slurry phase biological treatment);
- Dehalogenation (an ex-situ chemical treatment technology); and
- Ex-Situ Thermal Treatment technologies (including pyrolysis, thermal desorption, and incineration).

In consideration of the Site characteristics and circumstances (e.g., 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 subject to the initial screening step:

- Phytoremedation after removal;
- On-Site Upland Disposal;
- Near-Shore 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, remedial alternatives for the sediments were assembled. Table 7-2 shows the assembled remedial alternatives for the sediments in the streams and ponds (exclusive of the sediment in the Marsh Upland Area (MUA)). Table 7-3 presents the assembled remedial alternatives specifically for the sediment in the MUA.

For each sediment alternative, the projected post-remediation surface-weighted average THg concentration, the mass of the primary chemicals of concern (COCs) that would be removed, the affected sediment volume, and the reductions to the projected human health and ecological risks were calculated. Thiessen polygons were used to define individual areas of influence around each of the sediment sample locations within the overall sediment sampling network for use in these calculations. The automatically-derived polygons were then adjusted to account for the measured 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 and are presented in Figures 7-1 through 7-4. The Site-wide surface weighted average THg concentration in sediment for each alternative was calculated using the post-remediation concentration for each SMU (see Tables 7-2 and 7-3). It should be noted that the SMU numbers for some areas have changed from the 2007 Draft Phase III Remedial Action Plan (RAP) as a result of the Phase III supplemental sampling.

A detailed description of each sediment alternative is presented in Sections 7.3 and 7.4 below for the general stream and pond areas and the MUA, respectively. The remedial alternatives for sediment were then assembled into Site-wide remedial alternatives (see Section 8), which also include remedial alternatives to address the Site soil and groundwater.

7.3 DETAILED SEDIMENT ALTERNATIVE DESCRIPTIONS (EXCLUSIVE OF ALTERNATIVES FOR THE MUA SEDIMENT AREA)

Mercury sediment concentrations within the Eastern Channel Corridor (ECC), Lower Drinkwater River Corridor (LDRC), Lily Pond/Upper Factory Pond (LP/UFP), and Middle/Lower Factory Pond (M/LFP) RCAs exceeded the Site-specific human health and ecological preliminary remediation goals (PRGs) for THg. THg was by far used as the design basis COC for the Site-wide sediment since mercury contamination in the waterways was the most widespread. In addition, the removal of sediment to meet the THg PRGs would also result in removal to meet the sediment PRGs for the other COCs due to their co-location. To address these exceedances, six remedial alternatives were developed for these RCAs:

- No Action – Sediment Alternative 1;
- Limited Action – Sediment Alternative 2;
- Removal of Sediment in the ECC Only – Sediment Alternative 3;
- Removal of Sediment to Eliminate Site-wide Mercury Exceedances of Human Health and Ecological PRGs – Sediment Alternative 4;
- Removal of Sediment to Eliminate Surface Weighted Average Total Mercury Exceedances of Human Health and Ecological PRGs in Each RCA – Sediment Alternative 5; and
- Widespread Removal of Sediment to Approach Background – Sediment Alternative 6.

There were no human health or ecological PRG exceedances for sediment in the Upper Drinkwater River Corridor (UDRC) (SMUs 9, 10, and 11). As such, the six remedial alternatives do not include any sediment response action in this RCA. The general assumptions made for all of the sediment alternatives are as follows:

- For all sediment alternatives that include the dredging or excavation of sediment, it has been assumed that backfill of the excavation to match the existing below water grade would be required.
- Backfill material will be clean material and will be tested prior to its use to ensure that COC levels are less than the sediment PRGs established for the Site.
- Excavated/dredged material will be required to pass the Paint Filter Liquids Test (PFLT) prior to transport for off-site disposal, and excavated/dredged material will be solidified, if necessary, to pass the PFLT.
- For alternatives that include removal of sediments from the ECC, the intent of the removal action is to remove all of the sediment within the ECC such that there is no need for any continuing management of potential risks except for the potential indirect risk associated with fish consumption.
- For areas requiring long-term monitoring of sediment COC concentrations, a 30-year monitoring period was assumed.

7.3.1 Sediment Alternative 1 – No Action

The No Action alternative serves as a baseline for comparison of the overall effectiveness of the other remedial alternatives. The No Action alternative includes no remedial activities to remove, treat, or contain the COCs in Site sediment. This alternative relies on natural attenuation processes alone to reduce the concentrations of the COCs in the sediment to potentially attain the ROs, but does not include monitoring to document future COC concentrations in the sediments.

7.3.2 Sediment Alternative 2 – Limited Action

This Limited Action alternative involves a combination of monitored natural recovery (MNR) for the sediments with human health or ecological PRG exceedances in the ECC, LDRC, LP/UFP, and M/LFP, and non-engineering measures for the Site. Consistent with common usage, the term MNR is used in this Revised Phase III RAP for sediment recovery and MNA is used for groundwater and soil recovery. As previously stated, non-engineering measures generally include measures taken by the owner, Cooperating Parties, local government, and/or regulatory agencies to reduce the potential of human receptors coming into contact with affected environmental media (in this case, contaminated sediment or biota affected by contaminated sediment).

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 (that may reduce their concentration and/or toxicity); and
2) The natural deposition of un-impacted sediments over the contaminated sediments (reducing the mobility and bioavailability of the COCs present).

Provided that ongoing sources of contamination are eliminated or are very 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 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 two years, five years, and every five years after the year five monitoring through a 30-year monitoring period;
- Implementing an appropriate activity and use limitation (AUL) for the sediments in areas associated with significant potential human health risks;
- Posting and maintaining warning signs regarding the area-wide fish consumption advisory along the banks of the ECC, LDRC, L/UFP, and M/LFP. 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 and fishing 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 of Sediment in the ECC Only

This Limited Action alternative is presented in Figure 7-1 and involves a combination of excavation, solidification of the excavated material as necessary for transport and disposal, off-site treatment as necessary to meet land disposal restrictions (LDRs), disposal of the excavated sediment, and limited implementation of non-engineering measures. Removal will occur in SMUs 2 through 8 and the required removal depth varies from 0.4 to 2 feet along the channel. It should be recalled that the limited removal of soil associated with the soil UCL exceedance in the Upper North Area (UNA) has been included as part of this alternative given the location of the UCL exceedance at the bank of the ECC. The intent of this removal action is to remove all sediment from within the ECC such that no long term management of potential risks is required, except for the potential risk associated with fish consumption. Long-term monitoring would be required in SMUs 12 through 69 as the projected post-remediation THg concentrations within the other RCAs with contaminated sediment exceed the human health and ecological PRGs.

Specifically, the components of this Limited Action alternative include:

- Excavation of approximately 2,529 CY of sediment in the ECC from SMUs 2 through 8;
- Solidification of excavated material as necessary for transportation and disposal;
- Transportation of excavated material by truck and rail to a permitted hazardous waste-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 THg concentrations and mercury concentrations in fish tissue over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five monitoring through a 30-year monitoring period;
- Implementing an appropriate activity and use limitation (AUL) for the sediments in areas associated with significant potential human health risks;
- Posting and maintaining warning signs regarding the area-wide fish consumption advisory along the banks of the ECC, LDRC, L/UFP, and M/LFP. 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 and fishing of the health and safety considerations associated with COC-impacted sediments. It is important to note that site workers would receive pre-work briefings.

7.3.4 Sediment Alternative 4 – Removal of Sediment to Eliminate Exceedances of Human Health and Ecological PRGs for Mercury on a Site-Wide Average Basis

This Limited Action alternative is presented in Figure 7-2 and involves a combination of excavation/dredging, solidification of the excavated material as necessary for transport, off-site treatment (as necessary to meet LDRs) and disposal of the sediment excavated, and limited implementation of non-engineering measures. These measures are designed to reduce the projected post-remediation THg concentration in sediments to meet the identified human health and ecological PRGs on a Site-wide average basis. Removal/dredging will occur in SMUs 2 through 8, 19, 22, 24 through 27, 29, 63 and 64, with required removal depths between 0.4 and 2.5 feet, depending on the SMU. Specifically, the components of this Limited Action alternative include:

- Excavation of approximately 24,077 CY of sediment from the identified SMUs;

- Solidification of excavated material as necessary for transport;
- Transportation of excavated material by truck and rail to either a permitted hazardous waste or non-hazardous waste 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 THg concentrations and mercury concentrations in fish tissue over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five monitoring through a 30-year monitoring period;
- Implementing an appropriate activity and use limitation (AUL) for the sediments in areas associated with significant potential human health risks;
- Posting and maintaining warning signs regarding the area-wide fish consumption advisory along the banks of the ECC, LDRC, L/UFP, and M/LFP. 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 and fishing of the health and safety considerations associated with COC-impacted sediments. It is important to note that site workers would receive pre-work briefings.

7.3.5 Sediment Alternative 5 – Removal of Sediment to Eliminate Exceedances of Human Health and Ecological PRGs for Mercury in Each RCA

This Removal Action alternative is presented in Figure 7-3 and involves a combination of excavation/dredging, solidification of the excavated material as necessary for transport, off-site disposal, and limited implementation of non-engineering measures. These measures are designed to reduce the projected post-remediation total mercury concentration in sediments in each individual aquatic RCA to meet the identified human health and ecological PRGs. Removal/dredging will occur in SMUs 2 through 8, 19, 22, 24 through 27, 29, 52, 63 and 64, and the required removal depths range between 0.4 and 2.5 feet, depending on the SMU. Specifically, the components of this more extensive Removal Action alternative include:

- Excavation of approximately 25,097 CY of sediment;
- Solidification of excavated material as necessary for transport;
- Transportation of excavated material by truck and rail to either a permitted hazardous waste or non-hazardous waste 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 two years, five years, and every five years after the year five monitoring through a 30-year monitoring period; and
- Posting and maintaining warning signs regarding the area-wide fish consumption advisory along the banks of the ECC, LDRC, L/UFP, and M/LFP. Signage would likely be posted at public access points to the river, channel, and ponds.

7.3.6 Sediment Alternative 6 – Removal of Sediment to Approach Background

This most extensive Removal Action alternative is presented in Figure 7-4 and involves a combination of excavation/dredging, solidification of the excavated material as necessary for transport, off-site disposal of the sediment excavated/dredged, and limited implementation of non-engineering measures. These measures are designed to reduce the projected post-remediation THg concentration in sediments to approach the Site sediment background concentration of 0.62 mg/Kg. Removal/dredging will occur in all SMUs except SMUs 1, 9, 10, and 11, and the required removal depths range between 0.4 and 4 feet, depending on the SMU. Specifically, the components of this extensive Removal Action alternative include:

- Excavation of approximately 205,050 CY of sediment;
- Solidification of excavated/dredged material as necessary for transport;
- Transportation of excavated material by truck and rail to either a permitted hazardous waste or non-hazardous waste 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 fish tissue samples to track mercury concentrations in fish tissue over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five monitoring through a 30-year monitoring period; and
- Posting and maintaining warning signs regarding the area-wide fish consumption advisory along the banks of the ECC, LDRC, L/UFP, and M/LFP. Signage would likely be posted at public access points to the river, channel and ponds.

7.4 DETAILED SEDIMENT ALTERNATIVE DESCRIPTIONS FOR THE MARSH UPLAND AREA

Mercury sediment concentrations within the MUA exceeded the Site-specific human health and ecological PRGs for total mercury. THg was used as the design basis COC for the Site-wide sediment since mercury contamination in the waterways was the most widespread. In addition, the removal of sediment to meet the THg PRGs would also result in removal to meet the sediment PRGs for the other COCs due to their co-location. To address these exceedances, four remedial alternatives were developed for the MUA sediments:

- No Action – MUA Sediment Alternative 1;
- Limited Action – MUA Sediment Alternative 2;
- Removal of Sediment to Eliminate Mercury Concentration Exceedances of Human Health and Ecological PRGs – MUA Sediment Alternative 3; and
- Widespread Removal of Sediment to Approach Background – MUA Sediment Alternative 4.

Detailed descriptions of these four alternatives are presented in Sections 7.4.1 through 7.4.4 below.

7.4.1 MUA Sediment Alternative 1 – No Action

The No Action alternative serves as a baseline for comparison of the overall effectiveness of the other remedial alternatives. The No Action alternative includes no remedial activities to remove, treat, or contain the COCs in Site sediment. This alternative relies on natural attenuation processes alone to reduce the concentrations of the COCs in the sediment and to potentially attain the ROs, but does not include monitoring to document future COC concentrations.

7.4.2 MUA Sediment Alternative 2 – Limited Action

This Limited Action alternative is presented in Figure 7-5 and involves MNR of the MUA sediments with human health and ecological PRG exceedances for mercury and implementation of non-engineering measures. As previously stated, non-engineering measures generally include measures that would be taken by the owner(s), Cooperating Parties, local governments, and/or regulatory agencies to reduce the potential of human receptors coming into contact with affected environmental media (in this case, contaminated sediment or biota affected by contaminated sediment).

Specifically, the components of this Limited Action alternative include:

- Establishing a monitoring program to collect and analyze sediment and fish tissue samples to track sediment THg concentrations and mercury concentrations in fish tissue over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five monitoring through a 30-year monitoring period;
- Posting and maintaining warning signs regarding the area-wide fish consumption advisory along the banks of the MUA. Signage would likely be posted at public access points to the river, channel and ponds;
- Installing and maintaining warning signs around the perimeter of the MUA sediment identifying potential human health risks associated with MUA sediment;
- Implementing an appropriate activity and use limitation (AUL) for the sediment associated with significant potential human health risks;
- 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 and fishing of the health and safety considerations associated with COC-impacted sediments. Site workers would receive pre-work briefings; and
- 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 two years, five years, and every five years after the year five monitoring through a 30-year monitoring period.

7.4.3 MUA Sediment Alternative 3 – Removal of Sediment to Eliminate Exceedances of Human Health and Ecological PRGs for Mercury

This Removal Action alternative is presented in Figure 7-6 and involves a combination of excavation/dredging, solidification of the excavated material as necessary for transport, off-site treatment (as necessary to meet LDRs) and disposal of the sediment excavated, and limited implementation of non-engineering measures. These measures are designed to reduce the projected post-remediation surface-weighted average THg concentration in the MUA Sediment Area to meet the identified human health and ecological PRGs for total mercury. Removal/dredging will occur only in MUA SMU 2 to a required removal depth of 3 feet.

Specifically, the components of this Limited Action alternative include:

- Excavation of approximately 410 CY of sediment;
- Stabilization of excavated material as necessary for transport;
- Transportation of excavated material by truck and rail to either a permitted hazardous waste 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 samples to track sediment THg concentrations over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five monitoring through a 30-year monitoring period; and
- Installation and maintenance of signs around the perimeter of the MUA Sediment Area regarding the potential human health risks associated with the presence of COC-impacted sediments.

7.4.4 MUA Sediment Alternative 4 – Removal of Sediment to Approach Background

This most extensive Removal Action alternative is presented in Figure 7-7 and involves a combination of excavation, solidification of the excavated material as necessary for transport, and off-site treatment and disposal of the excavated sediment. This alternative reduces the projected post-remediation total mercury concentration in the sediments of this area to approach the Site sediment background concentration of 0.62 mg/Kg. Excavation of sediment from MUA SMUs 2, 3, 7, 8, and 11 through 15 will be performed and the required removal depth is either 3 or 4 feet, depending on the SMU. Specifically, the components of this extensive Removal Action alternative include:

- Excavation of approximately 4,714 CY of sediment;
- Solidification of excavated material as necessary for transport;
- Transportation of excavated material by truck and rail to either a permitted hazardous waste or non-hazardous waste 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 fish tissue samples to track mercury concentrations in fish tissue over time. It is assumed that monitoring would occur once at two years, five years, and every five years after the year five monitoring through a 30-year monitoring period; and
- Posting and maintaining warning signs regarding the area-wide fish consumption advisory along the banks of the MUA.

8.0 ASSEMBLY AND COMPARATIVE ANALYSIS OF SITE-WIDE REMEDIAL ALTERNATIVES

The media-specific soil, sediment and groundwater alternatives were assembled into Site-wide Alternatives (SWAs). Five SWAs were assembled for further evaluation in the detailed comparative analysis that was performed for the Draft Phase III Remedial Action Plan (RAP) (i.e., SWAs 1 through 5). For continuity, these same five basic SWAs were retained for the Revised RAP and they were assigned the same SWA numbers they had in the Draft RAP. However, based on the Phase III supplemental sampling program results, the scope of these five alternatives were either reduced or expanded for the specific upland or aquatic areas consistent with the overall remedial objectives (ROs). For example, the work needed to remediate the Cold Waste Area (CWA) was incorporated into the Revised RAP as applicable to each alternative. Also, the Phase III supplemental investigation results were used to confirm where removal or monitoring activity was warranted and to refine the required action boundary footprints for all areas. Following some initial comparative analysis of these five SWAs using the Phase III supplemental investigation data, SWA 4 was tailored to define two sub-alternatives for further consideration. The original SWA 4 was renumbered as SWA 4-3, and the two new sub-alternatives were numbered SWA 4-1 and SWA 4-2.

Each of the seven SWAs considered in this Revised RAP consists of retained general response actions, process options, and remedial technologies that have been discussed in Sections 5, 6, and 7. Table 8-1 provides a listing of the retained media-specific soil, groundwater, and sediment alternatives for each applicable RCA that were used to assemble the SWAs.

8.1 DESCRIPTION OF THE ASSEMBLED SITE-WIDE ALTERNATIVES

Seven SWAs were developed to address the identified soil, groundwater, and sediment ROs for the Site. Table 8-2 presents and briefly describes the individual soil, sediment, and groundwater alternatives that were incorporated into each SWA. An expanded version of this mapping of the media-specific alternatives onto the SWAs is presented in the Alternatives Summary Guide that may be referred to for the remaining discussions in this section (this Guide is located in the back pocket of the report binder). A description of each of the SWAs is presented below.

8.1.1 SWA 1 – Monitored Natural Attenuation/Recovery and Non-Engineering Measures

SWA 1 includes monitored natural attenuation for the impacted soil and groundwater, monitored natural recovery for the impacted sediment at the Site, and the implementation of non-engineering measures (see Figure 8-1). A list of the specific soil, sediment, and groundwater alternatives that were combined to assemble SWA 1 is provided in Table 8-2. SWA 1 would result in a Temporary Solution under the Massachusetts Contingency Plan (MCP).

8.1.2 SWA 2 – Targeted Source Removal

SWA 2 includes the removal of the sediment in the Eastern Channel Corridor (ECC) with high contaminant concentrations and the soil in the CWA with high contaminant concentrations that is acting as a continuing source of contaminant release and migration in the aquatic environment at the Site (see Figure 8-2). The remedial activities in the CWA also would include removal of any munitions debris items from the CWA that may pose an explosive safety threat. SWA 2 includes monitored natural attenuation for the remaining impacted soil and monitored natural recovery for the remaining impacted sediment in other areas of the Site. A set of non-engineering measures also would be implemented. The groundwater response would include monitored natural attenuation and the application of activity and use limitations (AULs) as needed to address significant potential human health exposures. A list of the specific soil, sediment, and groundwater alternatives that were combined to assemble SWA 2 is provided in Table 8-2. SWA 2 would result in a Temporary Solution under the MCP.

8.1.3 SWA 3 – Targeted Source Removal, the Elimination of Soil and Groundwater UCL Exceedances at the Disposal Areas, and Meeting Sediment PRGs for Mercury on a Site-Wide Average Basis

SWA 3 builds on and adds to SWA 2. In addition to the soil removal associated with SWA 2, soil that exceeds the soil upper concentration limits (UCLs) and which is indicated to be causing the groundwater UCL exceedances at the Southern Disposal Area (SDA) and the Marsh Upland Area (MUA) would be removed (see Figure 8-3). If additional soil removal is necessary in these areas to meet the Site-specific human health and ecological preliminary remediation goals (PRGs) developed for soil, that removal also would be performed as part of SWA 3. SWA 3 includes sufficient sediment hot spot source removal in the streams and ponds to allow the human health and ecological PRGs for sediment to be met on a Site-wide average basis. SWA 3 also includes monitored natural attenuation for the remaining impacted soil outside the disposal areas, monitored natural recovery for the remaining impacted sediment in other areas of the Site, and a monitoring program to collect and analyze mercury in fish. A set of non-engineering measures also would be implemented (including fencing, warning signs, and educational programs). The groundwater response would include monitored natural attenuation and the application of AULs as needed to address significant potential human health exposures. A list of the specific soil, sediment, and groundwater alternatives that were combined to assemble SWA 3 is provided in Table 8-2. SWA 3 would result in a Permanent Solution under the MCP.

8.1.4 SWA 4-1 – Targeted Source Removal, the Elimination of Soil and Groundwater UCL Exceedances, Meeting Human Health and Ecological PRGs in the Disposal Areas, Meeting Human Health PRGs for all COCs in the Non-Disposal Areas, and Meeting Sediment PRGs for Mercury on a Site-Wide Average Basis

SWA 4-1 builds on and adds to SWA 3. In addition to the soil removal associated with SWA 3, SWA 4-1 includes additional soil removal in the non-disposal areas (i.e., the Potential Greenway Area (PGA) and the Southern Conservation Commission Area (SCCA)) to meet the human health PRGs for all of the chemicals of concern (COCs) associated with these two areas (see Figure 8-4). A list of the specific soil, sediment, and groundwater alternatives that were combined to assemble SWA 4-1 is provided in Table 8-2. SWA 4-1 would result in a Permanent Solution under the MCP.

8.1.5 SWA 4-2 – Targeted Source Removal, the Elimination of Soil and Groundwater UCL Exceedances, Meeting Human Health and Ecological PRGs in the Disposal Areas, Meeting Human Health and Ecological PRGs for Mercury and Lead, and Meeting Sediment PRGs for Mercury on a Site-Wide Average Basis

SWA 4-2 also builds on and adds to SWA 3. In addition to the soil removal associated with SWA 3, SWA 4-2 includes additional soil removal in the non-disposal areas (i.e., the PGA and the SCCA) to meet all of the human health and ecological PRGs for the two primary COCs for the Site (mercury and lead) in all areas of the Site (see Figure 8-5). A list of the specific soil, sediment, and groundwater alternatives that were combined to assemble SWA 4-2 is provided in Table 8-2. SWA 4-2 would result in a Permanent Solution under the MCP.

8.1.6 SWA 4-3 – Targeted Source Removal, the Elimination of Soil and Groundwater UCL Exceedances, Meeting All Human Health and Ecological PRGs for Soil for All COCs in All Areas, and Meeting Sediment PRGs for Mercury in Each RCA

SWA 4-3 also builds on and adds to SWA 3. In addition to the soil removal associated with SWA 3, SWA 4-3 includes additional soil removal in the non-disposal areas (i.e., the PGA and the SCCA) to meet all of the human health and ecological PRGs for all COCs in all areas of the Site (see Figure 8-6). SWA-4-3 also includes sufficient sediment hot spot source removal in the streams and ponds to allow the human health and ecological PRGs for sediment to be met separately in each sediment-specific RCA. A list of the specific soil, sediment, and groundwater alternatives that were combined to assemble SWA 4-3 is provided in Table 8-2. SWA 4-3 would result in a Permanent Solution under the MCP.

8.1.7 SWA 5 – Approaching Background

SWA 5 builds on and adds significantly to SWA 4-3. SWA 5 includes much more Site-wide soil and sediment removal to allow the soil and sediment to meet their Site-specific human health and ecological PRGs, to eliminate soil and groundwater UCL exceedances, and for the soil and sediment to approach background concentrations. SWA 5 also includes a monitoring program to collect and analyze mercury in fish. A set of non-engineering measures also would be implemented (including fencing, warning signs, and educational programs) as needed. The groundwater response would include monitored natural attenuation and the application of AULs for the groundwater until such time as the groundwater quality improved to meet the ROs (see Figure 8-7). A list of the specific soil, sediment, and groundwater alternatives that were combined to assemble SWA 5 is provided in Table 8-2. SWA 5 would result in a Permanent Solution under the MCP.

8.2 Description of the Evaluation Criteria

The assembled SWAs 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 implementation;
4. Comparative costs;
5. Comparative risks;
6. Comparative benefits;
7. Comparative timeliness in terms of eliminating any uncontrolled sources of OHM and achieving a level of No Significant Risk; and
8. Relative impact on non-pecuniary interests (such as aesthetic values).

8.3 Detailed Comparative Evaluation of Remedial Action Alternatives

A detailed qualitative comparative analysis was performed of the seven SWAs. Using the evaluation criteria from 310 Code of Massachusetts Regulations (CMR) 40.0858 identified above in Section 8.2, each of the SWAs was qualitatively ranked for each of the eight criteria. Five qualitative rankings were used for this evaluation:

HIGH	Indicates that the alternative would have good performance relative to that criterion
MODERATE / HIGH	Indicates that the alternative would have between MODERATE and HIGH performance relative to that criterion
MODERATE	Indicates that the alternative would have satisfactory performance relative to that criterion
LOW / MODERATE	Indicates that the alternative would have between LOW and MODERATE performance relative to that criterion
LOW	Indicates that the alternative would have unsatisfactory performance relative to that criterion

These qualitative rankings were assigned for each criterion for each SWA using a combination of calculated material volumes, disturbed or remediated areas, estimated remedial costs, and professional judgment based on previous sediment remediation experience. Table 8-3 provides the summary of the detailed evaluation of the SWAs. The following sections provide a summary of the key considerations associated with each criterion.

8.3.1 Effectiveness

310 CMR 40.0858 identifies the following factors as being important in evaluating the effectiveness of an alternative under the MCP:

- whether it achieves a Permanent or Temporary Solution;
- the extent to which it reuses, recycles, destroys, detoxifies, or treats oil and hazardous materials (OHM) at the site; and
- the extent to which it reduces levels of untreated OHM to concentrations that approach background.

SWAs 1 and 2 would only result in a Temporary Solution under the MCP, and would then not be ranked as highly as SWAs 3, 4-1, 4-2, 4-3 and 5 which would lead to a Permanent Solution. None of the SWAs do a great deal with respect to reusing, recycling or treating the Site's contamination. As more sediment and soil is removed that has lower contaminant concentrations (i.e., SWAs 4-1, 4-2, 4-3 and 5) the potential for reuse of the dredged or excavated material for daily cover at a landfill or other similar uses would increase. Similarly, as more removal is done, the remaining contaminant levels continue to be reduced and get closer to approaching background. SWA 5 is the only SWA designed specifically to approach background. Taken collectively, performance for this criterion improves as the SWA number increases, as shown in Table 8-3.

8.3.2 Short-Term and Long-Term Reliability

310 CMR 40.0858 identifies the following factors as being important in evaluating the short-term and long-term reliability of an alternative under the MCP:

- the degree of certainty that the alternative will be successful; and
- the effectiveness of any measures required to manage residues or remaining wastes or control emissions or discharges to the environment.

The factors to be considered for this criterion tend to work in opposite directions for the SWAs identified for this Site. Relatively simple SWAs involving monitoring and non-engineering measures will have a high likelihood of being implemented successfully but would include no measures to manage the residual residues and wastes still present at the Site. More complex active remediation responses, however, could run into implementation challenges that could ultimately limit or delay their success, but they would ultimately result in much less residue and ongoing discharges/releases to be managed. As such, the SWAs with the lowest and highest alternative numbers would rank relatively lower than the SWAs with a well-defined intermediate response that addresses the majority of the Site's contamination (i.e., SWAs 4-1, 4-2 and 4-3). These short-term and long-term reliability rankings are shown in Table 8-3.

8.3.3 Difficulty in Implementation

310 CMR 40.0858 identifies the following factors as being important in evaluating the difficulties in implementing an alternative under the MCP:

- technical complexity;
- the integration with existing facility operations and other current or potential remedial actions (where applicable);
- monitoring, operations, maintenance or site access requirements or limitations;
- the availability of necessary services, materials, equipment, or specialists;
- the availability, capacity, and location of off-site treatment, storage and disposal facilities; and
- whether the alternative meets regulatory requirements for any approvals, permits or licenses likely to be required by Massachusetts Department of Environmental Protection (MassDEP) or other agencies.

Technical complexity is relatively uniform for SWAs 2 through 5 relative to the removal and material handling processes involved, but increases due to the scale and extent of the required operations as the alternative number increases. Relative to this factor only, this criterion would rank HIGH for SWA 1 and LOW for SWA 5. Integration with existing facility operations is not judged to be a significant or discriminating factor for the alternatives for this Site. Site access will be a significant consideration for the design and implementation of the recommended alternative, being a greater challenge to performance as the scale of the field response and material removal/handling increases (i.e., as the alternative number increases toward SWA 5). Work on both public and private land will be required and the Cooperating Parties own none of the land at the Site. Availability of services, equipment, specialists or off-site disposal capacity is not a concern for any of the SWAs.

Implementation of the recommended alternative will likely require a multi-step Massachusetts Environmental Policy Act (MEPA) review in a series of submittals that include an Environmental Notification Form (ENF), and potentially a Draft Environmental Impact Report (DEIR), and Final Environmental Impact Report (FEIR). The EIR is mandatory if more than 1 acre of bordering vegetated wetland (BVW) is altered [301 CMR 11.03(3)(a)a], or there is an alteration of more than 10 acres of other wetlands (e.g., cumulative, land under water, flood plain, and riverfront area) [301 CMR 11.03(3)(a)b]. This trigger is expected to be surpassed. EIR review can have significant time and cost implications and unknowns due to the level of detail, alterations, and specified scoping. Full MEPA review also requires one or more rounds of response to public comments. The project will also exceed ENF thresholds for wetlands (i.e., alteration of ½ acre of other wetlands land under water, flood plain, and riverfront area) [301 CMR 11.03(3)(b)1,f]; dredging of more than 10,000 cy of material [301 CMR 11.03(3)(b)3];

disposal of more than 10,000 CY of dredge material [301 CMR 11.03(3)(b)4]; and work in areas with rare species [301 CMR 11.03(2)(b)]. On the downstream end of the Site, the Indian Head River is mapped by the Natural Heritage and Endangered Species Program as a priority habitat.

With the understanding that dredge return waters will be covered by the Clean Water Act Section 401 Water Quality Certification (WQC) process and possibly the Section 404 process, and that there will not be a need to dewater groundwater, the activities will need to be reviewed for potential construction phase stormwater dewatering. The U.S. Environmental Protection Agency (EPA) and MassDEP have authorized a National Pollution Discharge Elimination System (NPDES) Remediation General Permit for Massachusetts. Depending on activities and the flow of water to surface waters, there may be a need to obtain coverage under the Remediation General Permit. More specific details will need to be developed to determine whether the Remediation General Permit will cover site activities and whether it may be used rather than the NPDES Construction General Permit, or whether an Individual NPDES Construction Phase Permit will be required. Project construction plans should consider the conditions in both the NPDES Remediation General Permit and the NPDES Construction General Permit. The project also appears to require Federal consistency review by Massachusetts Office of Coastal Zone Management. Typically this review will be part of the Army Corps joint processing screening.

Regulatory requirements will be a significant factor relative to this criterion. Table 8-4 presents an overall summary of regulatory requirements likely to apply to one or all of the SWAs being considered. Since the Site includes a number of water bodies and wetlands, impacts to these areas are anticipated for six of the seven SWAs (i.e., SWAs 2 through 5). As such, the following permits will likely be required for these alternatives.

- <u>Chapter 91 Waterways Permit</u>

  A Massachusetts General Laws (MGL) Chapter 91 Waterways Permit protects 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. Given the nature of the dredging activity, only a permit (filed on Form Bureau of Resource Protection (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.

- <u>401 Water Quality Certification for Dredging Activities</u>

  Section 401 of the Clean Water Act provides the state with the authority to review projects that result in a discharge to the waters of the State, including excavating and filling wetlands, to ensure that the project will comply with state water quality standards and other appropriate requirements. The active remedial 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.

- <u>Massachusetts Wetlands Protection Act and Local By-laws</u>

The Wetlands Protection Act (WPA) 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 (NOI) will be filed with the Conservation Commissions in both 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.

In addition to these specific highlighted permits, how the MEPA review process unfolds will factor heavily into the relative difficulty or ease of implementation of the recommended alternative for the Site. Regulatory agencies in Massachusetts cannot act on permit applications (such as those highlighted above) when a project exceeds MEPA review thresholds without a Certification from the Secretary of the Executive Office of Energy and Environmental Affairs stating that MEPA review is complete. MEPA was designed to provide State agencies and government decision-makers with information that will help determine whether a proposed project has the potential to harm the environment and, if so, what mitigating measures should be implemented to address the potential impacts. A significant part of the MEPA process involves public review and commentary upon the project by all interested parties. MEPA regulations establish thresholds, a procedure and a timeframe for the review process. In consideration of the MEPA process and the various permitting efforts that will be involved with each SWA, the relative difficulty in implementation (and consequently the lower the level of performance) would be expected to increase with the alternative number. Overall then, in consideration of all of the factors associated with this criterion, this criterion would qualitatively rank HIGH for SWA 1 and LOW for SWA 5. These implementation difficulty rankings are shown in Table 8-3.

8.3.4 Cost

310 CMR 40.0858 identifies the following cost components as being important in evaluating the overall cost of an alternative under the MCP:

- cost of implementation, including design, construction, equipment, site preparation, labor, permits, disposal, operation, maintenance, and monitoring;
- cost of environmental restoration, potential damages to natural resources (surface waters, wetlands, wildlife, fish and shellfish habitat); and
- the relative consumption of energy resources in the operation of the alternatives, and externalities associated with the use of those resources.

The total costs of the SWAs were estimated to be (in 2010 dollars):

SWA 1	Not Estimated
SWA 2	$5,765,000
SWA – 3	$21,239,000
SWA – 4-1	$26,380,000
SWA – 4-2	$29,144,000

SWA – 4-3	$30,405,000
SWA – 5	$158,127,000

The basis of estimate (BOE), assumptions and cost estimation spreadsheets for each SWA are included in Appendix B. The relative consumption of energy (and associated OHM air and greenhouse gas (GHG) emissions) during the implementation of the alternatives will increase with the scale and duration of the remedial response. As such, the performance of this cost criterion in consideration of all of the factors identified in 310 CMR 40.0858 will decrease (toward LOW) as the alternative number increases. These cost rankings are shown in Table 8-3.

8.3.5 Risks

310 CMR 40.0858 identifies the following risks as being important in evaluating an alternative under the MCP:

- the short-term on-site and off-site risks posed during excavation, transport, disposal, containment, construction, operation or maintenance activities, or discharges to the environment from remedial systems;
- on-site and off-site risks posed over the period of time required to attain applicable remedial standards; and
- the potential risk of harm to health, safety, public welfare or the environment posed to human or environmental receptors by any OHM remaining at the disposal site after the completion of the remedial action.

For purposes of this evaluation, the short-term risks of each SWA were evaluated separately from the long-term residual risks. This was because the short-term and long-term risk rankings for the SWAs changed in different directions as the SWA number increased. The relative magnitude and severity of the short-term risks would increase with the volume of material to be removed, the number of different areas in which work must be performed, and duration of the required field operations. The short-term risks would include the direct disturbance and infringement on public and private property, a temporary suspension of their use, and potential significant and irreversible damage or change to ecological habitat. Short-term risks also would arise to people and the environment due to fugitive dust emissions, soil erosion, Site run-off, and the resuspension/re-deposition of sediments. In addition, more methylation of the mercury in the sediments would be expected as the extent of the disturbance of the sediments increases (as mercury that is currently isolated from an oxidizing environment is exposed to the air or oxygenated water). Increased methylation in the sediment would be a force that would increase the level of mercury in fish tissue (potentially undoing the intended benefits of the remediation). As such, short-term risk performance would be best (HIGHest) for the simpler, limited response (i.e., SWA 1) and LOWest for the most intrusive and comprehensive response (i.e., SWA 5). Conversely, the risks remaining after the completion of the remedial actions would follow exactly the opposite trend, since more and more of the identified potentially significant risks are eliminated as the alternative number increases. As such, long-term risk performance would be HIGHest for the most intrusive and comprehensive response (i.e., SWA 5) and LOWest for the simpler, limited response (i.e., SWA 1). These risk rankings also are shown in Table 8-3.

8.3.6 Benefits

310 CMR 40.0858 identifies the following benefits as being important in evaluating an alternative under the MCP:

- restoring natural resources;
- providing for the productive reuse of the site;
- the avoided costs of relocating people, businesses, or providing alternative water supplies; and
- the avoided lost value of the site.

There will likely be no costs associated with relocating people, businesses, or providing alternative water supplies for the Site, so this factor is not applicable for this evaluation. As the amount of contaminated media removed and the number of active remediation areas increases (i.e., as the alternative number increases), the performance of the SWA relative to the remaining benefits improves. SWA 2 through SWA 5 all would remediate the CWA, which would eliminate the need for access restrictions and allow this pond-side area to be used for recreation. These SWAs also will allow habitat in the Eastern Channel Corridor (ECC) to re-establish and be potentially productive. As more contaminated sediment is removed, the likelihood will increase and the time until the fish tissue mercury levels fall to levels that will allow the fish consumption advisory to be lifted will be shortened. However, a clear trade-off must be considered between the long-term benefit to selected ecological species of more extensive remediation (i.e., dredging and excavation) and the potential loss or significant change in ecological habitat for a much larger number of species that would occur over the short- and moderate-term. As such, a very intrusive and comprehensive response is associated with a range of considerable benefits and damages. As such, benefits of the SWAs would be HIGHest for the more moderate intrusive and comprehensive response (i.e., SWA 4) and LOWest for the simpler, limited response (i.e., SWA 1) and the very intrusive and comprehensive response (i.e., SWA 5). These benefit rankings also are shown in Table 8-3.

8.3.7 Timeliness in Eliminating Uncontrolled Sources and Achieving No Significant Risk

SWA 1 does nothing to remove the primary sources of identified contamination now present at the Site, but SWAs 2 through 5 remove the primary source of mercury contamination in the ECC and the potentially explosive munitions debris items as well as associated chemical constituents from the soil in the CWA. SWA 3 and SWAs with higher numbers, have different sets of conditions that can all be judged as posing no significant risk relative to different compliance areas and different sets of COCs. As such, SWAs 1 and 2 would rank LOW with respect to this criterion, with improved performance for SWAs 3 through 5 as the alternative number increases. These relative rankings are reflected in Table 8-3.

8.3.8 Impact on Non-Pecuniary Interests (Aesthetic Values)

As the SWA alternative number increases, a greater amount of the overall stream and pond or upland soil area (i.e., more sediment management units (SMUs) and more soil polygons) will be disturbed, either for operation areas, access roads, or the actual areas to be excavated or dredged. These disturbed areas will ultimately be restored, but the aesthetics of the Site will be degraded for the period of the remedial activities and for some time afterward while the plant and animal species respond to the restoration efforts. The more sediment and soil that will be removed, handled and disposed, the greater the number will be of truckloads of material that will have to be on the local public roads in this area (with the associated air, noise and traffic impacts) which would further degrade non-pecuniary interests in the local area. This will increase traffic congestion and noise in the area. As such, performance of the SWAs with respect to aesthetics will degenerate as the alternative number increases. These risk rankings also are reflected in Table 8-3.

8.4 Recommended Remedial Action Alternative

The relative ranking results presented in Table 8-3 were compiled and counted. Table 8-5 presents the results of the comparative rankings for each of the SWAs for each of the eight MCP detailed evaluation criteria. Table 8-5 indicates how many of each ranking category was assigned to each SWA by showing an "X" for each time that SWA was ranked with that category. It should be noted that nine Xs are shown for each SWA. This is because the "Risk" criterion was evaluated separately for "Short-Term Risk" and "Residual Risk".

No SWA that was indicated to have unsatisfactory performance with respect to one or more criteria was further considered with respect to selection as the recommended alternative. This left only SWA 4-1 and SWA 4-2 for consideration. Based on the relative rankings, these two SWA are very close. SWA 4-2 ranks slightly higher for only the Residual Risk portion of the Risk criterion. It should be noted, however, that both SWAs were ranked as having better than satisfactory performance with respect to Residual Risk.

Table 8-6 presents a head-to-head comparison of SWA 4-1 and SWA 4-2 with respect to a number of the critical components of the remedial response. Both of these SWAs will: lead to a Permanent Solution; eliminate the two primary source areas at the Site (i.e., the ECC and the CWA); and eliminate the soil and groundwater UCL exceedances. These two SWAs are identical with respect to the remediation of the Site's sediment in the ECC, the streams and ponds, and in the MUA. Both SWAs remove sediment in 11.2 acres of stream and pond, which represents 19.3% of the Site's aquatic area. Both SWAs meet all of the human health PRGs in all of the upland soil areas for all identified COCs. SWA 4-1 also meets all of the ecological PRGs for all of the identified COCs in the upland areas except the PGA and the SCCA. The ecological PRGs that are not projected to be met in these two areas relate to a set of metals (i.e., antimony, barium, copper, lead, mercury, thallium and zinc) and hexachlorobenzene. A linkage of all of these constituents to the former Fireworks operations has not been made (e.g., volatiles, solvents, and inorganics other than mercury and lead). The projected residual concentrations of these constituents are all less than an order of magnitude above their respective ecological PRGs, and the exceedances for each constituent were typically only within one or two polygons within each area. SWA 4-2 would further eliminate the ecological PRG exceedances for mercury and lead in the PGA and the SCCA. This additional removal amounts to 5,887 CY of soil and an additional SWA cost of $2.76 million.

Based on this comparative information, SWA 4-1 was selected as the recommended remedial action alternative for the Site because it would achieve satisfactory performance with respect to all of the detailed evaluation criteria and meets all of the ROs identified for the Site at the lowest cost and least impact to the natural resources at the Site compared to the other SWAs. It is, thus, the most cost-effective remedial alternative for the Site.

8.5 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; and
3. Evaluating the feasibility of reducing the concentrations of OHM in soil at a disposal site to levels at or below applicable soil UCLs.

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 OHM is not located on, and the elimination or control of that source cannot be achieved at that portion of the disposal site.

The recommended remedial action alternative, SWA 4-1, reduces the concentrations of constituents in soil to levels below their respective UCLs and eliminates critical exposure pathway(s). However, SWA 4-1 does not reduce the concentrations of constituents to achieve or approach background levels. In addition, since the concentrations of lead and mercury in groundwater are currently above their UCLs at certain locations, 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.

8.5.1 Technological Feasibility

The three technological feasibility criteria that were used for the evaluation for SWA 4-1 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 OHM 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 the 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 currently exceed UCLs. In both areas, these elevated groundwater concentrations are a direct result of source area contamination in the soil immediately up-gradient of these areas. Although active groundwater treatment could be implemented at this Site to reduce the groundwater concentrations to below the UCLs, this could not be done cost-effectively. As such, the recommended 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 Comprehensive Site Assessment (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 source removal 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 above.

8.5.2 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 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 OHM 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 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 OHM, 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 SWA 4-1 and SWA 5 have been evaluated using these considerations, since under SWA 5 concentrations of COCs are reduced to approach background.

The overall cost of SWA 4-1 is approximately $26.4 million whereas SWA 5 has a cost of approximately $158.1 million, representing an incremental cost difference of approximately $131.7 million (a factor of 6 difference in cost).

To assess the relative potential benefits of SWA 4-1 and SWA 5, an assessment was made of how each alternative would impact the human health and ecological receptors currently projected to be at risk.

Neither SWA 4-1 nor SWA 5 is projected to have any human health receptors at risk following implementation of the response. With respect to potential ecological risks under SWA 4-1, some residual soil-related impact to the American woodcock (an insectivorous bird); the short-tailed shrew (an insectivorous mammal), and to soil invertebrates, terrestrial plants and microbial communities in subareas of the PGA and the SCCA may remain. Since the ecological PRG for mercury for the mink (a piscivorous mammal) and the belted kingfisher (a piscivorous bird) were below the Site background level for mercury, these two species (and the groups they represent) would remain potentially at risk upon implementation of SWA 4-1. Assuming implementation of SWA 5, the potential ecological risks for the Site's fish-eating species would remain the same as for SWA 4-1. Again, this is because the projected mercury PRGs for the mink and the belted kingfisher are lower than the background level for the site. Implementation of SWA 5 would partially eliminate the projected risks to the American woodcock and short-tailed shrew and to the soil invertebrates, terrestrial plants and microbial communities in the noted areas. This represents a very modest incremental ecological risk benefit for SWA 5 for soil and none for sediment over SWA 4-1. As previously noted, however, a clear trade-off must be considered between the net benefit associated with the incremental improvement of a small set of ecological species (resulting from more extensive remediation) and the potential loss or significant change in ecological habitat for a much larger number of species that would occur over the short- and moderate-term. The incremental cost difference of $131.7 million for SWA 5 is substantial and disproportionate to the incremental reduction of net ecological risk for this alternative and, thus, does not justify its selection.

With regard to protection of non-pecuniary interest, such as aesthetic values and wetland and wildlife habitat damage, implementation of SWA 5 ("Approaching Background") would result in a significant and extensive impact/destruction of habitat across the majority of the Site. A total of 57 acres of stream and pond bottom and 9.1 acres of upland area would be subject to direct disturbance due to dredging or excavation under SWA 5. Additional area would be disturbed for the access roads and operations areas that would be required to store, handle and transport the volume of soil and sediment associated with SWA 5. Although both alternatives would result in the loss of greater than 5,000 sf of wetlands or wildlife habitat, SWA 5 would involve substantially greater impacts and loss of habitat over SWA 4-1 (only 11.3 acres of stream and pond bottom and 5.1 acres of upland area would be subject to direct disturbance due to dredging or excavation under SWA 4-1) and would require much more significant efforts relative to environmental restoration. In addition, SWA 5 would involve much greater traffic, air emissions and noise impacts in the adjacent communities and much greater GHG emissions.

Based on the feasibility evaluation and benefit-cost analysis above, SWA 4-1 is the recommended remedial action alternative for the Site. This alternative is protective of human health and the environment (meets Site-specific PRGs and ROs), 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 SWA 5, are proportionate to the benefits of implementing this remedial action alternative. The individual components of SWA 4-1 are summarized in the Alternatives Summary Guide.

8.6 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 above, the only limiting factor to not being able to achieve a Permanent Solution immediately following the performance of the recommended removal actions is the presence of OHM in isolated areas above applicable groundwater UCLs, specifically lead in the SDA and mercury in the MUA. 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 up-gradient 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 within approximately 5 years. 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.

In addition, following the removal of the majority of the primary and secondary sources of mercury in the sediments of the Site's aquatic system, the concentrations of mercury in fish tissue will fall over time. This parameter will be tracked relative to the threshold concentration that triggered the issuance of the fish consumption advisory for mercury in these water bodies.

9.0 COMPLETION STATEMENT

The Phase III Remedial Action Plan (RAP) was conducted in accordance with the pertinent provisions of the Massachusetts Contingency Plan (MCP) and the Phase III performance standards described in 310 Code of Massachusetts regulations (CMR) 40.0853. This Phase III RAP describes and documents the information, reasoning and results used to identify and evaluate remedial action alternatives in sufficient detail to support the selection of a proposed remedial action alternative. It is the opinion of the Licensed Site Professional (LSP)-of-Record that the proposed remedial action alternative documented in this Phase III is a Temporary Solution in the short term and that “definitive and enterprising steps” have been identified that are likely to achieve a Permanent Solution in the relatively near future.

10.0 REFERENCES

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TABLES

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APPENDIX A

DEVELOPMENT OF HUMAN HEALTH AND ENVIRONMENTAL PRELIMINARY REMEDIATION GOALS

APPENDIX B

BASIS OF ESTIMATE FOR REMEDIAL ACTIONS AND COST ESTIMATE

B-1 Basis of Estimate – Background and Description of Alternatives

B-2 Basis of Estimate – Area-Specific Operations and Quantities

B-3 Proposed Site Configuration for Site Access and Material Handling Areas

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APPENDIX B-1

Basis of Estimate – Background and Description of Alternatives

APPENDIX B-2

Basis of Estimate – Area-Specific Operations and Quantities

APPENDIX B-3

Proposed Site Configuration for Site Access and Material Handling Areas

APPENDIX B-4

Soil and Sediment Removal Quantities

APPENDIX B-5

Cost Estimation Tables and Assumptions