REMEDIAL ALTERNATIVES REPORT FOR THE DAVIDS ISLAND ENVIRONMENTAL RESTORATION PROJECT

SITE No. E360077

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Prepared For:

The City of New Rochelle
Westchester County, New York

Prepared By:

TETRA TECH EC, INC.

CERTIFICATION PAGE

I Brian Sielski certify that I am a NYS registered professional; engineer and that this Report was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10) and that all activities were performed in full accordance with the DER-approved work plan and any DER-approved modifications.

NY PE# 084250
September 12, 2016

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LIST OF ACRONYMS

AKRF	AKRF, Inc.
AST	Aboveground Storage Tank
BaP	Benzo(a)pyrene
bgs	Below ground surface
bss	Below sediment surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CSM	Conceptual Site Model
COC	Constituent of Concern
CSCO	Commercial Use Soil Cleanup Objective
DDT	Dichloro-diphenyl trichloroethane
EE/CA	Engineering Evaluation/Cost Analysis
ERP	Environmental Restoration Program
FWIA	Fish and Wildlife Impact Analysis
GRA	General Response Action
HASP	Health and Safety Plan
IRM	Interim Remedial Measure
kV	Kilovolt
LDR	Land Disposal Restriction
LEL	Lowest Effect Level
MC	Munitions Constituents
mg/kg	Milligram per Kilogram
MHHW	Mean Higher High Water
MHT	Mean High Tide
MHW	Mean High Water
msl	Mean Sea Level
NAPL	Non-Aqueous Phase Liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NTCRA	Non-time Critical Removal Action
NYCRR	New York Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
O&M	Operation and Maintenance
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PPE	Personal Protective Equipment
PVC	Polyvinyl Chloride
ppm	parts per million

LIST OF ACRONYMS (CONT'D)

RA	Removal Action
RAA	Remedial Alternatives Analysis
RAO	Remedial Action Objective
RAR	Remedial Alternatives Report
RCRA	Resource Conservation and Recovery Act
RRSCO	Restricted-Residential Soil Cleanup Objective
SCG	Standards, Criteria, and Guideline
SCO	Soil Cleanup Objective
SEL	Severe Effect Level
SI	Site Investigation or Site Inspection
SQG	Sediment Quality Guideline
SVOC	Semi-Volatile Organic Compound
TBC	To Be Considered
TCLP	Toxicity Characteristic Leaching Procedure
TOGS	Technical and Operational Guidance Series
TSCA	Toxic Substances Control Act
USACE	U.S. Army Corps of Engineers
USCO	Unrestricted Use Soil Cleanup Objective
UST	Underground Storage Tank
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

Tetra Tech EC, Inc. (Tetra Tech) is under contract to the City of New Rochelle, Westchester County, New York (the City) to conduct a Site Investigation (SI) and Remedial Alternatives Analysis (RAA) as part of the Davids Island Environmental Restoration Project (the Project). This report presents the results of the evaluation of potential remedial alternatives performed by Tetra Tech for the Island. This Remedial Alternatives Report (RAR) was completed in substantial compliance with the New York State Department of Environmental Conservation (NYSDEC) DER-10 *Technical Guidance for Site Investigation and Remediation* (NYSDEC, 2010a).

The purpose of the RAA is to identify and evaluate remedial alternatives to address contaminated soil and sediment. The process included:

- Establishment of Remedial Action Objectives (RAOs);
- Identification of General Response Actions (GRAs) to address the RAOs;
- Identification and screening of technologies applicable to each GRA;
- Selection of process options for retained technologies;
- Combination of selected process options to form remedial alternatives;
- Evaluation of alternatives;
- Selection of the preferred alternative for soil and for sediment; and
- Documentation of RAA in this RAR.

Davids Island is an approximately 80-acre island located in the Long Island Sound, less than a mile east of the mainland of New York at New Rochelle, New York. The site is the former location of a military base named Fort Slocum. Investigation activities were conducted for the City as part of the Project between 2007 and 2010. In addition, concurrent activities for the Project were also performed by Tetra Tech under U.S. Army Corps of Engineers (USACE) Contract No. DACW33-03-D-0006, a contract held by a joint venture between Jacobs Engineering Group and Tetra Tech EC, Inc. As applicable to the objectives of the City's SI, the results of concurrent activities were also utilized within this RAR.

Summary of Investigation Results

The results of the SI indicated surface and subsurface soil at Davids Island are primarily affected by semi-volatile organic compounds (SVOCs), typically polycyclic aromatic hydrocarbons (PAHs), pesticides, and metals at concentrations above NYSDEC Soil Cleanup Objectives for Restricted Residential Use (RRSCOs). These constituents were frequently detected in the samples, and are relatively widespread in the soils across the Island. The development and operational history of the Island, predominantly the generation and emplacement of historic fill and waste materials from former operations, appear to be the primary source of these contaminants of concern (COCs). Elevated levels of polychlorinated biphenyls (PCBs) were sporadically present in the soils; these PCB-contaminated areas were remediated under USACE direction in 2009/2010 and are not included in this RAR.

Sediments along the southeastern portion of the Island have been affected by former Island operations, specifically emplacement of cinder material and glass from an on-site incinerator. In general, elevated constituent concentrations were present in the sediments collected from the east-southeastern and southern portions of the Island, including sampling points within Long Island Sound that had levels above criteria throughout the sediment core (0 to 2 feet). The locations along the eastern and west-southwestern shores of the Island had fewer detections (and fewer exceedances), especially in the deeper sediment intervals.

The historic incinerator landfill represents the most significant environmental concern on the Island, as material produced by the historic incinerator appears to have been used as fill around the Island and the overwhelming majority of contamination found above criteria is located in this fill. The historic incinerator landfill area covers a substantial portion of the southeastern corner of the Island and extends seaward beyond the low tide line along the shoreline. Based on the results of the SI, the northern, southeastern, and southwestern portions of the Island are the areas of elevated contamination and/or greatest fill thickness. The central portions of the Island have little fill and typically contain little to no contamination. As such, the potential for actual future human health exposures will depend strongly on the specific layout of any future facilities and activity areas established at the site.

Ecologically, there are fish and wildlife resources associated with Davids Island, and the habitats present provide intrinsic value to ecological receptors. Metals were found at levels in the surface soils exceeding NYSDEC soil criteria for the protection of ecological resources and in the intertidal and subtidal sediments exceeding the lowest effect level (LEL) and/or severe effect level (SEL) for marine sediments (Tetra Tech, EC 2012). The Fish and Wildlife Impact Analysis (FWIA) classified sediments from the eastern and central beach areas in the southeastern portion of the Island as degraded to significantly degraded, based upon elevated concentrations of historic landfill-related constituents, observed toxic effects, and alterations in the benthic communities.

Remedial Action Objectives

The RAOs, based on NYSDEC DER-10, are as follows for each impacted media:

<u>Soil</u>

- Prevent, to the extent practical, direct contact exposure pathways to soil containing residual contamination concentrations above NYSDEC SCOs;

- Prevent inhalation of, or exposure to, site-related contaminants;
- Prevent migration of site-related contaminants that would result in groundwater or surface water contamination;
- Prevent impacts to biota from ingestion/direct contact with soil causing toxicity or impacts from bioaccumulation through terrestrial food chain; and
- Remove the sources of contamination.

Sediment

- Prevent, to the extent practical, direct contact exposure pathways to sediments containing residual contamination concentrations above NYSDEC sediment criteria;
- Prevent migration of site-related contaminants that would result in near shore surface water contamination;
- Prevent impacts to biota from ingestion/direct contact with sediments causing toxicity or impacts from bioaccumulation through the food chain; and
- Remove the sources of contamination.

Development of Alternatives

Following identification of RAOs, identification of GRAs, and screening of remedial technologies and process options, the following remedial alternatives were developed for detailed evaluation:

Soil

- Alternative SL-1: No Further Action
- Alternative SL-2: No Further Action with Site Management (Limited Action)
- Alternative SL-3: Removal of COCs in Soil Exhibiting Concentrations in Excess of NYSDEC Commercial Use SCOs
- Alternative SL-4: Removal of COCs in Soil Exhibiting Concentrations in Excess of NYSDEC Restricted-Residential Use SCOs
- Alternative SL-5: Removal of COCs in Soil Exhibiting Concentrations in Excess of NYSDEC Unrestricted Use SCOs

Sediment

- Alternative SD-1: No Further Action
- Alternative SD-2: No Further Action with Site Management (Limited Action)
- Alternative SD-3: Removal of COCs in Sediment Based on Habitat Impacts

- Alternative SD-4: Removal of COCs in Sediment in Excess of NYSDEC Sediment Guidance Value (SGVs)s

Evaluation of Alternatives

The media-specific remedial alternatives were first assessed individually and then on a comparative basis using the following seven evaluation criteria:

1. Overall Protection of Human Health and the Environment;
2. Compliance with Standards, Criteria, and Guidance (SCGs);
3. Short-Term Impacts and Effectiveness;
4. Long-Term Effectiveness;
5. Reduction of Toxicity, Mobility, and/or Volume;
6. Feasibility; and
7. Cost.

Comparative Analysis of Soil Alternatives

Overall Protection of Human Health and the Environment

Alternative SL-5 is the most protective, since it would remove surface and subsurface soils to the extent of known contamination exceeding NYSDEC SCOs for Unrestricted Use (USCOs) in all areas of the Island. Alternatives SL-4 and SL-3 are protective, but less so than SL-5, as some residual contaminated soil would remain under these alternatives. Alternative SL-4 would remove contaminated soil up to 2 feet bgs to the extent of contamination above NYSDEC RRSCOs and Alternative SL-3 would remove contaminated soil up to 1 foot bgs to the extent of contamination above NYSDEC SCOs for Commercial Use Passive Recreation (CSCOs). Alternative SL-2 would prevent human exposure through institutional controls, but does not provide any removal or treatment that significantly reduces migration of contaminants. Alternative SL-1 is the least protective, since it would not remove or treat contaminants nor reduce the risk of human or environmental exposure.

Compliance with SCGs

Chemical-specific SCGs would be achieved only to depths of 1 foot bgs or 2 feet bgs in Alternatives SL-3 and SL-4, respectively. These alternatives would leave contamination above SCOs below these depths, and soils would not be removed from the historic incinerator landfill area. For SL-5, all contaminated soils would be removed from the Island. Alternatives SL-1 and SL-2 would not remove contamination from the Site. All of the alternatives can be accomplished in accordance with action- and location-specific SCGs.

Short-Term Impacts and Effectiveness

Alternatives SL-1 and SL-2 would have the lowest short-term impact. There would be no potential risks to workers or the public during implementation of these alternatives, since no active remediation would be performed. Alternatives SL-3 and SL-4 involve excavation of contaminated soils and transportation of contaminated material to the on-site upland disposal area. Alternative SL-5 would have the highest short-term impacts and lowest short-term effectiveness because this alternative would (1) involve the deepest depths for excavation; (2) leave no contaminated soil on Island thus requiring the handling of the greatest quantity of material; and (3) require the longest period of time for implementation.

Long-Term Effectiveness

Alternatives SL-3, SL-4 and SL-5 are effective at reducing potential risk. Alternative SL-5 would remove all contaminated soil, while SL-3 and SL-4 would leave some residual contamination, but would mitigate potential exposures. Areas of residual contamination would be subject to institutional controls to minimize exposure, and long-term operation and maintenance (O&M) would be required. Alternative SL-2 would be less effective, since existing contamination would remain in place. Exposure to contaminated soil would be mitigated through institutional controls. Alternative SL-1 would not be effective, since it would not reduce potential risks. Long-term monitoring would be required for all alternatives except SL-5.

Reduction of Toxicity, Mobility, and/or Volume

Alternatives SL-3, SL-4 and SL-5 offer significant reduction in toxicity, mobility, and/or volume of contaminated soil since soil with contamination exceeding remedial goals would be excavated in all areas of the Island except SL-3 and SL-4 leave contaminants in the upland disposal (historic incinerator landfill area). These alternatives include the construction of a multi-media cap and vertical barrier wall at the historic incinerator landfill area to potentially reduce contaminant mobility in this area of the Island where contaminated material would remain in place. Alternative SL-5 offers the most reduction, as the largest volume of soil would be removed and no contaminated soil would remain on-island. Alternative SL-1 and SL-2 offer no reduction in mobility, toxicity, or volume since no active remediation would be performed under these alternatives.

Feasibility

All of the alternatives evaluated are technically and administratively feasible. Alternative SL-1 is the easiest to implement, since no remedial activities would be employed and no materials are required. Alternative SL-2 would also be easy to implement, involving institutional controls and limited materials and services. The remaining alternatives would all be relatively difficult to implement due to the geographic restriction of working on an Island. Alternatives SL-3, SL-4, and SL-5 would require construction activities (e.g., excavation, capping, and vertical barrier services, backfill and capping materials) and associated administrative activities (e.g., permitting, public participation and coordination, etc.). Alternative SL-5 would be the most difficult to implement as it requires the most soil excavation/handling, the largest quantity of materials, and the additional coordination for off-site transportation and disposal. Alternatives SL-3, SL-4 and SL-5 will require permitting and site restoration and potential post restoration monitoring following remediation.

Cost

Alternative SL-1 would have no capital costs and small, periodic O&M costs, associated only with periodic reviews. Alternative SL-2 has the next lowest capital and O&M costs for implementation of institutional controls. In order of next lowest capital and O&M costs would be Alternative SL-3, then Alternative SL-4 and lastly Alternative SL-5 (due to the amount of material scheduled for removal). Overall, the ranking of the alternatives based on net present value from lowest to highest is: SL-1, SL-2, SL-3, SL-4, and SL-5.

Comparative Analysis of Sediment Alternatives

Overall Protection of Human Health and the Environment

Alternatives SD-3 and SD-4 are the most protective of human health and the environment. Alternative SD-4 is the most protective, since it would remove surface sediments and historic landfill debris (up to 2 feet) from the high beach, intertidal and sub-tidal areas to levels below the NYSDEC SGVs. A small area associated with the former skeet range will also be remediated following further delineation as part of the predesign phase. Alternative SD-2 would limit human exposure, but does not provide any removal or treatment and does not address contaminant migration or ecological exposures. Alternative SD-1 is the least protective, since it would not remove or treat contaminants nor reduce the risk of human or environmental exposure.

Compliance with SCGs

Chemical-specific SCGs would be achieved only to depths of 2 feet below sediment surface (bss) in Alternatives SD-3 and SD-4. Alternatives SD-1 and SD-2 would not remove contamination. Removal and restoration activities would be performed in accordance with applicable action- and location-specific SCGs.

Short-Term Impacts and Effectiveness

Alternatives SD-1 and SD-2 would have the lowest short-term impact, with no potential risks to workers or the public since no active remediation would be performed. There would be no reduction of risk to the environment in either of these alternatives. The short-term impacts of

Alternatives SD-3 and SD-4 would be higher, as both involve removal of historic landfill-related debris and excavation/transport of contaminated sediments to the on-site upland disposal area. Of the two, Alternative SD-4 would have the higher short-term impacts because this alternative involves handling of the greater quantity of material. Risks to workers and the public would be mitigated through engineering controls and implementation of a health and safety plan during implementation of these alternatives.

Long-Term Effectiveness

The magnitude of potential human health and ecological risks would be mitigated for Alternatives SD-3 and SD-4 by (1) removing a source of contamination and contaminated sediments; (2) reducing contaminant migration to the marine environment; and (3) stabilization of the shoreline to prevent further erosion of historic landfill material into the adjacent waters. Institutional controls would be implemented to manage remaining contaminated material, consisting of restricting future use and access. Alternatives SD-1 and SD-2 would not provide long term effectiveness in mitigating risks to human health and the environment.

Reduction of Toxicity, Mobility, and/or Volume

Alternatives SD-3 and SD-4 offer significant reduction in the toxicity, mobility, and/or volume of historic incinerator landfill debris and contaminated sediment. Alternatives SD-1 and SD-2 offer no significant reduction in mobility, toxicity, or volume.

Feasibility

Alternative SD-1 is the easiest to implement, since no remedial activities would be employed in this alternative and no materials and only limited services are required. Alternative SD-2 would also be easy to implement, involving only institutional controls and limited materials and services. Technically, the remaining two alternatives would be more difficult to implement due to the geographic restriction of working on the Island. Alternatives SD-3 and SD-4 involve construction activities and associated administrative activities. These alternatives require excavation, backfilling, stabilization and capping materials. The quantity of materials under Alternative SD-4 would exceed that of Alternative SD-3. Alternatives SD-2 and SD-3 will require permitting for completion, limited site restoration and potential post implementation monitoring. Alternatives SD-4 and SD-5 will require permitting, site restoration and post restoration monitoring following remediation.

Cost

Alternative SD-1 would have no capital costs and small, periodic O&M costs, associated only with reviews. Alternative SD-2 has the next lowest capital and O&M costs for implementation of institutional controls. Capital and O&M costs for Alternatives SD-3 and SD-4 are associated with removal of historic landfill material and sediments, and long-term monitoring. Overall, the ranking of the alternatives based on net present value (capital and O&M) from lowest to highest is: Alternatives SD-1, SD-2, SD-3 and SD-4.

Proposed Plan for Site Remediation

The proposed remedial alternatives for the Island incorporate Alternatives SL-3 and SD-3. Implementation of Alternative SL-3 will remove contaminated soils that are in excess of NYSDEC Commercial SCOs to 1 foot bgs and transport any non-hazardous waste-level material to the on-site upland disposal area (located in the historic incinerator landfill area in the southwestern portion of the Island allowing for passive park development). The excavated areas will be backfilled with clean soils, and a multi-media cap will be constructed over the upland disposal area. Alternative SD-3 will remove sources of contamination and known impacted sediments (for subsequent disposal in the on-site upland disposal area) in combination with conservation of existing cobble/boulder intertidal habitat to provide protection against further migration and transfer into the marine environment. The inclusion of institutional controls will provide overall long-term support for these alternatives. Both SL-3 and SD-3 will require pre-construction permitting, site restoration and post remediation and restoration monitoring.

The overall net present value for implementation of the selected remedies (i.e., SL-3 and SD-3), based on a 30-year period of performance and a 3% discount rate, is $ 19.9M.

1.0 INTRODUCTION

1.1. Purpose and Organization of Report

Tetra Tech EC, Inc. (Tetra Tech) is under contract to the City of New Rochelle, Westchester County, New York to conduct a Site Investigation (SI) and Remedial Alternatives Analysis (RAA) and prepare Site Investigation and Remedial Alternative Reports presenting the results of the SI and RAA activities performed at Davids Island (the Island or the "Site"). The activities were conducted as part of the Davids Island Environmental Restoration Project (the Project). This document presents the Remedial Alternatives Report (RAR), which provides the results of the RAA performed by Tetra Tech for the Island. This RAR was completed in substantial compliance with the New York State Department of Environmental Conservation (NYSDEC) DER-10 *Technical Guidance for Site Investigation and Remediation* (NYSDEC, 2010a).

The primary objective of the Project is to obtain the data necessary to select a remedial alternative and then implement the remedial action alternative to obtain a Certificate of Completion under the NYSDEC Environmental Restoration Program (ERP). To achieve this objective, the general scope of work includes:

- Conducting a systematic, detailed investigation of the City of New Rochelle-owned portion of Davids Island;
- Selecting a long-term remedial action that is cost-effective and protective of human health and the environment;
- Performing remediation as necessary, consistent with the planned use (passive recreational use, a park) of the Island;
- Obtaining a Certificate of Completion indicating the remediation has been achieved according to approved work plans; and
- Removing or remediating environmental conditions preventing future beneficial reuse of the property.

The purpose of the RAA is to identify and evaluate remedial alternatives for contaminated soil and sediments at the Site. This RAR outlines the evaluation and selection of the preferred long-term remedial action alternatives for soil and sediment at the Island.

This RAR is organized into the sections described below.

Section 1.0 Introduction – This section presents the purpose of this report and the organization for the remainder of this report. It also provides a description of the site background (including its location and history) and summarizes the investigation work conducted on the Island, the physical setting of the Island, and the contaminant conditions.

Section 2.0 Description of Analysis Criteria – A description of the seven criteria that will be used in the analysis of the remedial alternatives is presented in this section.

Section 3.0 Identification and Development of Alternatives for Soil – This section provides the remedial action objectives (RAOs) and the general response actions (GRAs) for soil. This section also describes the rationale for combination of GRAs into soil remedial alternatives.

Section 4.0 Detailed Analysis of Alternatives for Soil – This section provides details of the five (5) soil remedial alternatives. It also presents the results of a comparative analysis of the relative performance of each alternative.

Section 5.0 Identification and Development of Alternatives for Sediment – This section provides the sediment RAOs and GRAs, along with the rationale for combination of GRAs into remedial alternatives for Island sediment.

Section 6.0 Detailed Analysis of Alternatives for Sediment – Both a detailed description of the four (4) sediment remedial alternatives and a comparative analysis of the alternatives are provided in this section.

Section 7.0 Selection of Preferred Remedial Alternative – This section presents the preferred alternatives for soil and sediment at the Island based on the evaluations presented in the previous sections.

Section 8.0 References – This section cites the references that were relied upon for information and guidance during the preparation of this RAR.

In addition, there are two appendices to this document, containing cost estimates for the remedial alternatives.

1.2. Site Background

1.2.1. Site Location

Davids Island is an approximately 80-acre island located in the Long Island Sound, less than a mile east of the mainland of New York at New Rochelle, New York. The site is the former location of a military base named Fort Slocum. The legal definition of the property is Block 780, Lot 1 in the City of New Rochelle, Westchester County, New York (AKRF, 2002). A project location map is provided as Figure 1-1.

1.2.2. Site Description/Layout

The Island has remained vacant since the United States military left the Island in the 1960s. Abandoned buildings and related infrastructure existed at the Island, but were severely deteriorated due to vandalism, neglect, and arson. Demolition and removal of the Island buildings were undertaken by the USACE and have been completed (see Section 1.3.1). Dense vegetation covers much of the Island. In addition, there is a Consolidated Edison Company (Con Edison)-owned utility corridor on the southwest side of the Island. A general layout of Davids Island, prior to building demolition, is presented on Figure 1-2.

1.2.3. Site History

The federal government leased the use of the Island beginning in 1861 or 1862. Prior to development, the Island served as pasture land and farmland, and was partially used for recreation with a dance pavilion and picnic grounds. During the Civil War, the Island contained a hospital (DeCamp General Hospital) that treated over 5,000 soldiers and held more than 2,500 Confederate prisoners of war.

Davids Island was officially bought by the Government in 1867, and the Island became a major recruiting base by 1878. A cemetery was established on the Island in 1878, but was subsequently removed in 1887 to make way for construction of barracks (USACE, 2005). In 1890, Davids Island became part of the New York Harbor Defense System, with pits and tunnels dug into the ledge rock to house a series of cannons. The Island was officially named Fort Slocum in 1896 in honor of Major General Henry Warner Slocum.

During World War I, Fort Slocum was the recruit examination station for the northeastern United States. Between 1917 and 1919, over 140,000 recruits passed through the Island. Fort Slocum was also used during World War II as a port of embarkation and an overseas staging area. Between the years of 1945 and 1967, Fort Slocum served a variety of functions. These functions included a U.S. Air Force Base, a rehabilitation center, a Chaplain's School, and an Information School (among other uses). Between 1955 and 1961, the Island contained the Fort Slocum Nike Battery (NY-15), which consisted of a fire control facility for the missiles installed at nearby Hart Island (USACE, 2005).

In 1967, the Island was purchased by the City of New Rochelle and was immediately considered for redevelopment. The following year the Island was sold to Con Edison for the construction of a nuclear generating facility. The plans for a nuclear facility were abandoned in 1973, and the Island was resold back to the City of New Rochelle. In 1977, the Island was designated as an Urban Renewal Area. Various proposals for redevelopment of Davids Island occurred from 1981 through 1994; however, no plans were implemented.

1.3. Summary of Investigation Results

Investigation activities were conducted for the City as part of the Project between 2007 and 2010. The results of the SI were provided in the Site Investigation Report (Tetra Tech, 2011). In addition, concurrent activities for the Project were also performed by Tetra Tech under U.S. Army Corps of Engineers (USACE) Contract No. DACW33-03-D-0006, a contract held by a joint venture between Jacobs Engineering Group and Tetra Tech EC, Inc. (Jacobs - Tetra Tech EC Joint Venture). As applicable to the objectives of the City's SI, the results of concurrent activities are also described within this report.

The following subsections summarize the findings and conclusions of the SI and concurrent activities.

1.3.1. 2005 through 2009 USACE Building Demolition and Associated Activities

Tetra Tech performed building demolition, debris removal, and asbestos remediation on the Island as contracted with the USACE. This project included the demolition and disposal of 94 buildings and structures between November 2005 and February 2009, along with the disposal of ACM; wood, glass, and roofing material; and steel and building rubble. As described in the After Action Report (Tetra Tech, 2009d), the following represent the major elements of work that were conducted on the Island in support of the building demolition and debris removal:

- Permanent Pier Design;
- Environmental Assessment Studies and Report;
- Archaeological, Architectural, and Historic Preservation Studies;
- Mobilization and Demobilization Activities;
- Asbestos Abatement of Structurally-Sound Buildings;
- Demolition and Debris Disposal of 94 Buildings and Structures;
- Restoration of Building and Structure Footprint Areas;
- Inventory and Removal of Man-made Landscape Features;
- Recycling and Reuse of Building Materials;
- Mortar Battery Pit and Tunnel Mapping and Maintenance; and
- Transportation and Disposal Activities.

Prior to structure demolition, as applicable, interior wood and metal debris (such as doors and windows) were removed. Metal was placed in the steel pile for recycling, unpainted wood was placed in the construction debris pile for future processing and load out, and painted wood was placed in lined roll-offs for disposal as lead-containing hazardous waste. Any ACM was wrapped in polyethylene sheeting, placed in lined roll-off containers, sealed, and disposed in an off-site landfill permitted to accept asbestos. Following the demolition of each building or structure, the foundation was typically filled with clean, crushed concrete/brick debris and rubble, and then covered with beneficially re-usable naturally decomposed vegetation and mulched grub material as topsoil cover.

In addition, a geotechnical investigation and design of marine dock area, an Environmental Assessment, and historical and archaeological investigations were conducted for the USACE under this contract.

The building demolition work was essentially completed in early 2009.

1.3.2. 2007 through 2010 Site Investigation

The SI program consisted of the physical and chemical characterization of surface and subsurface soil, groundwater, sediments, and other media present at the Island, as well as the collection of multiple environmental media samples and chemical analysis. The field activities were performed in accordance with NYSDEC's *Technical Guidance for Site Investigation and Remediation* (DER-10), other NYSDEC requirements, and the NYSDEC-approved Work Plan (Tetra Tech, 2007).

The SI and sampling program strategy focused on the areas of the Island most likely to contain contamination based on previous site operations and features. Tetra Tech grouped the former facilities at Davids Island into functional areas based on the knowledge obtained about the former operations of the different areas and facilities at the Island and their expected levels of contamination, which focused the SI on specific sources, compounds/analytes, and media of concern. Within these areas, related activities and utilized infrastructure locations and equipment were investigated and characterized for potential mitigation and/or remedial measures. These areas included:

- A-1 Officers Row;
- A-1a Officers Housing;
- A-2 Support Facilities;
- A-2a Support Facilities by Dock Area;
- A-2b Electrical Substation;
- A-3 Hospital Area;
- A-4 Sewage Disposal Plant;
- A-5 Enlisted Men's Housing;

- A-5a Armory/Firehouse Area;
- A-6 Non-Commissioned Officers' Housing;
- A-7 Mortar Battery;
- A-8 Incinerator Area;
- A-9 Nike Area;
- A-10 Far Southeastern Buildings;
- L-1 Former Landfill Area; and
- P-1 Parade Ground.

For ease of investigation and result discussion/presentation, these former operational functional areas were grouped into four directionally identified Functional Areas:

- Western Functional Areas, which include functional areas A-1, A-1a, A-2, A-2a, A-2b, and P-1;
- Northern Functional Areas, which include functional areas A-3 and A-4;
- Eastern Functional Areas, which include functional areas A-5 and L-1/A-5a; and
- Southern Functional Areas, which include functional areas A-6, A-7, A-8, A-9, and A-10.

TtEC evaluated the nature and extent of contamination present within surface soil, subsurface soil, groundwater, and near-shore sediment at the Island during the site investigation activities by visually observing the characteristics of the collected media and by submitting representative samples for laboratory analytical analysis. Analytical data for the SI samples were provided as Tables 4-4 through 4-14 of the SI Report. The analytical results were compared to NYSDEC recommended standards and/or guidance values.

1.3.2.1 Western Functional Areas (Soil/Water)

The Western Functional Areas primarily consisted of facilities used to house occupants of the Island and support the daily operations of Fort Slocum.

Functional Area A-1, Officer's Row, consisted of 13 buildings, facing east, that were located along the roadway bounding the Parade Ground. Ten samples were collected from surface soils and analyzed for semi-volatile organic compounds (SVOCs) and/or polycyclic aromatic hydrocarbons (PAHs), pesticides, polychlorinated biphenyls (PCBs), metals, and asbestos. Analysis indicated SVOCs, PAHs, PCBs, and metals were detected in the surface soil samples with soil samples collected from specific locations having concentrations above restricted residential soil cleanup objectives (RRSCOs; see Section 3.1 for the definition). Asbestos was not detected in any samples from Area A-1 surface soils.

Subsurface soil samples were collected to a depth of 12 feet below ground surface (bgs), and these samples indicated that PAHs were present above RRSCOs. PCBs were detected in one 7 to 8-foot bgs interval sample below a transformer location.

Functional Areas A-1a, A-2 and A-2a consisted of a group of 18 structures primarily situated at the southwestern portion of the Island, including the Dock Area. Ten surface soil samples were collected within these three areas during the SI and analyzed for SVOCs, pesticides, metals, and asbestos. Pesticides and asbestos were not detected in these surface soil samples; however, SVOCs (specifically PAHs) and metals exceeded RRSCOs at several locations. Subsurface soil samples were then collected at these locations with surface soil exceedances. PAH compounds again exhibited concentrations above their applicable RRSCOs.

Identified transformer locations within Functional Areas A-1a, A-2, and A-2a were sampled for PCBs in the surface and/or subsurface soils. Occurrences of the PCB Aroclor-1260 were encountered above RRSCOs at several locations.

In addition, four surface soil samples were collected at locations surrounding an aboveground storage tank (AST) found near the dock. None of the volatile organic compound (VOC) or SVOC detections were at levels exceeding their respective RRSCOs. An underground storage tank (UST) near Building 40 was investigated via subsurface soil sampling. With the exception of benzo(a)anthracene, there were no VOC, SVOC, or lead occurrences detected above RRSCOs.

Standing water and/or groundwater samples were collected at two locations within the Western Functional Areas. A groundwater sample was collected from the area near the UST, and this sample did not contain VOCs above RRSCOs. Metals concentrations in soils greater than RRSCO values near Building 20 likely represent native conditions.

Surface and/or subsurface soils proximal to the former electrical substation facility (A-2b) and the former Parade Ground (P-1) area were also collected and analyzed. Results from the electrical substation area indicated no surface soil constituents above RRSCO values. The Parade Ground soils contained slight RRSCO exceedances for PAHs and metals, specifically indeno(1,2,3-cd)pyrene and arsenic.

1.3.2.2 Northern Functional Areas (Soil/Water)

The northern portion of the Island consisted of the Hospital Area (Area A-3) and the Sewage Disposal Plant (Area A-4). The Hospital Area consisted of six former buildings along Hutchinson Road and Howard Road, where the primary operations were to provide health care for the Island workers and visitors. The Sewage Disposal Plant consisted of three former buildings associated with the management of sewage at the Island. The buildings were located between the sea wall and Hutchinson Road. Several specific locations within the Northern Functional Areas that were sampled included locations with the presence of drums, the former sewage treatment settling tanks, and the area beneath the water tower. Six drum locations were also characterized.

Area-wide sampling was conducted and surface soil and/or subsurface soils were collected and analyzed for VOCs, SVOCs/PAHs, pesticides, PCBs, metals, and asbestos during the sampling rounds. Several PAHs, pesticides (4,4-dichloro-diphenyl trichloroethane [DDT]), arsenic, lead, and mercury exceeded their RRSCOs during the delineation process. In addition, soil samples were collected from drum areas, storm/sewer drains, the former cemetery, and the former sewage settling tank locations. Mercury was present above its standard value proximal to one drum location. Analyses of storm/sewer drain subsurface soils indicated no detections above RRSCOs. Subsurface soils in the vicinity of the former cemetery exhibited metals above RRSCOs at 5 to 7 feet bgs, while the former sewage treatment settling tank area contained concentrations of three PAHs at levels above RRSCOs (i.e., benzo(a)anthracene, benzo(a)pyrene, and indeno(1,2,3-cd)pyrene).

One groundwater sample was collected within the Northern Functional Areas at drum location DR16. No constituents were above applicable NYSDEC standards in groundwater.

1.3.2.3 Eastern Functional Areas (Soil/Water)

The Eastern Functional Areas consisted of a mix of occupant housing and support facilities. A primary feature within the eastern part of the Island was the former pond landfill, designated as Functional Area L-1. This area, located at the east-central portion of the Island, historically could have been used to dispose of wastes generated by operations and activities performed at the Island. Area A-5a was four former brick and concrete structures historically used as Pump Houses, recreational facilities, and the Armory and Firehouse.

Surface soils were collected at the Enlisted Men's Housing/Barracks Area (A-5), which had historically consisted of a series of 20 barrack buildings and support facilities for the occupants. SVOCs (primarily PAHs) were present in soils exceeding RRSCOs. Pesticides were also detected, although below criteria. Several metals (arsenic, barium, lead, and mercury) were found to be spatially distributed with exceedances above the RRSCOs. Surface soils were also collected from the chimney clean-out chutes near these former buildings and the Skeet Range in the A-5 area. Both PAHs and metals exceeded RRSCO values during investigation activities proximal to the chutes. The investigation of surface soils at the Skeet Range, located near Building 60, yielded detections of metals, with all of the concentrations being below RRSCOs.

Subsurface soil samples were collected both within the general area of the Eastern Functional Areas and proximal to specific surface locations. The presence of PAHs exceeding RRSCOs were noted at approximately 3 feet bgs near the barracks. Subsurface soil sampling also indicated the presence of PAH compounds and/or metals (specifically arsenic and mercury) above RRSCOs to a depth of 6 feet bgs near the chimney clean-out chutes and storm/sewer drains and to 8 feet bgs within the former Skeet Range. Soils in the vicinity of the former electrical distribution system were sampled to a depth of 3 feet bgs utilizing test pit excavations. Multiple constituents were detected however, only minimal PAH exceedances were found, and no PCBs were detected.

The Former Pond Landfill Area (L-1) and the Armory Firehouse Area (A-5a) were investigated and surface, subsurface and groundwater samples were collected when practicable. During area-wide sampling, no SVOCs, pesticides, or asbestos were detected above RRSCOs in surface soils. Metals were present above the RRSCOs during the investigation events. Transformer area sampling yielded no detections of PCBs in surface soils.

Area L-1 was investigated further via the installation of soil borings and test pits. Subsurface soil analyses indicated that no VOCs, SVOCs, PCBS, or metals were present above RRSCOs. Observations documented the presence of petroleum odors and soil staining proximal to one test pit location.

Three groundwater samples were collected from the alleged pond landfill area only. None of the samples exhibited VOC exceedances.

1.3.2.4 Southern Functional Areas (Soil/Water)

The Southern Functional Areas of the Island were used to house and test munitions, as well as provide support for these operations. The Nike Area, designated as Area A-9, and the Mortar Battery Area, designated as Area A-7, are intermixed together and represent some of the newest areas of construction at the Island. The Nike Area was used as a control center for the launch of Nike Missiles on nearby Hart Island. The Southern Functional Areas also contained Area A-6, the Non-Commissioned Officer's Housing; Area A-8, the Incinerator Area; and Area A-10, the Far Southeastern Buildings. Samples were collected from surface soils, subsurface soils, sediments, and groundwater both on an area-Wide basis and more specifically at targeted areas.

Sampling at the Non-Commissioned Officers' Housing (A-6) indicated surface soils, which were analyzed for SVOCs, pesticides, metals, and asbestos, contained concentrations of PAHs and metals (barium, cadmium, and lead) at levels above RRSCOs. The highest concentrations for the PAHs were detected in the surface soil sample collected from AW52, north of former Building 102. Although pesticides were sporadically detected in the surface soil samples, there were no locations that contained concentrations greater than RRSCOs.

Subsurface soil sampling indicated an interval of PAH contamination above RRSCO values at depths between 4 and 12 feet bgs around location AW52 (in the east-northeastern portion of the Functional Area), along with dark staining and a petroleum odor from 6 to 10 feet bgs. A corroded and crushed steel drum, surrounded by a brick subsurface cistern, was found immediately south of the boring location during test pit operations. This area had some of the highest PAH concentrations detected in any soil samples collected at the Island.

Surface soil collection and analysis was conducted at Areas A-7 – Mortar Battery, A-8 – Incinerator Area, A-9 – Nike Area, and A-10 – Parker Road Buildings. Surface soil sampling for VOCs, SVOCs, pesticides, PCBs, metals, and/or asbestos were conducted both area-wide and at specific targeted locations. Typically, PAHs, pesticides and metals were detected above RRSCOs. In the incinerator area, several metals including arsenic, cadmium, copper, lead, and mercury exceeded the RRSCO values. Generally, exceedances of RRSCOs were noted in the surface soil samples collected to the north and east of former Building 115. Further sampling proximal to the Incinerator Area yielded similar exceedances of PAHs and metals.

Specific sampling of soils in the Nike Missile area proximal to drums contained mercury and cadmium above RRSCOs, while two locations at the Former Small Arms Firing Range exceeded criteria for metals. Analysis of transformer area surface soils yielded PCB concentrations above criteria. A removal action for PCB-impacted soils in this location was consequently conducted (see Section 1.3.4 and Tetra Tech, 2010b).

Subsurface sampling in these Southern Functional Areas generally yielded detections below criteria values for a majority of the constituents. A few metals (notably arsenic, mercury and lead) and PAHs (specifically in an observed ash layer) were present at concentrations exceeding RRSCOs at depths up to 16 feet bgs.

Perched groundwater was collected from one location in the Incinerator Area. Sample analysis yielded detections of VOCs below their respective RRSCO values.

1.3.2.5 Munitions-Related Activities

As part of the SI, sampling activities related to the potential for munitions constituents (MC; i.e., explosives and metals) to be present on selected portions of the Island (including Functional Areas A-5 and A-7/8/9/10), were conducted by Tetra Tech jointly for the USACE and the City. Surface and/or subsurface soils were collected from the range fan of the former Skeet Range for metals analysis and from the 8- and 15-inch Gun Platforms, Batteries Kinney and Fraser, and Batteries Haskin and Overton areas for explosive constituents. Detailed information on these sampling activities, along with result discussions, assessment of potential risk, and conclusions and recommendations, was presented in the Site Inspection Report for Fort Slocum/Davids Island, FUDS MMRP Number C02NY061602 (Tetra Tech, 2010c).

1.3.2.6 Background Soil

Background soil samples were selected and collected on the basis of matching soil types from four parks located in the City of New Rochelle. Up to 19 SVOCs were detected, primarily PAHs. Four compounds – benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene – were detected at concentrations slightly greater than RRSCOs in the surface soil sample from location BKG04 (Five Islands Park). For the metals, only arsenic was present at concentrations above RRSCOs, exceeding in the samples from BKG01 (Hudson Park) and BKG08 (Nature Study Woods Park).

1.3.2.7 Sediments

Deposition of cinder material and glass from the historic incinerator landfill was observed at the shoreline within Functional Areas A-6 and A-7/8/9/10. Near-shore surface sediment and deeper sediments further from the shoreline were collected to define the extent of the waste mass in the historic incinerator landfill area and assess the potential for migration of contaminants to the surrounding sediments. In addition, as part of the concurrent munitions-related investigative activities performed under USACE direction, 12 locations were sampled within the range fan of the former Skeet Range, present on the east-central portion of the Island (Functional Area A-5). These samples were located near the low tide point on the shoreline and were evenly spaced to the east and northeast of the on-land portion of the range. Samples were obtained from two depth intervals, surface (0 to 0.125 feet bgs) and shallow subsurface (1 to 2 feet bgs), and analyzed for metals.

A-1 – Officer's Row

As part of the sampling event for the Fish and Wildlife Impact Analysis (FWIA) Step IIC Toxic Effects Analysis, two reference stations were located on the western side of the Island within Functional Area A-1. The intertidal location contained detectable concentrations of PAHs, with low level exceedances for six constituents. Exceedances were also noted for chromium (both intertidal and subtidal), copper (subtidal), and nickel (intertidal); concentrations for these metals were less than two times the applicable screening criteria.

A-5 – Enlisted Men's Housing/Barracks Area

Twenty metals were detected in the Skeet Range shoreline samples, with seven of these constituents (cadmium, chromium, copper, iron, lead, manganese, and nickel) occurring at concentrations above criteria in at least one location. In general, the more northern sampling points contained higher concentrations, and therefore more exceedances. In addition, more elevated levels were typically present in the 1 to 2-foot bgs samples.

A-6 – Non-Commissioned Officers' Housing

During the multiple sampling events, a total of 31 sediment samples were collected from the shorelines on the west-southwestern and eastern sides of Functional Area A-6. Concentrations above sediment criteria were noted for up to six PAHs – benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene – and up to four metals – chromium, copper, lead, and mercury. In general, the higher concentrations were located along the west-southwestern shoreline. An exception was the 0 to 0.5-foot sediment sample collected from location SL42, on the eastern side.

A-7 – Mortar Battery, A-8 – Incinerator Area, A-9 – Nike Area, and A-10 – Far Southeastern Buildings

The data for this area indicate locations with either few to no detections with few to no exceedances; or numerous detections with exceedances of criteria. The sampling points located directly along the shoreline mainly fall into the second alternative, especially those present in the southern and east-southeastern portions of Functional Areas A-7/8/9/10. Specifically for PAHs, compounds above criteria included benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene, and the more elevated levels were noted in locations SL11 and SL25. Peak concentrations for copper and lead were noted in SL15, SL25, SL53, SL54, and/or SL60. In addition, these locations contained additional metal constituents (including cadmium, chromium, mercury, and/or zinc), at concentrations greater than screening criteria.

In comparison, the sediment locations to the east and west-southwest of the Functional Area had fewer detections (and fewer exceedances), especially in the deeper sediment intervals. Select shallower interval samples (especially 0 to 0.5-foot) off the eastern side of the Island (such as locations SL38 and SL40) did contain elevated PAH and/or metal concentrations, with criteria exceedances; however, these values were typically less than the previously discussed southern/east-southeastern locations.

1.3.2.8 Summary

The current understanding of contaminant distribution, and therefore the Conceptual Site Model (CSM) for the Island, has continuously evolved over the course of the SI (and concurrent activities). The historic incinerator landfill represents the most significant environmental concern on the Island. Material produced by the incinerator appears to have been used as fill around the Island, and the overwhelming majority of contamination found above criteria is located in this fill. The historic incinerator landfill area covers a substantial portion of the southeastern portion of the Island and extends seaward beyond the low tide line along the shoreline. In comparison to what was previously thought, the historic pond landfill area in the eastern portion of the Island does not appear to be an appreciable source of contamination. Based on the results of the SI, the northern, southeastern, and southwestern portions of the Island are the areas of elevated contamination and/or greatest fill thickness. The central portions of the Island have little fill and typically contain little to no contamination.

Surface Soils

The surface soils across the Island are primarily affected by concentrations of SVOCs (mostly PAHs) and metals. These constituents generally appear to be ubiquitous in the surface soils. The comparison of on-site soils to the background surface soil detections indicate native Island soils likely contain limited concentrations of PAHs (generally less than 1,000 ug/kg), and to a lesser extent, metals. Higher concentrations for the PAHs and metals (and therefore more elevated exceedances) typically were observed in areas with, and are likely caused by, extensive amounts of historic fill emplacement, reworking of soils, and site operations, such as the disposal of combustion by-products in the historic incinerator landfill area. Isoconcentration contour plots for the surface soils (which contained the majority of exceedances), which show the distribution of concentrations, and therefore the principal areas of contamination, for benzo(a)pyrene, arsenic, lead, and mercury, are presented in Figures 1-3A through 1-3D, respectively. Benzo(a)pyrene was chosen to represent the PAHs, as elevated concentrations of other individual compounds were generally located in the same points/areas as high levels of benzo(a)pyrene.

Occurrences of pesticides, although detected around the Island, were mostly below RRSCOs. These concentrations may be a result of occasional use of pesticides during Island operations. In addition, arsenic detections in individual soil samples may also be related to pesticide use at the Island. Exceedances for pesticides (4,4'-DDT and 4,4'-DDE) were typically at drum presence sample locations (e.g., DR17 in Functional Areas A-3/A-4).

PCBs were limited in detection frequency, and sample locations exhibiting surface soil exceedances for PCBs were typically transformer areas. PCB exceedances were remediated in 2009/2010 under USACE direction; see Section 1.3.4.

Subsurface Soils

For the subsurface, detected constituents and their respective concentrations were generally consistent with, or lower than, the results observed from the surface soil investigation program. PAHs and metals were again the most commonly found parameters in subsurface soil samples collected during the SI. Concentrations above RRSCOs for individual PAHs and metals were detected in soil samples collected at depths ranging up to 16 feet bgs. However, RRSCOs were typically exceeded at a lower frequency and generally at lower concentrations in the subsurface soil samples in comparison to the surface soil samples.

Groundwater

Water samples were collected to assess the effects of soil contamination and/or tank material on groundwater at specific locations around the Island. No VOC compounds were detected at concentrations above NYSDEC standards/guidance values. The concentrations of iron, magnesium, and sodium present in a sample of standing water from a vault by Building 20 were greater than their criteria values, and may be indicative of native conditions for the water at the Island, including salt water intrusion during tidal cycles. Subsequent to sampling, the water was discharged to the ground surface, with NYSDEC concurrence, and the vault area filled with crushed concrete and brick.

Sediments

The SI results indicate sediments along the southeastern portions of the Island have been affected by site operations, specifically deposition of cinder material and glass from the historic incinerator landfill area in the vicinity of Functional Areas A-6 and A-7/8/9/10. Up to six PAH compounds [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and/or indeno(1,2,3-cd)pyrene] and up to nine metals [cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc] were detected at concentrations greater than sediment criteria during the multiple sediment sampling events.

In general, sampling points located directly along the shoreline and seaward from the southern and east-southeastern portions of Functional Areas A-7/8/9/10 had numerous elevated constituent concentrations that were higher than criteria. Typically, for these locations, the exceedances were present throughout the sampled intervals (i.e., between 0 and 2 feet).

Sediment locations along the eastern and west-southwestern shores had fewer detections (and fewer exceedances), especially in the deeper sediment intervals. In these areas, there were a few select elevated PAH and/or metal concentrations, with criteria exceedances, present in a limited number of points (such as locations SL38 and SL40) at the shallower intervals (especially 0 to 0.5-foot).

1.3.3. 2007/2008 UST Interim Remedial Measures

Two interim remedial measures were performed to limit the potential for ASTs to affect environmental media in the future. The empty 275-gallon single-walled steel AST located at the far western portion of the Island near the dock area, within Functional Area A-2, was crushed and placed in the steel pile for subsequent recycling. The oil/water mixture in the AST located on the concrete pad at the southern end of former Building 110, within Functional Areas A-7/8/9/10, was transferred into three 55-gallon drums using a rotary hand pump, and then properly disposed. The Building 110 AST was removed in accordance with local, state, and federal regulations, and recycled as scrap metal.

Two additional USTs were identified during the USACE demolition activities and were investigated in July 2007 during the SI portion of the Project for the City. The first UST (UST A) was an approximately 10,000-gallon single walled steel tank that was located underneath the pump island east of former Building 40 (historically used as a wagon shed/garage), with remote fill piping running from the northwest corner of the UST to the former dock area. The second UST (UST B) was identified on the east side of Building 61 (historically an enlisted men's barracks) during demolition and consisted of a 550-gallon single walled, 1/16-inch thick, single-walled steel tank (approximately 6-feet long by 4 feet in diameter) inside a concrete vault. IRM activities were described in the Underground Storage Tank Closure Report (Tetra Tech, 2009a), and are summarized below.

Investigation activities were undertaken in July 2007 to determine if UST A had impacted soil quality and groundwater on the Island and to obtain information necessary to determine the scope of work necessary for UST removal. A total of six subsurface soil samples were collected from four borings installed around UST A and one boring installed beneath the fill piping during the UST removal. No evidence of petroleum contamination was encountered in the vicinity of UST A. Groundwater was collected from beneath the south end of the UST, and no TCL VOCs were detected in the sample. Removal of the UST and associated piping was performed by Tetra Tech on October 9, 2008.

UST B was located in a vault that was constructed out of bricks and stone block approximately 5 feet wide by 7 feet long. The floor of the vault was inaccessible due to the presence of debris and rubble; therefore, no surface or subsurface samples were collected during the SI. UST B was approximately half filled with No. 2 fuel oil and sludge), and this unused product and sludge were evacuated from the tank using a vactor truck.

Following cleaning and removal, a small pinhole was exposed on the south end of UST B. The material in the vicinity of this pinhole within the UST vault was investigated for evidence of a release. No staining or petroleum odors were present. No groundwater was encountered during the UST removal activities, and no piping was observed entering or exiting the UST vault. Soil sampling results indicated no VOCs or SVOCs at levels above NYSDEC RRSCOs.

A "No Further Action" letter in regard to the UST closures was received from Westchester County on February 9, 2009.

1.3.4. 2009/2010 USACE PCB Remediation

The USACE and the City of New Rochelle came to an agreement that the USACE would undertake the remediation of a distinct portion of the contaminated soil on the Island using remaining federal funds allocated for the investigative and remedial services on Davids Island. The focus of the work was the removal and disposal of PCB-contaminated soils, to the extent practical, following the processes outlined in the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

1.3.4.1 July 2009 Delineation Activities

Based on the results of sampling conducted on the Island as part of the SI, additional investigation of select areas on the Island was performed. Tetra Tech conducted surface and subsurface soil sampling to further delineate PCB contamination at former transformer areas in preparation for remediation activities in July 2009 as part of an amendment to the USACE contract.

Surface and/or subsurface sampling activities were performed in the areas containing elevated levels of PCBs to delineate PCB-contaminated soil to a level of 1 part per million (ppm; equivalent to milligrams per kilogram, or mg/kg). The 1 ppm value is the cleanup level for PCBs in soil without further conditions, as outlined in the Toxic Substances Control Act (TSCA), 40 CFR 761.61(a)(4)(i). This Federal standard is equal to the NYSDEC restricted use residential, restricted-residential, commercial, and protection of ecological resources soil cleanup objective (SCO) values for the sum of PCBs (1 mg/kg), listed in New York Code of Rules and Regulations, Title 6, Subpart 375-6, Remedial Program Soil Cleanup Objectives (6 NYCRR 375-6; December 2006). Therefore, use of 1 mg/kg criteria also achieved these restricted use State standards.

The results of this investigation task were utilized to determine areas/volumes for interim removal. The PCB delineation sampling was presented in the After Action Report for PCB Remediation (Tetra Tech, 2010b).

1.3.4.2 Remediation Project Documentation

Although Fort Slocum/Davids Island is not listed on the EPA's National Priorities List (NPL), the remedial work for the USACE was conducted in accordance with CERCLA. Specifically, an Engineering Evaluation/Cost Analysis (EE/CA) was required for a Non-Time Critical Removal Action (NTCRA) according to Section 300.415(b)(4)(i) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). An EE/CA was prepared by Tetra Tech to: (1) identify the nature and extent of PCB-contaminated surface and/or subsurface soils in select areas of the Island; (2) assess the potential risks to human health and the environment due to the PCB-contaminated soils; (3) evaluate various response action alternatives; and (4) recommend the most appropriate and preferred alternative. After the draft version was reviewed by stakeholders, discussed at a public meeting (16 October 2009), and made available for public review and comment (through 10 October 2009), a Final EE/CA document was prepared that determined the best action would be to remove all of the PCB-contaminated soil with concentrations above the 1 ppm criterion via excavation and off-site transportation and proper disposal in accordance with applicable regulations (Tetra Tech, 2009b).

On October 26, 2009, an Action Memorandum: Non-Time Critical Removal Action, PCB-Contaminated Areas at Former Fort Slocum/Davids Island, New Rochelle, NY was signed by USACE, New York District (USACE, 2009). The Action Memorandum outlined the selected action to be undertaken at the Island. Also in October 2009, an Interim Removal Action (RA) Work Plan was prepared by Tetra Tech to present the methods and procedures for performance of the USACE-approved removal response action and the figures depicting the extent and depth of the proposed excavation areas (Tetra Tech, 2009c).

1.3.4.3 2009/2010 Excavation

From November 2009 through January 2010, PCB remediation activities were performed on the Island (Tetra Tech, 2010b). Based on the results of the previously described delineation activities, there were five excavation areas where soil removal activities were conducted. These included the following:

- Area 1 - Between former Buildings 10 (to the south) and 11 (to the north);
- Area 2A - Vicinity of former Building 32A (between former Building 32 to the south and former Building T-34 to the northeast);
- Area 2B - West of former Building 32;
- Area 3 - Adjacent to the northwestern corner of former Building 20; and
- Area 4 - Surrounding former Building 109 and between former Buildings 102 (to the northeast) and 109 (to the southwest).

Prior to the start of work, the proposed limits of the excavations, as provided in the Final Interim RA Work Plan (Tetra Tech, 2009c), were surveyed for all removal areas. In addition, due to the potential for fugitive dust emissions during performance of the excavation activities, an air monitoring program was implemented at the Site to monitor dust levels at the perimeter of the exclusion zone and/or beyond.

During the remediation activities, soil was removed using an excavator, placed in lined roll-off containers, and removed from the Island. Post-excavation samples were collected, and if necessary based on the results of these analyses (i.e., PCBs still greater than 1 ppm), additional excavation activities were performed. Once clean limits were obtained, the excavations were typically lined with sheet plastic and/or high visibility fence to provide demarcation of the excavated area for potential future remedial events, if necessary, then backfilled with processed brick and concrete material from the on-site stockpile, which was approved for re-use, as per the Interim RA Work Plan (Tetra Tech, 2009c). To bring the excavation to grade, a top layer of sand/mulch organic mixture, also from the borrow area, was spread over the processed material.

In Areas 2A, 2B, and 4, PAH and lead analyses were added to the post-excavation sampling to provide further characterization of the material at the boundaries of the excavated areas. These results were incorporated into the discussion of the extent of contamination during the SI, and were used during assessment of remedial alternatives for these other contaminants on the Island during this RAA.

Details on the specific removal activities conducted in each of the above Areas, including Area-specific modifications as applicable, are provided in the After Action Report for PCB Remediation (Tetra Tech, 2010b).

1.3.5. Contaminant Fate and Transport

An understanding of the environmental fate and potential transport mechanisms of the constituents present on the Island is necessary to determine the potential for on-site and off-site migration, and to assess the potential for exposure. Contaminants may migrate from a source area through a variety of mechanisms. The importance of a given migration mechanism is controlled by the specific physical, geochemical, hydrogeologic, and climatic conditions at a given site location, as well as by the physicochemical characteristics of the contaminant and the contaminated media.

1.3.5.1 Shallow Soil Route

Migration of shallow soil contamination will occur to a limited degree at the Island, and this route will be a minor environmental fate and transport mechanism, based on the physicochemical properties of the contaminants of concern and the conditions at the Island. Elevated concentrations of individual PAHs (248 mg/kg), pesticides (142 mg/kg), and metals (such as lead at 21,900 mg/kg) were present in the surface soils. However, the potential for migration would be reduced by the high affinities for adsorption and low aqueous solubility of these constituents. Based on the surface topography and porous nature of the underlying soils, surficial water will likely be drained through percolation, with limited amounts being directed into the storm water drainage system and/or radially towards Long Island Sound. Storm events, however, may generate sufficient energy for migration of surficial contamination (either as dissolved components or fine particulates) via run-off or on-site ponding, with subsequent lateral spreading to adjacent soils and/or horizontal percolation. Lateral spreading, though, is expected to be non-existent or minimal in vegetated areas, and only a probable scenario within unvegetated areas. A majority of the Island area is heavily vegetated, with minimal areas covered with former footprints of building structures (concrete slabs and/or processed brick and concrete), which will reduce the possibility of airborne entrainment of contaminated shallow soil particulates.

1.3.5.2 Subsurface Soil Route

Contamination of subsurface soil at a site location generally occurs as a result of the historic disposal practices employed during past operations. As a consequence of these activities, chemical constituents may potentially migrate into and through the surrounding soils through percolation of rain, dissolution in groundwater, and/or gravity. The occurrence of preferential pathways (e.g., pipe bedding, utility corridors, etc.) at a site may enhance migration, horizontally and/or vertically, in the subsurface.

As indicated by the analytical data, subsurface soils at the Island have been affected by site processes, including petroleum handling/storage, incineration and/or landfilling of wastes, and transformers and drums. The subsurface soil data indicated the presence of PAHs (up to 470 mg/kg) and select metals (up to 3,080 mg/kg for copper) at elevated concentrations, especially in locations of former facility operations. Further migration of these constituents into and through the vadose zone soils may occur (via percolation, gravity, etc.), until they come into contact with a more impermeable layer (e.g., the underlying bedrock). The constituents of concern (specifically PAHs and metals) are generally persistent and of limited mobility within soil matrices under normal environmental conditions, primarily due to their low aqueous solubilities and high affinities for adsorption. The SI investigation indicated these constituents at concentrations above their respective RRSCOs at depths up to 16 feet bgs, which is likely due more to an emplaced subsurface source (e.g., USTs, historic incinerator landfill) than to migration from a surficial or near surface source (although transport is possible dependent on the constituent concentration, adsorptive affinities, and specific geologic properties of a specific area of the Island).

1.3.5.3 Groundwater Route

There are no significant groundwater resources present in the overburden soils or the bedrock to depths of 120 feet bgs at the Island. Limited areas of seasonally observed perched groundwater were encountered in the overburden materials during the SI and previous investigations. One such area was the northern portion of Functional Area L-1/A-5a, where water was noted on top of a clay layer, at approximately 4 to 6 feet bgs, at the location of a former pond (now filled). The first 150 to 200 feet of the Island, generally from the shoreline to the perimeter road, is tidally influenced by Long Island Sound, and water is likely present in the soils during the tidal cycle.

The perched groundwater sampled during the SI contained no VOCs at concentrations above criteria. Migration of PAHs and pesticides into the perched waters will be limited as a result of their high adsorptive affinities and low aqueous solubilities. Naturally-occurring water conditions in the area may contain metal concentrations that are not related (in whole or in part) to site activities.

1.3.5.4 Sediment Route

The sediments along the southeastern portion of the Island have been affected by former operations, specifically deposition of historic incinerator landfill material, and PAHs and metals are present above screening criteria values. With their low aqueous solubilities and high affinities for adsorption, the PAHs are likely sorbed to the sediment particles (in comparison to being present in the pore water). These constituents will generally persist, with transport via the sediment load potentially occurring with sufficient flow, such as increased tidal activity during storm events. The sediments within Long Island Sound are serving as a primary sink for the metals, as indicated by the analytical results.

1.3.5.5 Biota Route

Contaminants present in soil (surface or shallow subsurface) and sediments may accumulate in plants or organisms directly through bioconcentration, or indirectly by bioaccumulation through the food chain. This migration of contaminants into biota may be an important environmental transport mechanism at the Island, potentially affecting terrestrial plants, invertebrates, reptiles, birds, and mammals. This transport mechanism is especially significant for pesticides in on-site soils and select metals (such as arsenic, lead, cadmium, chromium, and mercury) in on-site soils and sediments. Specifically, the mercury present in the sediments may be of concern as it is highly bioconcentrated in fish. The further migration of incinerator wastes, and the subsequent detected constituents, into the sediments of Long Island Sound surrounding the Island is also expected to be a major fate and transport mechanism. Although it appears that the southeastern portion of Davids Island is relatively stable based on aerial photography interpretation (as discussed in the Shoreline Change and Weather Conditions Study, provided as Appendix L of the SI Report), the shoreline has undergone changes in shape and size, partially as a result of landfilling with the incinerator waste materials.

1.3.5.6 Air Route

Volatilization of VOCs from the surficial and subsurface soils is possible; however, it is likely limited due to the minimal detections of these compounds and the surface cover across the Island (extensive vegetation and/or remnants of former structures such as roads). Airborne entrainment of contaminated soil particles is a potential transport mechanism, especially for those constituents with high adsorptive affinities such as PAHs, pesticides, and metals. However, as the majority of the Island is covered with vegetation and/or other surface cover, this route would be of lesser importance. Airborne entrainment of particulates would generally only occur during significant dry/drought periods and/or when dust would be generated during intrusive activities in a contaminated area.

1.3.6. Exposure Assessment

Potential exposure scenarios were evaluated by assessing the current environmental setting and the current and projected future land uses of the Island. The Island is currently abandoned, except for a Con Edison utility corridor. Projected future land use of the Island may consist of a park or other recreation facility.

1.3.6.1 Potential Human Receptors

Trespassers, either a young adult or an adult, were identified as the potential human receptors linked to the current use of the abandoned Island. With regard to the anticipated future use of the Island, the following human receptors were identified:

- Construction Worker (adult);
- Underground Utility Worker (adult);
- Park Worker (adult); and
- Park Recreator (all ages).

These potential receptors related to future activities on the Island may be exposed to contaminants via routes such as incidental and unintentional ingestion, dermal absorption (through direct contact with surface or subsurface soil and/or sediments), and inhalation of soil-related particulates or volatile constituents in outdoor or indoor air (if buildings are constructed in the future and VOCs are present in the subsurface) through their projected activities. The use of surface water and groundwater for domestic consumptive purposes (i.e., potable water source) is not a potential concern because no freshwater surface water bodies are present at the Island and public water for consumption will be obtained from sources other than groundwater.

1.3.6.2 Potential Human Exposure Pathways

An assessment of risk and exposure for contaminants on the Island were identified based on the potential exposure functional area/location and environmental media associated with each investigated area of the Island. Additionally, the potential for human exposure to specific environmental media at a potential exposure point were identified as related to exceedances of NYSDEC criteria. A pathway is considered to be potentially complete for this exposure assessment if there is an exceedance of a risk-based level for a constituent in a medium to which an identified human or ecological receptor is exposed through one or more exposure pathways. PCBs are not discussed in the following sections, as the exposure pathways for this constituent group have been remediated (see Section 1.3.4). In addition, the IRMs for the ASTs and USTs have eliminated the risks associated with these exposures (see Section 1.3.3).

The original CSM identified five human receptors that may be affected by contaminated soil, sediment, or groundwater during the current or projected future uses of Davids Island. The potential human receptors include current trespasser, future construction worker, future underground utility worker, future park worker, and recreational users of a future park. Three of the human receptors (i.e., future construction worker, future underground utility worker, and future park worker) also may be exposed to the subsurface soils of the Island because of the intrusive nature of these activities and interaction with the ground. In addition, the future construction worker, future underground utility worker, and future park worker could come into contact or be exposed to perched water at the Island. Exposure to near-shore surface sediments may be a possibility for all of the human receptors.

Soils

Surface soils have elevated levels of SVOCs (specifically PAHs), pesticides, and/or metals (such as arsenic, barium, cadmium, copper, lead and mercury), depending on location on the Island. Some of the highest levels of constituents were found proximal to specific operational locations, such as transformer areas, drum presence locations, chimney clean-out chutes, storm/sewer drain system, sewage treatment settling tank, Skeet Range, etc. In addition, surface soils associated with historic fill placement generally have widespread levels of PAHs and metal compounds such as arsenic, mercury and lead above criteria. The exceedances of the screening values indicate potentially complete exposure pathways exist relative to the surface soil and potential receptors.

Subsurface soil exceedances exist for SVOCs (specifically PAHs) and metals. The presence of elevated PAHs diminished with depth, and these constituents were generally found in areas with surface soil contamination. Localized contamination exists from former site activities, while areas of widespread exceedances of PAHs and metals are likely associated with historic fill placement. Subsurface soils could be a source of potential exposure for the three identified human receptors expected to perform intrusive activities that disturb the soil at depth.

The exposure potential is most significant for receptors that may interact directly with the surface soils (relative to projected exposure to the subsurface soils), and often appears to be concentrated in localized “hot spot” areas near identifiable features or past operations (e.g., drums, historic incinerator landfill area, etc.), rather than spread out evenly throughout the entire Island.

Groundwater

No groundwater exposure concerns were identified.

Sediments

Sediment samples were collected within Functional Areas A-5, A-6, and A-7/8/9/10 above the mean high tide (MHT) line, in the intertidal zone, and in the surface and subsurface depths of the subtidal zone (generally from 100 to 350 feet out from the shoreline). Specifically, the sediments along the southeastern portion of the Island present a potential exposure point for human receptors.

Concentrations of PAHs (e.g., benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and/or indeno(1,2,3-cd)pyrene) and metals (e.g., cadmium, chromium, copper, iron, lead, manganese, and/or nickel) were detected at levels that exceeded NYSDEC sediment screening values in the surface sediments above the MHT line. Subsurface (i.e., 1 to 2 feet bgs) sediment collected in the range fan for the Skeet Range (located in the eastern portion of the Island) contained the metals cadmium, chromium, iron, lead, and nickel above NYSDEC sediment criteria.

The potential for exposure is indicated for all of the identified receptors relative to intertidal sediments due to the presence of the following PAHs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene. The metals cadmium, chromium, copper, iron, lead, mercury, and nickel were also identified at exceedance levels in many of the intertidal samples.

The same six PAHs identified in the MHT and intertidal sediment samples above criteria were also detected in subtidal surface sediments at levels in exceedance of screening values. Metals (e.g., chromium, copper, lead, and mercury) were also identified at concentrations greater than sediment screening levels at all subtidal surface sampling locations. Subsurface intervals for the subtidal sediment, including locations at 0.5 to 1 foot below mudline and at 1 to 2 feet below mudline, exhibited PAH and/or metal (e.g., cadmium, chromium, copper, iron, lead, mercury, nickel, and/or zinc) concentrations exceeding criteria.

1.3.6.3 Fish and Wildlife Impact Analysis Summary

Ecologically, there are fish and wildlife resources associated with Davids Island, and the habitats present provide intrinsic value to receptors. The long occupation and use of the Island has resulted in the disturbance of the Island's native vegetation and habitat with the introduction of non-native plantings and opportunistic invasive plant species. The Island affords habitat that includes cover types of deciduous forested habitat, open beach, intertidal, and subtidal habitats. Small areas of Spartina wetland are scattered around the Island, but no continuous band of marsh is present. Small upland freshwater wetland areas were also found in the interior portions of the Island. A variety of bird species, and to a lesser extent mammal species, utilizes the upland habitats present on the Island.

A NYSDEC significant coastal habitat area associated with Huckleberry Island borders the waters off Davids Island. In addition, the off-shore waters represent essential fish habitat for a variety of finfish and shellfish species. The NYSDEC Natural Heritage Program identified coastal rocky intertidal habitat as being a unique environmental resource present on the Island. Several endangered and threatened species associated with the NYSDEC significant coastal habitat area have the potential to use the upland habitats. Two osprey nests, one active and one in-active, were observed on the Island. Ospreys are a Species of Special Concern in New York State.

Historical incineration of waste, and the subsequent disposal of ash and cinder material into the historic incineration landfill area, has resulted in the artificial extension of the upland area into the waters of Long Island Sound. Cinder material was observed on the beaches adjacent to the historic incineration landfill. Chemical data for surface soils and sediments detected elevated levels of PAHs and metals in the ash and cinder material. A FWIA was performed for the historic incinerator landfill area and near shoreline to assess environmental risks to fish and wildlife resources from the historical disposal of ash in this portion of the Island. The pathways analysis identified complete exposure pathways and routes for fish and wildlife resources to come into contact with elevated PAHs and metals present in this material.

Steps IA-D through Step IIB of the FWIA showed that criteria-specific analysis identified metals, and to a lesser extent PAHs, exceeding screening level benchmarks for the protection of ecological resources. Maximum detected concentrations of PAHs and metals (such as arsenic, copper, chromium, lead, nickel, and/or zinc) in soils in the upland areas of the historic incineration landfill were found to exceed NYSDEC SCOs for the protection of ecological resources. PAH exceedances were associated with specific sampling locations, while the metal exceedances were more wide-spread across the historic incinerator landfill area. Under current exposure conditions, the presence of contamination in the surface soils poses a potential risk to the wildlife resources present.

Cadmium, copper, chromium, lead, and mercury were also found to exceed lowest effect level (LEL) and/or severe effect level (SEL) criteria for marine sediments at stations in intertidal and subtidal sediments throughout the shoreline (Tetra Tech, EC, 2012). Of these metals, copper, chromium, and lead had the most prevalent exceedances in the intertidal and subtidal environments.

The Toxic Effects Analysis (Step IIC) assessed if the presence of historic landfill-related chemical constituents in the intertidal and shallow subtidal sediments were impacting the marine benthic communities present. The FWIA Step IIC process classified sediments from the eastern and central beach areas in the southeastern portion of the Island as degraded to significantly degraded, based upon elevated concentrations of historic landfill-related constituents, observed toxic effects, and alterations in the benthic communities.

2.0 DESCRIPTION OF ANALYSIS CRITERIA

The remedial alternatives to be developed for soil and sediment in subsequent sections of this RAR will be evaluated using the following seven criteria:

1. Overall Protection of Human Health and the Environment;
2. Compliance with Standards, Criteria, and Guidance (SCGs);
3. Short-Term Impacts and Effectiveness;
4. Long-Term Effectiveness;
5. Reduction of Toxicity, Mobility, and/or Volume;
6. Feasibility; and
7. Cost.

The seven criteria are described in the following sections.

2.1 Overall Protection of Human Health and the Environment

This criterion provides an overall assessment of protection based on a composite of factors such as long-term and short-term effectiveness and compliance with SCGs. Evaluations of the overall protectiveness address:

- How well a specific site remedial action achieves protection over time;
- How well site risks are reduced; and
- How well each source of contamination is eliminated, reduced, or controlled for each remedial alternative.

2.2 Compliance with Standards, Criteria, and Guidance

This criterion is used to determine how each remedial alternative complies with SCGs. Each alternative is evaluated in detail for:

- Compliance with chemical-specific SCGs (e.g., NYSDEC Remedial Program Soil Cleanup Objectives);
- Compliance with action-specific SCGs (e.g., Resource Conservation and Recovery Act [RCRA] minimum technology standards);
- Compliance with location-specific SCGs (e.g., floodplains); and
- Compliance with appropriate criteria, advisories, and guidance (e.g., “To Be Considered” [TBC] material).

2.3 Short-Term Impacts and Effectiveness

This criterion addresses the impacts of the action during the construction and implementation phase until the RAOs have been met. Factors evaluated include protection of the community during the remedial actions; protection of workers during the remedial actions; environmental impacts resulting from the implementation of the remedial actions; and the time required to achieve protection.

2.4 Long-Term Effectiveness

This criterion addresses the results of the remedial action in terms of the potential risk remaining at a site after the remedial action objectives have been met. The components of this criterion include the magnitude of the residual risks; the adequacy and suitability of controls used to manage treatment residuals or untreated wastes; and the long-term reliability of management controls for providing continued protection from residuals (i.e., the assessment of potential failure of the technical components).

2.5 Reduction of Toxicity, Mobility, and/or Volume

This criterion addresses the statutory preference that treatment is used to result in the reduction of the total mass of toxic contaminants, the irreversible reduction in contaminant mobility, or the reduction of the total volume of contaminated media. Factors to be evaluated in this criterion include the treatment process employed; the amount of hazardous material destroyed or treated; the degree of reduction in toxicity, mobility or volume expected; and the type and quantity of treatment residuals.

2.6 Feasibility

This criterion addresses the technical and administrative feasibility of implementing a remedial action and the availability of various services and materials required during its implementation. *Technical feasibility* factors include construction and operation difficulties; reliability of technology; ease of undertaking additional remedial actions; and the ability to monitor the effectiveness of the remedy. *Administrative feasibility* includes the ability and time required for permit approval and for activities needed to coordinate with other agencies. Factors employed in evaluating the availability of services and materials include availability of treatment, storage, and disposal services with required capacities; availability of equipment and specialists; and availability of prospective technologies for competitive bid.

2.7 Cost

The types of costs that are addressed include: capital costs, operation and maintenance (O&M) costs, costs of periodic reviews (where required), present value of capital and O&M costs, and potential future remedial action costs. Capital costs consist of direct and indirect costs. Direct costs include expenditures for the equipment, labor, and materials necessary to install remedial actions. Indirect costs include expenditures for engineering, administrative, and other services required to complete the implementation of remedial alternatives. Annual O&M costs include auxiliary materials and energy, disposal of residues, purchased services, administrative costs, insurance, taxes, license costs, maintenance reserve and contingency funds, rehabilitation costs, and costs for long-term monitoring.

This assessment evaluates the costs of the remedial actions on the basis of present worth. Present worth analysis allows remedial actions to be compared on the basis of a single cost representing an amount that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the remedial action over its planned life. A required operating performance period and a discount rate are assumed to calculate present worth cost. A discount rate of five percent (5%) is assumed for a base calculation. The discount rate represents the anticipated difference between the rate of investment return and inflation. The estimated costs provided for the remedial actions have an accuracy of -30 to +50 percent.

3.0 IDENTIFICATION AND DEVELOPMENT OF ALTERNATIVES FOR SOIL

3.1 Remedial Action Objectives

3.1.1 Standards, Criteria, and Guidance

A broad range of New York State or Federal SCGs are relevant to the nature of the work involved in the Project. The SCGs are specific requirements depending on what, how and where the clean-up work is to be done and what chemical constituents or compounds are involved. These SCGs may prescribe required procedures, prohibit actions, or establish minimum performance benchmarks. SCGs for the Project were developed and submitted as Table 3-1 of the Work Plan for Site Investigation/Remedial Alternative Report (Tetra Tech, 2007).

As part of the locational-specific SCGs, the use of the Site was considered. As stated in New York Code of Rules and Regulations (NYCRR), Chapter 6, Subpart 375-1.8 Remedial Program, the "use of a site, or portion of a site, shall be for either unrestricted or restricted use."

(i) "Unrestricted use" which is a use without imposed restrictions, such as environmental easements or other land use controls; or

(ii) "Restricted use" which is a use with imposed restrictions, such as environmental easements, which as part of the remedy selected for a site requires a site management plan that relies on institutional controls or engineering controls to manage exposure to contamination remaining at the site.

For the Davids Island Environmental Restoration Project, surface and subsurface soil concentrations were compared to the recommended criteria released by NYSDEC in December 2006 identified as NYCRR Chapter 6, Subpart 375-6 Remedial Program Soil Cleanup Objectives (NYSDEC Subpart 375-6 SCOs), along with the Supplemental Soil Cleanup Objectives outlined in the Soil Cleanup Guidance (CP-51; NYSDEC, 2010b). Restricted-residential use was the SCO used for comparison of the soil analytical results during the SI (denoted as "RRSCOs"). Restricted-residential use shall only be considered when there is "common ownership or a single owner/managing entity of the site." Restricted-residential use as set forth in subparagraph 375-1.8(g)(2)(ii):

(a) shall, at a minimum, include restrictions which prohibit:

  (1) any vegetable gardens on a site, although community vegetable gardens may be considered with Department approval; and

  (2) single family housing; and

(b) includes **active** recreational uses, which are public uses with a reasonable potential for soil contact.

Tables 4-4 through 4-10 of the SI Report contain the surface and subsurface soil analytical results for the various functional areas on the Island. Constituent concentrations exceeding the RRSCO values were highlighted in these tables. Results of the investigation program indicated soils were primarily affected by concentrations of SVOCs (mostly PAHs), pesticides, and metals above the NYSDEC RRSCOs. The SI determined that relatively high concentrations of these constituents in the surface soils generally indicated concentrations of similar constituents in subsurface soil samples, and concentrations of detected constituents in subsurface soil were generally consistent with or less than the results observed in the overlying surface soils. Therefore, contaminants of concern (COCs) for surface soils and subsurface soils were grouped together and are listed in Table 3-1.

NYSDEC Subpart 375-6 also contains commercial use SCOs. As per 375-1.8(g)(2)(iii), "commercial use" is the land use category that shall only be considered for the primary purpose of buying, selling or trading of merchandise or services. Commercial use also includes **passive** recreational uses, which are public uses with limited potential for soil contact.

It is the intent of the City of New Rochelle to develop the Island as passive recreational use, including walking trails with historical and environmental signage.

3.1.2 Remedial Goals

Remedial goals for the soil COCs are based on the NYSDEC Subpart 375-6 SCO values for soil. Table 3-2 summarizes the potential SCG-based remedial goals for soil for unrestricted (USCO), restricted-residential (RRSCO), and commercial (CSCO) uses.

3.1.3 Remedial Action Objectives

Soil RAOs for the Project were identified based on guidance from NYSDEC DER-10. The RAOs are as follows:

- Prevent, to the extent practical, direct contact exposure pathways to soil containing residual contamination concentrations above NYSDEC SCOs;
- Prevent inhalation of or exposure to site-related contaminants;
- Prevent migration of site-related contaminants that would result in groundwater or surface water contamination;
- Prevent impacts to biota from ingestion/direct contact with soil causing toxicity or impacts from bioaccumulation through terrestrial food chain; and
- Remove the sources of contamination.

3.2 General Response Actions

To meet the RAOs developed for soils at the Site, the following General Response Actions (GRAs) for surface and subsurface soil have been identified:

1. No Further Action
2. No Further Action with Site Management (Limited Action)
    a. Institutional Controls (e.g., deed restrictions and/or environmental easements)
    b. Engineering Controls (e.g., fencing)
3. Containment
    a. Capping
    b. Permeable Cover
4. Removal and Disposal
    a. On-Site
    b. Off-Site
5. Treatment
    a. *Ex Situ*
    b. *In Situ*

No Further Action involves no treatment but would implement reviews for periodic re-evaluation of site conditions.

No Further Action with Site Management (Limited Action) involves measures that restrict access to contaminated areas through physical and/or administrative measures, and also includes long-term monitoring.

Containment actions include technologies that involve little or no treatment, but provide protection of human health and the environment by reducing mobility of contaminants and/or eliminating pathways of exposure.

Removal, Disposal and Treatment actions include technologies that act to reduce the volume, toxicity and/or mobility of contaminants. Disposal actions include both on-site and off-site disposal technologies. Treatment technologies include *in situ* treatment, or removal and *ex situ* treatment (e.g., physical, chemical, thermal, biological).

3.3 Identification and Screening of Technologies and Development of Alternatives

The screening of remedial technologies is performed in two steps: (1) the identification and screening of technology types and process options for each GRA, and (2) the evaluation and selection of representative process options. The following sections discuss the results of these steps.

3.3.1 Identification and Screening of Technologies

The remedial technology types associated with each of the GRAs typically considered for the cleanup of contaminated soil were developed from DER-10 *Technical Guidance for Site Investigation and Remediation* (NYSDEC, 2010); the October 1988 *Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988); evaluation of new and emerging technologies; and experience on other hazardous waste projects.

Remedial technology types associated with each GRA are discussed in this section. Most of these remedial technology types contain several different process options that could apply to the contaminated soil. These potentially applicable technologies and process options are screened based on technical feasibility, considering site-specific conditions, contaminant types, and concentrations. Typical treatment technologies for PAH- and metal-contaminated soils are thermal desorption, solvent extraction, and solidification/stabilization.

Potential technologies for remediation of contaminated soil exceeding SCG-based remedial goals are discussed and summarized with the results of the initial screening. For those technologies that were not retained for further evaluation, the rationale for their elimination is included. Table 3-3 summarizes the results of the preliminary screening of soil technologies and process options.

3.3.1.1 No Further Action

Description: No Further Action is an option that does not include any remedial measures. It allows for long-term monitoring, periodic reviews of the site, and reevaluation of the need for remedial action.

Initial Screening: No active remediation or institutional controls are implemented under this option. Any reduction in the toxicity, mobility or volume of contaminants would be the result of natural attenuation, since no treatment would be implemented. The No Further Action alternative is retained for further evaluation as a baseline for comparison of other alternatives.

3.3.1.2 No Further Action with Site Management (Limited Action)

This alternative consists of technologies that are generally passive, including monitoring, access restrictions (e.g., engineering controls such as fencing and warning signs), and institutional controls (e.g., deed restrictions, environmental easements health and safety plan, soil management plan, etc.).

Access Restrictions

Description: Access to the site, and use of the site, would be restricted by providing a security fence around the site and affixing signs (as appropriate).

Initial Screening: Fencing around the impacted soil areas would effectively prevent exposure to the impacted materials. A security fence could be installed to prevent access to the Island. This process option is retained for further evaluation.

Deed Restrictions and/or Environmental Easements

Description: With this process option, land use restrictions would be included in the deed and would be retained through real estate transactions. Examples would include use restrictions and limitations on excavation at the site.

Initial Screening: Use restriction would be required as a final step in the development of remedial alternatives that do not remediate the property to unrestricted use conditions. Deed restriction and/or environmental easements is retained as a process option.

Health and Safety and Soil Management Plans

Description: This process option includes the preparation, implementation and maintenance of plans for the property. The plans would require monitoring and use of personal protective equipment (PPE) during construction activities at the site, and would provide soil management requirements.

Initial Screening: Plans would be required as the final step in the development of remedial alternatives that do not remediate the property to unrestricted use conditions. Plans are retained as a process option.

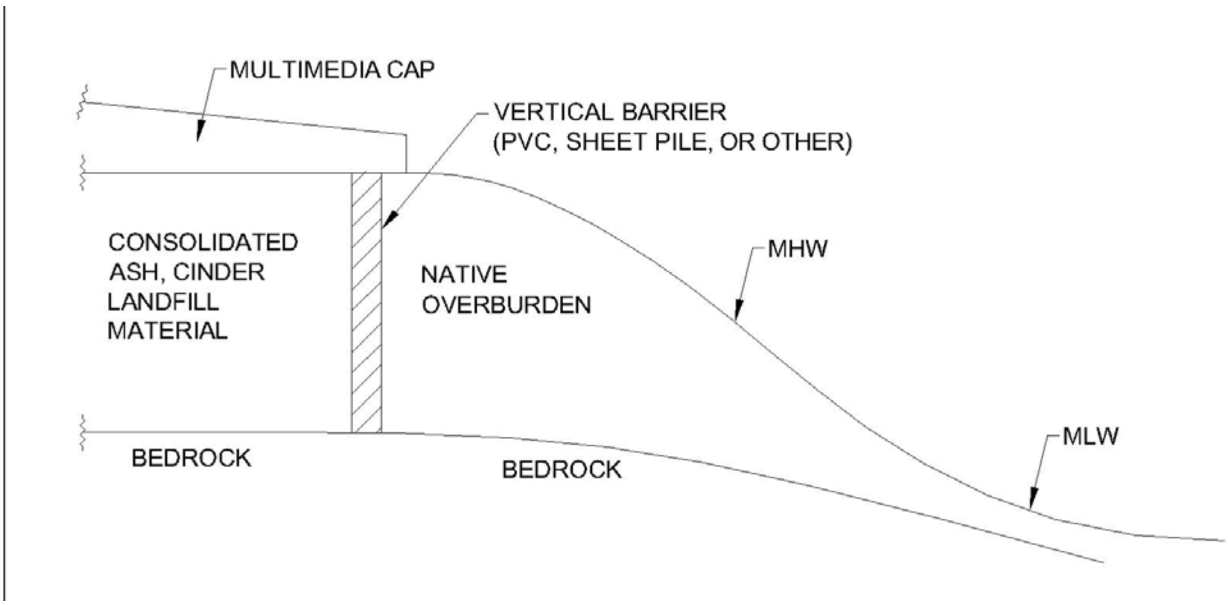
Monitoring and Site Reviews

Description: This process option includes periodic data collection (e.g., quarterly, annual, etc.) and review of the data to assess the current conditions at the site. These data would be used to determine if implemented remedial activities have achieved the RAOs or are continuing to be protective of human health and the environment as conditions improve towards achieving the RAOs. Should site reviews indicate conditions are worsening or the current conditions pose an unacceptable risk to human health or the environment, additional activities could be implemented.

Initial Screening: Periodic monitoring and site reviews are necessary to assess the progress of remedial activities and the protectiveness of implemented actions until RAOs are achieved. They are a necessary component of nearly all remedial actions, the exception being those that immediately achieve RAOs, and are therefore retained as a process option.

3.3.1.3 Containment

Containment provides isolation of contaminated soil from potential receptors and/or uncontaminated media. Capping technologies and/or vertical barriers can generally be used to contain contaminated soil, minimize human exposure to soil, control migration of contaminants, control migration of non-aqueous phase liquid (NAPL), and reduce leaching of contaminants from the soil to groundwater. Capping of contaminated soil at the Island could be achieved by using permeable soil caps, clay caps, asphalt caps, and multiple layer caps. Vertical barriers, including sheet piling, slurry walls and grout curtains, were retained for potential use as a vertical barrier around the on-site disposal area, and to support deeper excavations when necessary. The subsurface vertical barrier around the disposal area will act to spatially confine the consolidated landfill material, excavated soils and dewatered sediments within the disposal area and prevent this material from horizontal migration. The vertical barrier will be used in concert with a cap alternative to stabilize and complete the disposal area design. A conceptual vertical barrier and capping system is shown below:



A Conceptual Vertical Barrier Wall and Typical Capping System

Permeable Soil Cap

<u>Description</u>: A permeable soil cap can be installed over contaminated soil to mitigate direct contact with contaminants. A permeable soil cap would have a high permeability relative to clay, and would allow percolation of surface water, runoff, etc.

<u>Initial Screening</u>: A permeable soil cap would be effective in mitigating direct contact with contaminated surface soils; however, soil caps do not reduce contaminant migration to underlying soils or groundwater. Permeable soil caps are susceptible to erosion from climatic and storm

forces, which can be mitigated with a properly maintained vegetative cover. Permeable soil caps are also susceptible to settling, ponding of liquids, and naturally occurring invasions by burrowing animals and deep rooted vegetation if not properly maintained. This option is retained for the areas of the Island impacted with site-related contamination in surface and subsurface soils.

Clay Cap

Description: Clay caps are commonly used as cover for lands that contain both hazardous and non-hazardous wastes. Bentonite, a natural clay with high swelling properties, is often mixed with on-site soil and water to produce a low permeability layer. A low permeability clay cap would not only physically isolate the source, but also reduce the potential for leaching of contaminants to groundwater by creating a low permeability barrier.

Initial Screening: A clay cap would be effective in mitigating direct contact with contaminated soils and would also mitigate contaminant migration by reducing surface infiltration; however, clay caps do not mitigate contaminant migration beneath the water table. Clay, which consists of fine material, is susceptible to erosion from climatic and storm forces, which can be mitigated with a properly maintained vegetative cover. Proper particle distribution is essential to create a low permeability cap. Clay caps are also susceptible to cracking, settling, ponding of liquids, and naturally occurring invasions by burrowing animals and deep rooted vegetation if not properly maintained. This option is retained for the areas of the Island impacted with site-related contamination in surface and subsurface soils.

Asphalt Cap

Description: An asphalt cap would consist of graded soil and a gravel sub-base, with asphalt paving as a final cover. The cap would minimize wind and rain erosion, preserve slope stability, and provide protection from the elements for layers below it.

Initial Screening: Asphalt caps provide a low permeability cover to mitigate direct contact with contaminated soils and infiltration; however, asphalt caps do not mitigate contaminant migration beneath the water table. They are less susceptible to erosion from climatic and storm forces than a soil or clay cap. An asphalt cap is subject to cracking and settling if not properly maintained. However, it would be effective in achieving remedial action objectives for soil including mitigating direct contact with contaminated soils. Portions of the Island may be paved during site restoration activities. Therefore, this option is retained.

Membrane Cap

Description: A membrane cap would consist of synthetic materials. Membrane materials popularly include polymers, rubbers, and coated fabrics. The cap would minimize infiltration of precipitation and provide protection from the elements for layers below it.

Initial Screening: The major benefits of synthetic membranes are their availability and low permeability. There is the potential for failure in the long term due to damage from puncturing, tearing, or weathering. However, membranes can be used successfully through proper design and installation, including proper seaming and placement to prevent tearing, root penetration, and other surface damage. Therefore, this option is retained.

Multi-Media Cap

Description: A multi-media cap is a combination of two or more of the single layer capping technologies. A disadvantage of one cap type can be compensated for by an advantage of another. Most caps recommended for hazardous waste projects are multi-layer caps. The multi-media cap would typically consist of two feet of clay, a synthetic liner, filter fabric, one foot of sand, two feet of top soil, and vegetation at the top.

Initial Screening: The performance of a properly installed, multi-layered cap is generally excellent. There is still a need for periodic monitoring and maintenance of the cap but to a lesser extent than a single media cap. This type of cap would require more restrictions on future use of the site and would be less practical to install around buildings and on small areas while offering little increased benefit. However, this type of cap has the advantage of reducing infiltration, in addition to minimizing exposure. Therefore, this option is retained.

Sheet Piling

Description: This technique could be used as a subsurface vertical barrier whereby the soil within the enclosure is dewatered and soil remedial activities could proceed in a "dry" state. Steel or heavy gauge polyvinyl chloride (PVC) sheet piling cutoffs require very little maintenance. Recent advances in jointing technology have made sheet piling relatively resistant to leakage. Sheet piling would be installed below grade of the disposal area to provide a physical barrier between the compiled ash and cinder material and debris, isolating it from the surrounding subsurface overburden and horizontally containing the compiled material within the disposal area. The piling would be installed above the high water demarcation preventing direct exposure to tidal inundation. Rip rap rock will be used as a surficial barrier and shoreline stabilization layer of the edge of the cap and the vertical barrier as an added embankment stabilization layer.

Initial Screening: Sheet piling is not considered feasible for containment of the entire area of impacted soil. However, sheet piling may be used as a source control due to the potential pathway to underlying bedrock. Proper design will allow for installation is shallow bedrock. Therefore, sheet piling may be used as a permanent vertical barrier around the on-site disposal area, and for temporary support of deeper excavations. Therefore, this option is retained.

Slurry Walls

Description: Slurry walls are a common subsurface barrier because they are a relatively inexpensive means of reducing groundwater flow through contaminated source materials. Slurry walls are constructed in a vertical trench that is excavated under a slurry. This slurry, usually a mixture of bentonite and water, acts essentially like a drilling fluid. It hydraulically shores the trench to prevent collapse, and at the same time, forms a filter cake on the trench walls to prevent high fluid losses into the surrounding ground. In some cases, soil or cement are added to the bentonite slurry to form a soil-bentonite or cement-bentonite slurry wall. Slurry wall installation typically requires the handling of potentially contaminated excess spoils and can be difficult to manage near a tidal water body.

Initial Screening: Slurry walls are typically used when they can be "keyed" into a confining layer. A slurry wall is not considered feasible for containment of the entire area of impacted soil. However, this option is retained as a potential barrier around the on-site disposal area.

Grouting

Description: Grouting is typically accomplished by drilling a grout tool down to a given depth and then raising up the tool while injecting grout through the jet. The actual grouting injection locations may be at plan intervals close enough to ensure overlap of the known radius of a jet tool, or may be further apart based on the ability of the grout to penetrate undisturbed soils that are beyond the tool radius. This technique can be used to construct a full or partial vertical barrier.

Initial Screening: This process typically results in an excess material volume which needs to be managed and disposed. Grouting is not considered feasible for containment of the entire area of impacted soil. However this option is retained as a potential barrier around the on-site disposal area.

3.3.1.4 Removal

Removal involves physical removal of contaminated soil with the intention of subsequent treatment and/or disposal. This category includes excavation and is a preliminary or support technology as a part of *ex situ* treatment options that first require removal of the contaminated media.

Excavation

Description: Excavation refers to the use of construction equipment such as backhoes, bulldozers, front end loaders, and clamshells that are typically used on land to excavate and handle contaminated soil.

Initial Screening: Excavation of contaminated soil would be required as the initial material handling step in numerous remedial alternatives. Excavation could also be used to remove contaminated surface soils in areas other than the source areas. The excavation areas would be replaced by clean backfill, which may serve as a physical barrier to subsurface contamination that may not be excavated. Excavation is retained for contaminated surface and subsurface soils.

3.3.1.5 *In Situ* Treatment

Treatment technologies are used to change the physical or chemical state of a contaminant or to destroy the contaminant completely, thereby reducing volume, toxicity and/or mobility of the contaminant. *In situ* treatment is a technology category in which contaminated soil is treated "in place," without removal of the soil media. The technologies evaluated in this category are soil flushing/washing, stabilization, thermal treatment, biodegradation, and chemical oxidation.

In Situ Soil Flushing/Washing

Description: Contaminants can be washed from soils by means of an extraction process termed "soil washing." An aqueous solution (e.g., surfactant) is injected into the area of impacted material. As the aqueous solution flows through the impacted media, sorbed contaminants are mobilized into solution by reason of solubility, formation of an emulsion, or chemical reaction with the flushing solution. The solution, combined with the removed constituents, is then extracted from the subsurface utilizing wells and multi-phase extraction methods. Additional processes can be used to enhance the removal of insoluble contaminants. Treatment of the extracted aqueous waste is necessary prior to disposal.

Initial Screening: *In situ* soil washing relies on the hydraulic conductivity and homogeneity of the subsurface medium for proper transmission of the washing reagent throughout the saturated zone and contact with contaminants of concern. As noted above, the site geology includes fine grained soils (i.e., silts), subsurface structures, and various fragments (i.e., clay, brick, and coal fragments) which could negatively impact the ability of the washing reagent to reach the contaminants of concern and could also negatively impact ease of extraction. The low solubility of the heavier PAHs in the suspected facility operational areas could prevent effective soil washing even in the presence of a surfactant. The low solubility of the heavier metals in impacted areas could also prevent effective soil washing even in areas with less fine grained soils. Additionally, this process when used over a wide area could generate a substantial quantity of wastewater that would require treatment and disposal. In addition, close to the shore, there is also a potential to mobilize contamination, and therefore, a potential to discharge contaminated water to the surrounding Long Island Sound waters. Therefore, this technology is not retained.

In Situ Stabilization

Description: *In situ* solidification/stabilization is a process whereby contaminated soils are converted in-place into a stable cement-type matrix in which contaminants are bound or trapped and become immobile. Silicates can stabilize contaminants such as metals and some organics, including low concentrations of PAHs. It has been demonstrated that chemical fixation products of certain silicate-based mixtures do not leach metals and most organics. Large augers are used to inject the stabilizing reagents and mix the impacted material. Treatment may be achieved in both the saturated and unsaturated zones with this technology.

Initial Screening: For the site contaminants present, this process option could potentially stabilize the contaminated soil and reduce the risks associated with exposure. However, based on the generally shallow depth and large areal extent of contamination, in situ stabilization would not be a feasible remedy for the impacted soil across the Island. This technology is not retained for further evaluation.

In Situ Thermal Treatment

Description: *In situ* thermal treatment is a physical separation treatment process that utilizes steam introduced into the impacted material to strip off the organic constituents. Steam is injected into the periphery of the contaminated areas to vaporize and mobilize contaminants, which are then extracted at centrally located vapor and liquid extraction points. In combination, electrical heating may be used to vaporize contaminants in less permeable zones or lenses. Vapor and liquid collection and treatment systems would be required to process the extracted liquid and vapor prior to disposal. Treatment is achieved in both the saturated and unsaturated zones.

Initial Screening: This process option could effectively reduce the risks associated with soils contaminated with organic compounds under the physical conditions present. Treatability studies would be required prior to design of an *in situ* thermal treatment remedy for the site. However, metals, one of the prevalent COCs in soils, would not be effectively treated by *in situ* steam stripping. Furthermore, the process can result in phase separation and contaminant mobilization in mid-process and is therefore a concern near the waters of the Long Island Sound. Therefore, this technology is not retained for further evaluation.

In Situ Biodegradation

Description: Biological treatment involves the use of native microbes or selectively adapted bacteria to degrade a variety of organic compounds. The biological processes usually involve the addition of microbes, nutrients, and oxygen. To enhance the performance of microbial activity in the subsurface, oxygen is added to the saturated zone via either an oxygen releasing compound or controlled direct injection of air or oxygen itself. Treatment is generally only accomplished in the saturated zone.

Initial Screening: Contaminants at the site are generally occurring in the unsaturated zone. Therefore, this technology is not retained for further evaluation. Additionally, biodegradation is not applicable for the remediation of metals.

In Situ Chemical Oxidation

Description: This technology involves the use of a chemical reagent that is injected into the soil via constructed wells or driven wellpoints to break down organic constituents into carbon dioxide and water. Generally, a hydrogen peroxide-based mixture is used, with additives and catalysts to enhance the reaction characteristics. The amount of reagent needed, spacing of injection points, and frequency of addition to achieve cleanup goals are dependent upon organic concentrations and soil characteristics.

Initial Screening: This technology is not well established for inorganics in soils. However, this technology has been shown to be effective in the destruction of organic constituents. Bench scale testing, in combination with field pilot studies, would be necessary to further refine the operational conditions of this technology. There are two basic limits to this technology as possibly applied to the Project. First, the technology may not be capable of oxidizing PAH compounds to an appropriate extent. Second, if sufficient reagents cannot oxidize the targeted contaminants, then there is a potential to mobilize contaminants to the surrounding water body. Therefore, this process option is not retained for further evaluation. Additionally, oxidation is not an applicable remediation for metals.

3.3.1.6 *Ex Situ* Treatment

Treatment technologies may be implemented *ex situ* (i.e., after excavation of contaminated soil). The process options for *ex situ* treatment technologies that were evaluated include: reuse/recycling, solidification/stabilization, thermal desorption, incineration, biodegradation, soil washing, soil vapor extraction, and chemical reduction/oxidation.

Reuse/Recycling

Description: This category of process options includes the processing of removed impacted material at the site and use of the material as part of the process to produce an end product. These process options include: cold batch asphalt (on- or off-site), hot mix asphalt batching, brick manufacturing, cement manufacturing, and co-burning in an industrial boiler. In addition, it is sometimes practical to use lime to amend soils for moisture and to re-use slightly impacted soils at sites, thereby reducing the amount of imported backfill that is needed and reducing the amount of off-site disposal that is required to mitigate a site.

Initial Screening: Impacted soils may be responsive to on-site amending for moisture and for reuse at the site. However, limited excavation of soils from source areas may not result in reusable soils.

This option may be applicable for the reuse of slightly or non-impacted soils at the site, and is retained for further evaluation.

Solidification/Stabilization

Description: Stabilization is a process whereby contaminated soils are converted into a stable cement-type matrix in which contaminants are bound or trapped and become immobile. Generally, cementing additives are used, with other reagents as necessary to stabilize the organic constituents present in the site soil. A pug mill is used to thoroughly mix the impacted material with the additives.

Initial Screening: This process would be effective for the impacted material. This technology would immobilize contaminants in the soil matrix and would require long-term monitoring at the point of disposal. Bench testing would be required to identify the appropriate additives and dosage rates. This technology can be used for effective immobilization of constituents present at the site and therefore is retained for further evaluation as a process option.

Thermal Desorption

Description: The thermal desorption technology is a thermal stripping process. Prepared soils are introduced into the enclosed heated chamber using a heated screw or belt conveyor. Direct or indirect heating methods are used to volatilize organics from the soil. The off-gas containing the thermally stripped compounds is then combusted in an afterburner, adsorbed in a carbon adsorption unit or treated by catalytic oxidation designed to ensure removal of these compounds to acceptable levels. Typical operating temperatures for thermal stripping of organics are 400^{o}F to 900^{o}F; however, higher temperatures are achievable. Operating temperatures are selected based on the hydrocarbons present in the soil.

Initial Screening: The removed materials would require screening and dewatering as feedstock preparation for this process. The off-gas could potentially require the use of air pollution control devices. The residue will contain metals that may require additional treatment such as stabilization prior to disposal in a landfill. This technology is not retained as an option for on-site treatment; however, this technology may be implemented at an off-site treatment and disposal facility for pretreatment of contaminated soil prior to disposal.

Incineration

Description: Incineration is a thermal destruction method which can be used to destroy combustible waste materials including organic contaminants in soils. Incineration systems such as multiple hearth, rotary kiln, infrared and fluidized bed can treat highly-contaminated soils at high temperatures (1200^{o}F to 1800^{o}F in the primary chamber and at 1400^{o}F to 2400^{o}F in the secondary chamber). Infrared incineration systems are used primarily for solids or sludges.

Initial Screening: High temperature incineration is suitable for removal of volatile and semi-volatile organics in contaminated soils. The off-gas could potentially require the use of air pollution control devices. The residue will contain metals that may require additional treatment such as stabilization prior to disposal in a landfill. This technology is not retained as an option for on-site treatment; however, this technology may be implemented at an off-site treatment and disposal facility for pretreatment of contaminated soil prior to disposal.

Biodegradation

Description: Biological treatment involves the use of native microbes or selectively adapted bacteria to degrade a variety of organic compounds. The biological processes usually involve the addition of microbes, nutrients, oxygen, and moisture. The microbial action serves to effectively degrade the organic constituents. Several options for implementing this approach on-site for excavated materials exist, including constructing a biopile, landfarming, and composting. In order to minimize odors from this process, heavy polyethylene sheeting may be used as a cover.

Initial Screening: Aerobic biodegradation has been demonstrated to be effective on the organic constituents present on-site. Use of this option on-site would eliminate the need for off-site transportation and disposal of impacted material. Some of the heavier organics would require lengthy time frames to degrade. The residue may contain metals that may require additional treatment prior to biological treatment. Therefore, biodegradation is retained as an option to be used in conjunction with additional treatment.

Soil Washing

Description: Soil washing of excavated soil involves processing the impacted material in a reactor vessel or other treatment unit in conjunction with a reagent solution designed to remove the organic constituents from the native soil. Determining the reagent and reaction time would require the performance of bench and pilot studies to optimize the process.

Initial Screening: Significant feedstock preparation is required for this process option. *Ex situ* soil washing overcomes heterogeneity concerns associated with *in situ* soil washing; however, the low solubility of certain higher-ringed PAHs could still prevent effective treatment via this process option. Large volumes of aqueous wastes would also be generated and would require further treatment and disposal. This process option is not retained.

Chemical Reduction/Oxidation (Redox)

Description: This technology involves the use of a chemical reagent that is injected into stockpiled soil to chemically convert hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. Redox reactions involve the transfer of electrons from one compound to another. Specifically, one reactant is oxidized (loses electrons) and one is reduced (gains electrons). The oxidizing agents most commonly used for treatment of hazardous contaminants are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide. Chemical reduction/oxidation is a short- to medium-term technology. Generally, a hydrogen peroxide-based mixture is used, with additives and catalysts to enhance the reaction characteristics. The amount of reagent needed, spacing of injection points, and frequency of addition to achieve cleanup goals are dependent upon organic concentrations and soil characteristics.

Initial Screening: The target contaminant group for chemical redox is organics. The technology can be used but may be less effective against non-halogenated VOCs and SVOCs, fuel hydrocarbons, and pesticides. Therefore, redox is retained as an option to be used in conjunction with additional treatment.

3.3.1.7 Disposal

This category of remedial process options refers to disposal of impacted soil on- or off-site, with or without any treatment. The remedial technologies are on-site disposal area (with or without treatment) and off-site disposal (with or without treatment).

On-Site Disposal Area

Description: Impacted soil would be excavated and then disposed in an on-site upland disposal area. The historic landfill area located in Functional Area A-8 (historically used for disposal of incinerator ash material) would be used as the on-site upland disposal area. Non-hazardous waste could be disposed at this location.

Initial Screening: The historic landfill area could be used for on-site disposal of non-hazardous soil. Contaminated material placed in this area would need to be properly contained to mitigate potential for exposure and migration of contamination from the area. This process option is retained for further evaluation.

Off-Site Disposal

Description: Hazardous contaminated soil would be transported to a regulated facility and properly disposed following treatment (if necessary) to meet land disposal restrictions (LDRs) Non-hazardous soil can be directly disposed off-site at a permitted, non-hazardous facility or potentially reused (e.g., as landfill cover) after treatment if appropriate and in accordance with NYSDEC rules.

Initial Screening: High disposal costs and regulatory restrictions are associated with off-site disposal, and limited availability of off-site treatment facilities and landfill capacity make off-site disposal difficult. The cost of transporting excavated material by barge from the Island to an off-site disposal facility adds to the high cost of this disposal option. Off-site disposal to a non-hazardous landfill either directly or after *ex situ* treatment is a viable option. Hazardous and non-hazardous materials may be encountered during remedial operations. These materials would have to be managed appropriately and therefore this option is retained.

3.3.2 Selection of Process Options

Process options are evaluated on the basis of overall remedial effectiveness, technical implementability, and cost relative to site-specific conditions, contaminant types, and contaminant concentrations.

- Process option effectiveness focuses on: (1) the ability to process the estimated quantities of material and meet contaminant reduction goals; (2) the effectiveness of protecting human health and the environment during the construction and implementation phases; and (3) the reliability of the technology with respect to contaminants and site conditions;
- Implementability refers to how easy it will be to employ the process option based on site and contaminant characteristics; and
- The cost evaluation is preliminary and relies upon engineering judgment and vendor-provided information to generate a relative cost of process options within a technology type.

The initially screened and accepted soil process options were evaluated qualitatively based on effectiveness, implementability, and cost as described above. Comparisons were made within each technology type by assessing the effectiveness, implementability and cost of each process option as low, moderate, or high relative to other process options within the technology type. When significant variations between process options within a technology type do not exist, a moderate rating was assigned. Based on this evaluation, specific process options were selected for development of media-specific remedial alternatives. Process options that were not selected are still technically feasible and may be substituted for the selected process option during remedial design. The results of the process option evaluation and selection are summarized in Table 3-4.

3.3.3 Development of Alternatives

Remedial technology types and process options associated with each GRA were screened based on technical feasibility, considering site-specific conditions, contaminant types, and concentrations. Representative process options were selected for each technically feasible technology type by evaluating the process options qualitatively based on effectiveness, implementability, and cost. Based on this evaluation, specific process options were selected for development of media-specific remedial alternatives. Based on the screening and evaluation of technologies and process options, the following media-specific remedial alternatives were developed for soils at the Island:

- Alternative SL-1: No Further Action
- Alternative SL-2: No Further Action with Site Management (Limited Action)
- Alternative SL-3: Removal of COCs in Soil Exhibiting Concentrations in Excess of NYSDEC Commercial Use SCOs
- Alternative SL-4: Removal of COCs in Soil Exhibiting Concentrations in Excess of NYSDEC Restricted-Residential Use SCOs
- Alternative SL-5: Removal of COCs in Soil Exhibiting Concentrations in Excess of NYSDEC Unrestricted Use SCOs

3.3.4 Preliminary Screening of Alternatives

The next stage in the evaluation typically consists of a preliminary screening of potential remedial alternatives based on the general criteria of effectiveness, implementability, and cost. The purpose of the screening step is to reduce the number of alternatives requiring detailed evaluation by identifying those alternatives having sufficient merit to undergo detailed evaluation. This is achieved by eliminating remedial alternatives that have significant adverse environmental or public health impacts or cannot be successfully implemented. Costs may be used to discriminate between treatment alternatives in the screening process, but not between treatment and non-treatment alternatives. As a result of the relatively small number of feasible alternatives developed, preliminary screening was not performed; all of the alternatives identified in the previous section were carried forward for detailed evaluation in Section 4.0.

4.0 DETAILED ANALYSIS OF ALTERNATIVES FOR SOIL

4.1 Detailed Analysis of Alternatives

This section presents descriptions of each remedial alternative for soil and the results of the evaluation of the alternatives against the seven criteria defined above.

4.1.1 Alternative SL-1: No Further Action

The No Further Action alternative includes no active remediation at the Site. All contaminated soils (i.e., material posing a potential threat to human health and/or the environment) would be left in place with no treatment or controls to prevent future exposure to contaminated media. Periodic reviews would be performed to assess any changes in the risk to human health and the environment posed by the Site. This alternative is developed as a basis of comparison for other alternatives.

4.1.1.1 Overall Protection of Human Health and the Environment

The No Further Action alternative would not remove, contain, or treat the contaminated media. Therefore, potential risks to human health and the environment resulting from contaminated soil above cleanup levels would remain unchanged. Risks associated with the potential for direct contact of contaminated soil would persist. In addition, there is the continued potential for migration of contaminants.

4.1.1.2 Compliance with SCGs

The No Further Action alternative does not comply with chemical-specific SCGs since no action would be taken to address contaminants in soil exceeding NYSDEC SCOs. Action- and location-specific SCGs are not triggered, since no on-site remedial activities would be performed.

4.1.1.3 Short-Term Impacts and Effectiveness

Under the No Further Action alternative there would be no short-term impacts to workers or the surrounding community. No construction would be required for implementation of this alternative. Workers conducting periodic reviews would potentially be exposed to contaminated soil. However, there is a Health and Safety Plan (HASP) in place for the property that requires use of PPE to minimize the risks of direct contact. This alternative would not result in any short-term improvement over current conditions. As no design or construction activities are required for this alternative, it would take no time to implement.

4.1.1.4 Long-Term Effectiveness

The No Further Action alternative would have no long-term effectiveness and/or permanence. The magnitude of human health and ecological risks would be the same following implementation of this alternative. No engineering controls would be implemented to manage the remaining contaminated material.

4.1.1.5 Reduction of Toxicity, Mobility, and/or Volume

This alternative would not involve any containment, removal, treatment, or disposal of the contaminated soil. Therefore, this alternative would not provide any reduction in the toxicity, mobility, and/or volume of contaminants.

4.1.1.6 Feasibility

There are no technical feasibility concerns with the No Further Action alternative. The effectiveness of the remedy would be evaluated during the periodic reviews and implementation of this alternative would not preclude further remedial action in the future.

There are no administrative feasibility concerns with this alternative. As this alternative involves no construction activities, availability of resources and use of proven technologies is not applicable. Consulting services are readily available for the periodic reviews. Coordination with regulatory agencies would be required for making decisions regarding any future remedial alternatives. However, there are no concerns with the ability or time required to interact with regulatory agencies.

4.1.1.7 Cost

There is no capital cost or annual O&M cost for the No Further Action alternative. Small periodic costs associated with site reviews to assess current conditions may be incurred.

4.1.2 Alternative SL-2: No Further Action with Site Management (Limited Action)

This alternative includes no active remediation at the Site. All contaminated soils (i.e., material posing a potential threat to human health and/or the environment) would be left in place with no treatment and limited controls to prevent future exposure to contaminated media. Under this alternative, deed restrictions and/or environmental easements would be implemented to restrict future use of the Site. Access restrictions and signs (as necessary) would be put in place. A HASP and Site Management Plan would be developed and implemented to describe (for example) adequate control measures and PPE/monitoring to be implemented during intrusive activities. Periodic reviews would also be performed to assess changes in the potential risk to human health and the environment posed by the Site.

4.1.2.1 Overall Protection of Human Health and the Environment

This alternative would not remove, contain, or treat the contaminated media resulting in continued source areas. Risks to human health resulting from contaminated soil above cleanup levels would be mitigated by institutional controls; deed restrictions and/or environmental easements, and proper implementation of the HASP and Site Management Plan would help mitigate risks. Fencing and signs would also help mitigate potential risks associated with direct contact exposure. However, there is the continued potential for migration of contaminants.

4.1.2.2 Compliance with SCGs

This alternative does not comply with chemical-specific SCGs since no action would be taken to address NYSDEC SCO exceedances. Action- and location-specific SCGs are not triggered, since no on-site remedial activities would be performed.

4.1.2.3 Short-Term Impacts and Effectiveness

Under this alternative there would be no short-term impacts to workers or the surrounding community. Minimal construction would be required for implementation of this alternative. Through development and implementation of a HASP, direct contact risks would be minimized; use of PPE would be required during intrusive activities. The Site Management Plan would help to mitigate risks. The time required to implement this alternative would be approximately six months.

4.1.2.4 Long-Term Effectiveness

Potential human health risks would be reduced by institutional controls following implementation of this alternative. Limited controls would be implemented to manage the remaining contaminated material, consisting of fencing, restricting future use, and prohibiting the use of groundwater at the Site. These controls would be effective at mitigating risks, though there is the potential for violation of these controls. Risks at the Site would be re-evaluated during the periodic.

4.1.2.5 Reduction of Toxicity, Mobility, and/or Volume

This alternative would not involve any containment, removal, treatment, or disposal of the contaminated soil. Therefore, this alternative would not provide any reduction in the toxicity, mobility, and/or volume of contaminants.

4.1.2.6 Feasibility

There are no technical feasibility concerns associated with this alternative for soil. The effectiveness of the remedy would be evaluated during the periodic reviews. As this alternative involves limited construction activities, availability of resources and use of proven technologies is not a concern. Consulting services are readily available for negotiation and implementation of deed restrictions and/or environmental easements, and HASP and Site Management Plan. Services are also available for conducting periodic reviews.

4.1.2.7 Cost

The capital cost associated with negotiation and implementation of the required institutional controls is $863,000. The O&M cost to maintain this alternative is estimated to be $66,000 per year. The net present cost of the alternative, based on a 30-year period of performance and a 3% discount rate, is $2.2M.

4.1.3 Alternative SL-3: Removal of COCs in Soil Exhibiting Concentrations in Excess of NYSDEC Commercial Use SCOs

Implementation of Alternative SL-3 would allow passive recreational use by removing the contaminated surface soil exceeding the commercial use SCOs to a depth of 1 foot bgs in all areas except for the historic incinerator landfill area (proposed upland disposal area), installing a vertical barrier wall on the easterly perimeter of the proposed disposal area and multi-media capping. Administrative controls such as signage would be used to enhance uses where acceptable and discourage access in the upland disposal area.

Of the constituents detected in surface soils, three PAHs [benzo(a)pyrene, benzo(a)anthracene, and indeno(1,2,3-cd)pyrene] and three metals [arsenic, lead, and mercury] were the most frequently detected at concentrations exceeding criteria during the SI. Due to their exceedance frequency, these six constituents were considered the main COCs for the alternative analysis. For the purposes of showing the overall horizontal extent of surface soil contamination, isopleths of the COCs were developed, and the areas where one or more of the constituents were present above CSCOs are shown on Figure 4-1.

As part of this alternative, surface soils would be removed horizontally to the extent of contamination above NYSDEC CSCOs for these main COCs in all areas except for the historic incinerator landfill area, as shown on Figure 4-1. In total, approximately 10.8 acres of surface soils will be removed.

Soils will be excavated to a depth of 1 foot in all areas. The total volume of soil to be removed as part of this alternative would be approximately 17,424 cubic yards (CY). Although not anticipated due to the shallow excavation depth, any water removed during soil excavation would be collected and would need to be sampled and analyzed for treatment/disposal.

Post-remediation confirmatory sampling is included as part of this alternative in areas where soil would be removed. Post-remediation sampling would be performed to ensure that remedial objectives have been met.

Any hazardous materials that are encountered would be managed in accordance with the appropriate protocols for these materials. During the SI, soil samples were collected from select locations across the Island where chemical analysis of previous soil samples generally exhibited more elevated concentrations of constituents and/or SCO exceedances. These samples were then submitted to the laboratory for Toxicity Characteristic Leaching Procedure (TCLP) analysis, to evaluate the presence of hazardous material at these locations. Two locations on the Island indicated the potential for material with hazardous levels of lead; results of the TCLP analyses are provided in Table 4-11 of the SI Report. Therefore, hazardous soil removal and unforeseen subsurface conditions are included as a contingency.

Excavated surface soils that are not affected by hazardous-level wastes would be removed and disposed at the on-site upland disposal area (the historic incinerator landfill area). Prior to placement of contaminated soils in the upland area, a vertical barrier wall would be constructed around the historic landfill area. The final design of the vertical barrier wall would require completion of a pre-design investigation and detailed groundwater modeling, and therefore the final location and design would be determined during the remedial design phase of the project. The vertical barrier will be positioned behind the delineated boundary of the adjacent wetland area. Figure 4-1 shows the proposed approximate location of the vertical barrier wall. Approximately 1,500 linear feet of barrier wall would be installed. The barrier wall technology for this analysis is assumed to use an impermeable wall constructed in a shallow trench and founded upon shallow bedrock. In areas of deeper bedrock, a bentonite slurry cut-off wall would be mixed in place using a trench box.

After placement of contaminated soils in the upland disposal area, a multi-media cap would be constructed over the upland disposal area to reduce human exposure, infiltration, and contaminant migration. The multi-media cap would cover an area of approximately 2.44 acres as shown on Figure 4-1. The final design of the multi-media cap would coincide with the vertical barrier wall determined during the remedial design phase of the project. One potential multi-media cap would consist of 6 inches of crushed concrete demolition debris, a geosynthetic liner, 1 foot of top soil, and vegetation at the top. In this configuration, the geosynthetic membrane would only be placed above the demolition debris if approved by the membrane manufacturer. Any multi-media cap would need to be periodically monitored and maintained but to a lesser extent than a permeable soil cap.

Clean backfill would replace areas where surface soil is removed. The placement of clean backfill (soil) to 1 foot deep in the excavated areas would serve as a protective, permeable cap. The purpose of a cap is to protect potential human receptors from exposure to residual contaminants in subsurface soil above NYSDEC CSCOs. Based on prior efforts on the Island, spud barges were used for loading and off-loading material, therefore navigational dredging will not be required.

Also included in this alternative are institutional controls, consisting of deed and access restrictions, environmental easements, development and implementation of a HASP, and development and implementation of a cap area management plan, which would be included within the Site Management Plan. Periodic reviews would also be performed to assess any changes in the risk to human health and the environment posed by the Site.

4.1.3.1 Overall Protection of Human Health and the Environment

This alternative would remove contaminated surface soil to 1 foot bgs in all areas except the historic incinerator landfill area. The potential risks to human health and the environment resulting from the presence of contaminants left in place at concentrations above cleanup levels would be reduced by capping. Implementation of a soil cap over residual contaminated soil and a multi-media cap over the historic incinerator landfill area would reduce the potential risks of migration in soils above bedrock and direct contact. Installation of a vertical barrier around the historic incinerator landfill (proposed upland disposal area) would reduce contaminant migration to the surrounding soils and near-shore sediments. Deed restrictions and/or environmental easements in conjunction with the development of a HASP and implementation of a cap area management plan would further mitigate risks.

4.1.3.2 Compliance with SCGs

This alternative would not comply with chemical-specific SCGs at depth because contaminated soils would be left in place below 1 foot bgs. Excavation and disposal of contaminated material would be performed in accordance with all applicable action- and location-specific SCGs. Installation of the vertical barrier wall and cap would also be performed in accordance with all applicable action- and location-specific SCGs.

4.1.3.3 Short-Term Impacts and Effectiveness

This alternative would involve substantial on-site construction activities, transportation of hazardous soil off-site, and movement of contaminated soil to an on-site upland disposal area. The vertical barrier wall would be installed primarily on the outside of the upland disposal area to minimize potential contaminant migration during installation. There would be a moderate risk of exposure to contaminants that may be mobilized during these activities. There would also be significant risks typically associated with construction activities, including movement of heavy equipment. Risks would be addressed by developing and implementing a HASP to provide protection for on-site workers. In addition, appropriate engineering controls (i.e., controlling access, etc.) would be needed. The timeframe required for implementation of this alternative is approximately 4 to 6 months.

4.1.3.4 Long-Term Effectiveness

The soil removal to SCG-based remedial goals to 1 foot bgs would have moderate long-term effectiveness and/or permanence in conjunction with capping and construction of a barrier wall.

The magnitude of potential human health and ecological risks would be mitigated by (1) removing a source of contamination (i.e., contaminated surface soils); (2) reducing contaminant migration; and (3) capping to prevent direct contact with contaminated subsurface soils and potentially limit surface water infiltration. Institutional controls would be implemented to manage remaining contaminated material, consisting of restricting future use and prohibiting the use of groundwater at the Site. The long-term effectiveness of this alternative is dependent on proper removal of surface soil, proper construction of a vertical barrier wall, proper construction and maintenance of the capped areas, and implementation of a cap area management plan. The magnitude of human health and ecological risks would be significantly reduced across the Island following implementation of this alternative.

4.1.3.5 Reduction of Toxicity, Mobility, and/or Volume

Removal of contaminated surface soil, capping, and installation of a barrier wall would reduce the potential for migration of contaminants. There would be a reduction in the area of contaminated soils and a reduction in the volume of hazardous material remaining at the Site following remedy implementation. Contaminated soil in the top 1 foot of the Site would be removed from all areas except for the historic incinerator landfill area which would become the upland disposal area. Relocation of impacted soils would reduce infiltration and mobility of contamination in remaining subsurface soils. The quantity of contaminated soil at the historic incinerator landfill area would increase; however, the mobility of contamination would be reduced by the barrier wall and by minimizing infiltration at the upland disposal with a multi-media cap.

4.1.3.6 Feasibility

Technical Feasibility: Surface soil excavation, transportation, disposal, vertical barrier wall installation, and capping are conventional technologies that are typically easy to implement. However, due to the geographic location of the Site, conventional technologies would be more difficult to implement. The majority of excavated soils would be transported to the on-site upland disposal area, minimizing the amount of materials to be transported off the Island. Soil excavation would not extend below approximately 1 foot bgs; therefore, technical challenges are not anticipated and conventional equipment can be used. Based on historic information, the majority of underground utilities on the Island are abandoned; however; there is a Con Edison-owned utility corridor for a 345 kilovolt (kV) underground transmission line on the southwestern side of the Island. Utility mark-outs are required before any intrusive activities in this area. In addition, any excavation work within 50 feet of the Con Edison property would require oversight by Con Edison personnel.

There are no significant groundwater resources present in the overburden soils or the bedrock to depths of 120 feet bgs at the Island. Limited areas of seasonally observed perched groundwater were encountered in the overburden materials during the SI and previous investigations. No groundwater dewatering is anticipated in this shallow removal alternative.

Future subsurface actions, if necessary, may require disturbing the cap and/or the vertical barrier wall; however, they could easily be implemented and disturbed portions could be repaired/ replaced, as necessary in accordance with a Site Management Plan.

Administrative Feasibility: Administratively, this alternative would be relatively easy to implement. Transportation of contaminated material to the on-site upland disposal would be relatively easy. An acceptable transportation plan for hazardous waste to be transported from the Island to an appropriate disposal facility would be established. Coordination with local authorities would be required to establish an acceptable transportation plan for transportation of backfill, cap materials, and vertical barrier materials to the Island. Coordination with regulatory agencies would also be required for periodic reviews. However, there are no concerns with the ability or time required to interact with local and regulatory agencies.

Availability of Services and Materials: Equipment, labor, and materials are available for all constructional components of this alternative. Consulting services are readily available for negotiation and implementation of deed restrictions, environmental easements, the HASP and the Site Management Plan. Services are also available for conducting periodic reviews and performing cap maintenance activities.

4.1.3.7 Cost

The estimated capital cost associated with this alternative and implementation of the required institutional controls is $12.1M. The O&M cost to maintain this alternative is estimated to be $133,000 per year. The net present cost of the alternative, based on a 30-year period of performance and a 3% discount rate, is $ 14.7M. See Appendix A for details.

4.1.4 Alternative SL-4: Removal of COCs in Soil Exhibiting Concentrations in Excess of NYSDEC Restricted-Residential Use SCOs

Alternative SL-4 would include the removal of soil with contamination in excess of the restricted-residential SCOs to a depth of 2 feet bgs in all areas except for the historic incinerator landfill area (proposed upland disposal area), installation of a vertical barrier wall, and multi-media capping.

Of the constituents detected in surface soils, three PAHs [benzo(a)pyrene, benzo(a)anthracene, and indeno(1,2,3-cd)pyrene] and three metals [arsenic, lead, and mercury] were the most frequently detected at concentrations exceeding criteria during the SI. Due to their exceedance frequency, these six constituents were considered the main COCs for the alternative analysis. For the purposes of showing the overall horizontal extent of surface soil contamination, isopleths of the COCs were developed, and the areas where one or more of the constituents were present above RRSCOs are shown on Figure 4-2.

As part of this alternative, surface soils would be removed horizontally to the extent of contamination above NYSDEC RRSCOs for these main COCs in all areas except for the historic incinerator landfill area, as shown on Figure 4-2. A total area of approximately 14.8 acres of surface soils will be removed.

Contaminated soils will be excavated to a depth of 2 feet in all areas. The total volume of soil to be removed as part of this alternative would be approximately 47,755 CY. Any water removed during soil excavation would be collected and would need to be sampled and analyzed for treatment/disposal.

Post-remediation confirmatory sampling is included as part of this alternative in areas where soil would be removed. Post-remediation sampling would be performed to ensure that remedial design objectives have been met.

Any hazardous materials that were encountered would be managed in accordance with the appropriate protocols for these materials. During the SI, soil samples were collected from select locations across the Island where chemical analysis of previous soil samples generally exhibited more elevated concentrations of constituents and/or SCO exceedances. These samples were then submitted to the laboratory for TCLP analysis, to evaluate the presence of hazardous material at these locations. Two locations on the Island indicated the potential for material with hazardous levels of lead; results of the TCLP analyses are provided in Table 4-11 of the SI Report. Therefore, hazardous removal and unforeseen subsurface conditions are cost estimated as a contingency.

Excavated surface soils that are not affected by hazardous-level wastes would be removed and disposed at the on-site upland disposal area (the historic incinerator landfill area). Prior to placement of contaminated soils in the upland area, a vertical barrier wall would be constructed around the historic landfill area. The final design of the vertical barrier wall would require completion of a pre-design investigation and detailed groundwater modeling, and therefore the final location and design would be determined during the remedial design phase of the project. The vertical barrier wall will be positioned behind the delineated boundary of the adjacent wetland area so no encroachment of this area would be affected by the barrier placement. Figure 4-2 shows the proposed horizontal extent of the vertical barrier wall. Approximately 1,500 linear feet of barrier wall would be installed. The barrier wall technology for this analysis is assumed to use an impermeable wall constructed in a shallow trench and founded upon shallow bedrock. In areas of deeper bedrock, a bentonite slurry cut-off wall would be mixed in place using a trench box.

After placement of contaminated soils in the upland disposal, a multi-media cap would be constructed over the historic landfill to reduce human exposure, infiltration, and contaminant migration. The multi-media cap would cover an area of approximately 2.44 acres as shown on Figure 4-2. The cap would consist of 6 inches of crushed concrete demolition debris, a geosynthetic liner, 1 feet of top soil, and vegetation at the top. The multi-media cap would be periodically monitored and maintained but to a lesser extent than a permeable soil cap.

Clean backfill would replace all areas where surface soil is removed; the backfill depth after removal for Alternative SL-4 is proposed at 2 feet. The placement of clean backfill (soil) in the top 24 inches of the excavated areas would serve as a protective, permeable cap. The purpose of a cap is to protect potential human receptors from exposure to contaminants in subsurface soil above NYSDEC RRSCOs. Based on prior efforts on the Island, spud barges were used for loading and off-loading material, therefore navigational dredging will not be required.

Also included in this alternative are institutional controls, consisting of deed and access restrictions, environmental easements, development and implementation of a HASP, and development and implementation of a cap area management plan which would be included within the Site Management Plan. Periodic reviews would also be performed to assess any changes in the risk to human health and the environment posed by the Site.

4.1.4.1 Overall Protection of Human Health and the Environment

This alternative would remove contaminated surface soil in all areas except the historic incinerator landfill area to 2 feet bgs. The potential risks to human health and the environment resulting from the presence of contaminants left in place at concentrations above cleanup levels would be reduced by capping. Implementation of a cap over contaminated soil and over the historic incinerator landfill area would reduce the potential risks of migration in soils above bedrock and direct contact. Installation of a vertical barrier around the historic incinerator landfill (proposed upland disposal area) would reduce contaminant migration to the surrounding soils and near-shore sediments. Deed restrictions and/or environmental easements in conjunction with the development and implementation of a HASP would help mitigate risks. Development and implementation of a cap area management plan would also help to mitigate risks.

4.1.4.2 Compliance with SCGs

This alternative would not fully comply with chemical-specific SCGs because contaminated soils would be left in place at depth. Excavation and disposal of contaminated material would be performed in accordance with all applicable action- and location-specific SCGs. Installation of the vertical barrier wall and cap would also be performed in accordance with all applicable action- and location-specific SCGs.

4.1.4.3 Short-Term Impacts and Effectiveness

This alternative would involve substantial on-site construction activities, transportation of hazardous soil off-site, and movement of contaminated soil to an on-site upland disposal area. The vertical barrier wall would be installed primarily on the outside of the upland disposal area to minimize potential contaminant migration during installation. There would be a moderate risk of exposure to contaminants that may be mobilized during these activities. There would also be significant risks typically associated with construction activities, including movement of heavy equipment. Risks would be addressed by developing and implementing a HASP to provide protection for on-site workers. In addition, appropriate engineering controls (i.e., controlling access, etc.) would be needed. The timeframe required for implementation of this alternative is approximately 6 to 8 months.

4.1.4.4 Long-Term Effectiveness

The soil removal to SCG-based remedial goals to 2 feet bgs would have moderate long-term effectiveness and/or permanence in conjunction with capping, and construction of a barrier wall. The magnitude of potential human health and ecological risks would be mitigated by (1) removing contaminated soils; (2) reducing contaminant migration; and (3) capping to prevent direct contact with contaminated subsurface soils and potentially limit surface water infiltration. Institutional controls would be implemented to manage remaining contaminated material, consisting of restricting future use and prohibiting the use of groundwater at the Site. The long-term effectiveness of this alternative is dependent on proper removal of surface soil, proper construction of a vertical barrier wall, proper construction and maintenance of the capped areas, and implementation of a cap area management plan. The magnitude of human health and ecological risks would be significantly reduced across the Island following implementation of this alternative.

4.1.4.5 Reduction of Toxicity, Mobility, and/or Volume

Removal of surface soil contaminated above RRSCOs, capping, and installation of a barrier wall would reduce the potential for migration of contaminants. There would be a significant reduction in the area of contaminated soils and a reduction in the volume of hazardous material remaining at the Site following remedy implementation. Contaminated soil in the top 2 feet of the Site would be removed from all areas except for the historic incinerator landfill area which would become the upland disposal area. Relocation of impacted soils would reduce infiltration and mobility of contamination in remaining subsurface soils. The quantity of contaminated soil at the historic incinerator landfill area would increase; however, the mobility of contamination would be reduced by the barrier wall and by minimizing infiltration at the upland disposal area with a multi-media cap.

4.1.4.6 Feasibility

Technical Feasibility: Soil excavation, transportation, disposal, vertical barrier wall installation, and capping are conventional technologies that are typically easy to implement. However, due to the geographic location of the Site, conventional technologies would be more difficult to implement. The majority of excavated soils would be transported to the on-site upland disposal area, minimizing the amount of materials to be transported off the Island. Soil excavation would not extend below approximately 2 feet bgs; therefore, technical challenges are not anticipated and conventional equipment can be used. Based on historic information, the majority of underground utilities on the Island are abandoned; however; there is a Con Edison-owned utility corridor for a 345 kV underground transmission line on the southwestern side of the Island. Utility mark-outs are required before any intrusive activities in this area. In addition, any excavation work within 50 feet of the Con Edison property would require oversight by Con Edison personnel.

There are no significant groundwater resources present in the overburden soils or the bedrock to depths of 120 feet bgs at the Island. Limited areas of seasonally observed perched groundwater were encountered in the overburden materials during the SI and previous investigations. No groundwater dewatering is anticipated in this shallow removal alternative.

Future subsurface actions, if necessary, may require disturbing the cap and/or the vertical barrier wall; however, they could easily be implemented and disturbed portions could be repaired/replaced, as necessary in accordance with a Site Management Plan.

Administrative Feasibility: Administratively, this alternative would be relatively easy to implement. Transportation of contaminated material to the on-site upland disposal area would be relatively easy. An acceptable transportation plan for hazardous waste to be transported from the Island to an appropriate disposal facility would be established. Coordination with local authorities would be required to establish an acceptable transportation plan for transportation of backfill, cap materials, and vertical barrier material to the Island. Coordination with regulatory agencies would also be required for periodic reviews. However, there are no concerns with the ability or time required to interact with local and regulatory agencies.

Availability of Services and Materials: Equipment, labor, and materials are available for all constructional components of this alternative. Consulting services are readily available for negotiation and implementation of deed restrictions, environmental easements, the HASP and the Site Management Plan. Services are also available for conducting periodic reviews and performing cap maintenance activities.

4.1.4.7 Cost

The estimated capital cost associated with this alternative and implementation of the required institutional controls is $20.7M. The O&M cost to maintain this alternative is estimated to be $204,000 per year. The net present cost of the alternative, based on a 30-year period of performance and a 3% discount rate, is $24.8M. See Appendix A for details.

4.1.5 Alternative SL-5: Removal of COCs in Soil Exhibiting Concentrations in Excess of NYSDEC Unrestricted Use SCOs

Alternative SL-5 would include the removal of surface and subsurface soil exceeding the unrestricted use SCOs. Excavation depth would vary, but is expected to average approximately 4 feet across the Island, with maximum depths of approximately 16 feet bgs in certain areas. All excavated soils would be transported off-site for treatment (if necessary) and disposal.

Of the constituents detected in on-site soils, three PAHs [benzo(a)pyrene, benzo(a)anthracene, and indeno(1,2,3-cd)pyrene] and three metals [arsenic, lead, and mercury] were the most frequently detected at concentrations exceeding criteria during the SI. Due to their exceedance frequency, these six constituents were considered the main COCs for the alternative analysis. For the purposes of showing the overall horizontal extent of surface soil contamination, isopleths of the COCs were developed, and the areas where one or more of the constituents were present above USCOs are shown on Figure 4-3.

As part of this alternative, soils would be removed horizontally to the extent of contamination above NYSDEC USCOs across the entire Island as shown on Figure 4-3. An approximate total area of 59.4 acres of soils will be removed.

Soils will be excavated to an estimated average depth of 4 feet in all areas. The total volume of soil to be removed as part of this alternative would be approximately 383,328 CY. Any water removed during soil excavation would be collected and would need to be sampled and analyzed for treatment/disposal.

Post-remediation confirmatory sampling is included as part of this alternative in areas where soil would be removed. Post-remediation sampling would be performed to ensure that remedial design objectives have been met.

Any hazardous materials that were encountered would be managed in accordance with the appropriate protocols for these materials. During the SI, soil samples were collected from select locations across the Island where chemical analysis of previous soil samples generally exhibited more elevated concentrations of constituents and/or SCO exceedances. These samples were then submitted to the laboratory for TCLP analysis, to evaluate the presence of hazardous material at these locations. Two locations on the Island indicated the potential for material with hazardous levels of lead. Results of the TCLP analyses are provided in the SI Report. Therefore, hazardous removal and unforeseen subsurface conditions are cost estimated as a contingency.

Excavated soils would be removed from the island. No vertical barrier wall or capping would be required. Clean backfill would replace all areas where soil is removed. Based on prior efforts on the Island, spud barges were used for loading and off-loading material, therefore navigational dredging will not be required.

This alternative would not require institutional controls or periodic reviews, since all contamination would be removed from the Island.

4.1.5.1 Overall Protection of Human Health and the Environment

This alternative would remove contaminated soil exceeding USCOs throughout the Island. Risks to human health and the environment from contaminated soil would be eliminated by excavation off-site disposal of contaminated soil. There would be no future land use restrictions or long-term O&M required.

4.1.5.2 Compliance with SCGs

This alternative would comply with chemical-specific SCGs because contaminated soil would be removed to the USCOs. Excavation and disposal of contaminated material would be performed in accordance with all applicable action- and location-specific SCGs.

4.1.5.3 Short-Term Impacts and Effectiveness

This alternative would involve substantial on-site construction activities and transportation of a large quantity of soil off-site. There would be a substantial risk of exposure to contaminants that may be mobilized during these activities. There would also be significant risks typically associated with construction activities, including movement of heavy equipment. Risks would be addressed by developing and implementing a HASP to provide protection for on-site workers. In addition, appropriate engineering controls (*i.e.*, controlling access, etc.) would be needed. The timeframe required for implementation of this alternative is approximately 18-24 months.

4.1.5.4 Long-Term Effectiveness

The soil removal to SCG-based remedial goals would have excellent long-term effectiveness and permanence, since contaminated soil would be excavated and transported off-site for disposal. Human health and ecological risks eliminated across the Island following implementation of this alternative.

4.1.5.5 Reduction of Toxicity, Mobility, and/or Volume

In this alternative, contaminated soils at the Site would be removed from all areas. Removal of contaminated soils above USCOs would eliminate the mobility and volume of contaminated soil on the Island. Further reduction in toxicity and/or volume may be achieved via off-site treatment (if necessary) prior to off-site disposal.

4.1.5.6 Feasibility

Technical Feasibility: Soil excavation, transportation and disposal are conventional technologies that are typically easy to implement. However, due to the geographic location of the Site, conventional technologies would be more difficult to implement. An extremely large volume of contaminated soil would need to be excavated, managed and transported off the Island. Excavation depths may require shoring and dewatering. Conventional equipment can be used, however, technical challenges are anticipated. Based on historic information, the majority of underground utilities on the Island are abandoned; however; there is a Con Edison-owned utility corridor for a 345 kV underground transmission line on the southwestern side of the Island. Utility mark-outs are required before any intrusive activities in this area. In addition, any excavation work within 50 feet of the Con Edison property would require oversight by Con Edison personnel.

There are no significant groundwater resources present in the overburden soils or the bedrock to depths of 120 feet bgs at the Island. Limited areas of seasonally observed perched groundwater were encountered in the overburden materials during the SI and previous investigations. Based on the depths of the excavations, perched water may be encountered in select areas of the Island, and dewatering with off-site treatment and disposal may be required.

Administrative Feasibility: Administratively, this alternative would be relatively easy to implement. An acceptable transportation plan for hazardous waste to be transported from the Island to an appropriate disposal facility would be established. Coordination with local authorities would be required to establish an acceptable transportation plan for transportation of backfill and other required construction materials (e.g., equipment, sheet piles, etc.) to the Island. There are no concerns with the ability or time required to interact with local and regulatory agencies for implementation of this alternative.

Availability of Services and Materials: This alternative would require a long time to implement and would require substantial resources (e.g., labor, vehicles for transportation of soil both on and off Island, backfill materials, etc.). Although construction on an Island will pose additional challenges; equipment, labor, and materials should be available for all construction components of this alternative.

4.1.5.7 Cost

The estimated capital cost associated with this alternative and implementation of the required institutional controls is $ 112M. The O&M cost to maintain this alternative is estimated to be $35,250 per year. The net present cost of the alternative, based on a 30-year period of performance and a 3% discount rate is $ 113M. See Appendix A for details.

4.2 Comparative Analysis of Alternatives

The following section compares the relative performance of each of the five soil remedial alternatives using the specific evaluation criteria presented in Section 2.0. Comparisons are presented in a qualitative manner, and identify substantive differences between the alternatives. As with the detailed evaluation, the following criteria are used for the comparative analysis:

- Overall Protection of Human Health and the Environment;
- Compliance with SCGs;
- Short-Term Impacts and Effectiveness;
- Long-Term Effectiveness;
- Reduction of Toxicity, Mobility, and/or Volume;
- Feasibility; and
- Cost.

4.2.1 Overall Protection of Human Health and the Environment

Alternatives SL-3, SL-4, and SL-5 are the most protective of human health and the environment. Alternative SL-3 is less protective than the other alternatives because this alternative would remove only surface soil (up to 1 foot bgs) to the extent of contamination above NYSDEC CSCOs across the Island; whereas Alternative S-4 would remove contaminated soil up to 2 feet bgs) to the extent of contamination above NYSDEC RRSCOs. Alternative S-5 is the most protective, since it would remove surface and subsurface soils to the extent of known contamination exceeding NYSDEC USCOs in all areas of the Island.

Alternative SL-2 would prevent human exposure, but does not provide any removal or treatment that significantly reduces migration of contaminants or expedites the cleanup of the Site to regulatory standards. Alternative SL-1 is the least protective, since it would not remove or treat contaminants nor reduce the risk of human or environmental exposure.

4.2.2 Compliance with SCGs

The alternatives can all be accomplished in accordance with action- and location-specific SCGs. Chemical-specific SCGs would be achieved only to depths of 1 foot bgs and 2 feet bgs in

Alternatives SL-3 and SL-4, respectively. These alternatives would leave contamination above NYSDEC SCOs below these depths (i.e., CSCOs for Alternative SL-3, RRSCOs for Alternative SL-4). In addition, contaminated soils would not be removed from the historic incinerator landfill area for Alternatives SL-3 and SL-4. Alternative SL-5 would remove all contamination above USCOs regardless of depth. Alternatives SL-1 and SL-2 would not comply with chemical – specific SCGs, since no contamination would be removed from the Site under these alternatives.

4.2.3 Short-Term Impacts and Effectiveness

Alternatives SL-1 and SL-2 would have the lowest short-term impact. There would be no potential risks to workers or the public during implementation of these alternatives, since no active remediation would be performed.

Alternatives SL-3, SL-4 and SL-5 would all have short-term impacts to human health and the environment due to remediation activities on the Island and off-site transportation and disposal of contaminated soil. Each of the alternatives involves excavation of contaminated soils and the transportation of contaminated material to the on-site upland disposal area and/or off Island.

Cap construction in the upland disposal area for Alternatives SL-3 and SL-4 would result in some disturbance of site contaminants at the surface as a result of construction activities, but would not impact the remaining contamination in the subsurface. Alternatives SL-3, SL-4 and SL-5 also include handling and off-site disposal of hazardous-level wastes encountered during the activities. Of the three, Alternative SL-5 would have the highest short-term impacts because this alternative would (1) involve the deepest depth for excavation (average of 4 feet bgs, with localized excavations up to approximately 16 feet bgs in comparison to 1 foot bgs for SL-3 and 2 feet bgs for SL-4)); (2) involve the handling of the greatest quantity of material (383,328 CY in comparison to 17,424 CY for SL-3 and 47,775 CY for SL-4); and (3) require the longest period of time for implementation.

Risks to workers and the public would be mitigated through a Health and Safety Plan and appropriate health and safety controls, detailed soil management and transportation procedures, and engineering controls, as necessary.

4.2.4 Long-Term Effectiveness

Alternatives SL-3, SL-4 and SL-5 are effective at reducing potential risk to human health and the environment. Alternative SL-3 would be the least effective as it would only remove contaminated soil above NYSDEC CSCOs to depths of 1 foot bgs on the Island. Alternative SL-4 would be more effective at reducing potential risk to human health and the environment, as this alternative removes contaminated soil above NYSDEC RRSCOs to depths of 2 feet bgs. Alternative SL-5 would be the most effective at reducing potential risk because this alternative would remove identified contamination on the Island in excess of NYSDEC USCOs.

Contaminated soil would remain on-site under Alternatives SL-3 and SL-4. For these alternatives SL-3 and SL-4, the areas of residual contamination would be subject to capping and institutional controls to minimize human health exposure. Long-term O&M (e.g., cap maintenance, monitoring, etc.) and maintenance of land use restrictions would be required to ensure that these alternative continues to be effective.

Alternative SL-2 would be less effective, since all existing contamination would remain in place on the Site. Human health exposure would be minimized through institutional controls. Long-term O&M and land use restrictions would be required to ensure the effectiveness of this alternative. Alternative SL-1 would not be effective, since it would not reduce potential human health risks or risks to the environment.

4.2.5 Reduction of Toxicity, Mobility, and/or Volume

Alternatives SL-3, SL-4 and SL-5 offer significant reduction in toxicity, mobility, and/or volume of contaminated soil since soil with contamination exceeding remedial goals would be excavated in all areas of the Island (except for the incinerator disposal area for SL-3 and SL-4). Alternatives SL-3 and SL-4 include the construction of a multi-media cap and vertical barrier wall at the historic incinerator landfill area to potentially reduce contaminant mobility in this area of the Island where contaminated material would remain in place. Alternative SL-5 offers the most reduction, as the largest volume of soil would be removed from the Island.

Alternative SL-2 offers no significant reduction in mobility, toxicity, or volume. Alternative SL-1 offers no reduction in mobility, toxicity, or volume since no active remediation would be performed.

4.2.6 Feasibility

All of the alternatives evaluated are technically feasible. Alternative SL-1 is the easiest to implement, since no remedial activities would be employed in this alternative. Alternative SL-2 would also be easy to implement, involving only institutional controls. The remaining alternatives would all be more difficult to implement due to the geographic restriction of working on an Island. Alternative SL-5 would be the most difficult to implement because it would require the most soil excavation and handling for both off-site disposal and backfill.

Services, equipment, and materials are available for all alternatives. Alternative SL-1 requires no materials and limited services. Alternative SL-2 may require limited materials and limited services. Alternatives SL-3 and SL-4 would require excavation, capping and vertical barrier services.

Alternative SL-5 would require conventional excavation equipment, but would still be difficult to implement, requiring significant resources to manage the large quantity of soil associated with this alternative.

All of the alternatives evaluated are administratively feasible. Alternatives SL-1 and SL-2 would be the easiest to implement (short-term) since limited activities would be performed on the Island. The remaining alternatives all involve construction activities and associated administrative activities (e.g., permitting, public participation and coordination, etc.). Alternative SL-5 would have the most substantial coordination requirements for off-site transportation (based on volume), which Alternatives SL-3 and SL-4 would also entail but to a lesser degree. Long-term institutional management (e.g., monitoring, reporting, public coordination) would be associated with Alternative SL-2, Sl-3 and SL-4.

4.2.7 Cost

Alternative SL-1 would have no capital costs and small, periodic O&M costs, associated only with the periodic reviews. Alternative SL-2 has the next lowest capital and O&M costs for implementation of institutional controls. Alternative SL-3 has the next lowest capital and O&M costs, associated with removal of soils above CSCOs, cap maintenance, and monitoring. Alternative SL-4 has the second highest capital and O&M costs, while Alternative SL-5 has the highest capital, due to the amount of material scheduled for removal. Overall, the ranking of the alternatives based on net present value (capital and O&M) from lowest to highest is: Alternatives SL-1, SL-2, SL-3, SL-4, and S-5.

5.0 IDENTIFICATION AND DEVELOPMENT OF ALTERNATIVES FOR SEDIMENT

5.1 Remedial Action Objectives

5.1.1 Standards, Criteria, and Guidance

Chemical-, action- and location-specific SCGs for the project were originally submitted in Table 3-1 of the Work Plan (Tetra Tech, 2007). Additional sediment quality assessment was performed consistent with SCGs and described in the Scope of Work for Step IIC Toxic Effects Analysis for the Former Incinerator Landfill, Davids Island, New Rochelle, New York (Tetra Tech, 2010a).

During the SI, surface sediment analytical results for the high beach, intertidal and sub-tidal sediments sampled from the marine environment surrounding the Island were compared to NYSDEC Sediment Quality Criteria (NYSDEC, 1999). Tables 4-3A and 4-3B of the SI Report contain the NYSDEC sediment quality guidelines utilized during the characterization, and Table 4-14 of the SI Report presents the constituent concentrations for the sediment analyses, indicating exceedances of criteria with highlighting. Results of the investigation program indicate sediments in the historic incinerator landfill area are primarily affected by concentrations of SVOCs (mostly PAHs) and metals at levels above and below the NYSDEC sediment quality guidelines. Relatively high concentrations of these constituents were present in the surface sediments generally across the eastern, central and western beaches of the historic landfill area located in the southeastern portion of the Island. Therefore, COCs for sediments for high beach, intertidal and sub-tidal sediments were grouped together and are listed in Table 5-1.

5.1.2 Remedial Goals

Remedial goals for sediment COCs are based on the NYSDEC Sediment Quality Criteria (NYSDEC, 1999). Table 5-2 summarizes the potential SCG-based sediment quality guidelines for sediments for the protection of human health and the environment.

5.1.3 Remedial Action Objectives

Sediment RAOs for the Project were identified based on guidance from NYSDEC DER-10. The RAOs are as follows:

- Prevent, to the extent practical, direct contact exposure pathways to sediments containing residual contamination concentrations above NYSDEC SCOs;
- Prevent migration of site-related contaminants that would result in near shore surface water contamination;
- Prevent impacts to biota from ingestion/direct contact with soil causing toxicity or impacts from bioaccumulation through terrestrial food chain; and

- Remove the sources of contamination.

5.2 General Response Actions

To meet the developed RAOs, the following GRAs for sediment have been identified:

1. No Further Action
2. No Further Action with Site Management (Limited Action)
    a. Institutional Controls (e.g., deed restrictions and/or environmental easements)
    b. Engineering Controls (e.g., fencing)
3. Containment
    a. Capping
    b. Permeable Cover
4. Removal and Disposal
    a. On-Site
    b. Off-Site
5. Treatment
    a. *Ex Situ*
    b. *In Situ*

No Further Action involves no treatment but would implement reviews for periodic reevaluation of site conditions.

Limited Action involves measures that restrict access to contaminated sediment areas through physical and/or administrative measures, and also includes long-term monitoring.

Containment actions include technologies that involve little or no treatment, but provide protection of human health and the environment by reducing mobility of contaminants and/or eliminating pathways of exposure.

Removal, Disposal and Treatment actions include technologies that act to reduce the volume, toxicity and/or mobility of contaminants in the sediments. Disposal actions include both on-site and off-site disposal technologies. Treatment technologies include *in situ* treatment, or removal and *ex situ* treatment (e.g., physical, chemical, thermal, biological).

5.3 Identification and Screening of Technologies and Development of Alternatives

The screening of remedial technologies is performed in two steps: (1) the identification and screening of technology types and process options for each GRA, and (2) the evaluation and selection of representative process options for the sediments. For purposes of discussion, sediments were defined as cobble, boulder, and fine-grained sands and silts extending from approximately the vegetation line seaward to the shallow sub tidal sampling stations or mean low water (MLW).

5.3.1 Identification and Screening of Technologies

The remedial technology types associated with each of the GRAs typically considered for the cleanup of contaminated sediments were developed from the DER-10 *Technical Guidance for Site Investigation and Remediation* (NYSDEC, 2010); the October 1988 *Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988); NYSDEC *Technical Guidance for Screening Contaminated Sediments* (NYSDEC, 1999); NYSDEC Technical and Operational Guidance Series (TOGS) 5.1.9 *In Water and Riparian Management of Sediment and Dredged Material* (NYSDEC, 2004); evaluation of new and emerging technologies; and experience on other hazardous waste projects.

Potential methods for remediation of contaminated sediments exceeding SCGs or in response to observed impacts are discussed and summarized with the results of the initial screening. The proposed remedial technologies consider removal and disposal, either on or off-site. No *in situ* or on-site treatment technologies are proposed for sediments. For off-site disposal, treatment (off-site) prior to disposal may be necessary to meet disposal criteria. Typical treatment technologies for sediments contaminated with PAHs and/or metals are thermal desorption, solvent extraction, and solidification/stabilization. For those alternatives that were not retained for further evaluation, the rationale for their elimination is included. Table 5-3 summarizes the results of the preliminary screening of sediment technologies and process options discussed below.

5.3.1.1 No Further Action

Description: No Further Action is an option that does not include any remedial measures. It allows for long-term monitoring, periodic reviews of the site, and reevaluation of the need for remedial action.

Initial Screening: No active remediation or institutional controls are implemented under this option. Any reduction in the toxicity, mobility or volume of contaminants would be the result of natural attenuation, since no treatment would be implemented. The No Further Action alternative is retained for further evaluation as a baseline for comparison of other alternatives. Under this option, historic incinerator landfill material will continue to erode into the intertidal and sub-tidal zones. Effects on the environment and human health will go unabated unless natural recovery processes render exposure pathways incomplete.

5.3.1.2 Limited Action

Limited Action consists of technologies that are generally passive; including monitoring, access restrictions (e.g., engineering controls such as fencing and warning signs), and institutional controls (e.g., deed restrictions, environmental easements, health and safety plan, soil management plan, etc.).

Access Restrictions

Description: Access to the historic landfill area, the beach, and the intertidal areas would be restricted by providing a security fence around the affected regions and affixing signs (as appropriate) to restrict access to the areas via land. Boating access to the beach area would be restricted via signage along the intertidal area. Signage posted within the intertidal zone would also warn against trespass and shellfish harvesting from within the waters of the historic incinerator landfill area.

Fencing would not extend into the intertidal or sub-tidal zones, which could be accessible by recreational boaters, and fish and wildlife resources. Contaminants in the sediments would persist and documented effects on indigenous biota would continue unabated. Exposure of fish, wildlife and marine resources to heavy metals and PAHs will persist unless natural recovery processes render exposure pathways incomplete.

Initial Screening: Signage and access restrictions around the beach and intertidal areas of the historic incinerator landfill would limit but not prevent exposure to the impacted sediments by trespassers and recreational boaters. Exposure of fish, wildlife and marine resources to metals and PAHs in the sediments would continue unabated. This option does not address existing or future impacts to fish, wildlife or marine resources present in the sediments or marine waters surrounding the historic incinerator landfill. Maintenance of fencing and signage would have to be performed to ensure continued effectiveness of this option. This process option is retained for further evaluation.

Deed Restrictions and/or Environmental Easements

Description: With this process option, land use restrictions would be included in the deed and would be retained through real estate transactions. Examples would include land use restrictions, environmental easements, limitations on excavation, and limitation of access to intertidal and sub-tidal areas surrounding the historic incinerator landfill area.

Initial Screening: Access and use restrictions would be required as a final step in the development of remedial alternatives that do not remediate the site to unrestricted use conditions. Deed restrictions and/or environmental easements are retained as a process option. Deed restrictions will not address existing or future impacts to fish, wildlife or marine resources from the release of debris and associated contaminants from the historic incinerator landfill to the environment.

Health and Safety and Sediment Management Plans

Description: This process option includes the preparation, implementation and maintenance of plans for the sediments surrounding the historic incinerator landfill. The plans would require monitoring and use of PPE during maintenance, monitoring or construction activities associated with disturbance of sediments around the historic incinerator landfill area.

Initial Screening: Plans would be required as the final step in the development of remedial alternatives that do not remediate the sediments to unrestricted use conditions for human receptors. They will also not address continued impacts to fish, wildlife and marine resources occurring in the sediments surrounding the historic incinerator landfill.

Monitoring and Site Reviews

Description: This process option includes periodic data collection (e.g., quarterly, annual, etc.) and review of the data to assess the current conditions of the sediments surrounding the historic incinerator landfill. The data would be used to determine if implemented remedial activities have achieved the RAOs or are continuing to be protective of human health and the environment as conditions improve towards achieving the RAOs. If site reviews indicate conditions are worsening or the current conditions pose an unacceptable risk to human health or the environment, additional activities could be implemented.

Initial Screening: Periodic monitoring and site reviews are necessary to assess the progress of remedial activities and the protectiveness of implemented actions until RAOs are achieved. They are a necessary component of nearly all remedial actions (except those that immediately achieve RAOs), and therefore are retained as a process option.

5.3.1.3 Containment

Containment provides isolation of contaminated sediment from potential receptors and/or uncontaminated media. Capping technologies and/or vertical barriers can be used to contain contaminated sediments, minimize human and ecological (fish and wildlife) exposure to sediments, control migration of contaminants, and reduce leaching of contaminants. Capping of contaminated sediments could be achieved by using permeable rock rip-rap with impermeable capping materials, permeable cap materials, or multiple layer caps. This follows a general design for backfilling with a stabilized cap.

Permeable Sand and Rip-Rap Cap

Description: A permeable sand layer and rip-rap cap can be installed over compacted and stabilized contaminated sediment in the upper high tide zone to mitigate direct contact by humans and fish, wildlife and marine resources with contaminants in the sediments.

Initial Screening: A permeable sand and rip-rap cap would be effective in mitigating direct contact with contaminated sediments. However, the high energy tidal environments and bed rock outcrops in the southeastern portion of the Island would result in a high risk of scouring of cap material. Scour may be mitigated through placement of rip-rap or boulders to act as an energy dissipation barrier over the sand cap. Extreme ranges in tidal ranges or storm-induced tidal surges may compromise the integrity of an intertidal/ sub-tidal cap along the shoreline of the disposal area. This option is retained for the areas near or between the mean high water (MHW) mark and the mean higher high water (MHHW) mark line of the historic incinerator landfill area.

Multi-Media Cap

Description: A multi-media cap is a combination of two or more single-layer capping technologies such as a geotextile layer beneath the sand and rip-rap barrier. A disadvantage of one cap type can be compensated for by an advantage of another. Most caps recommended for hazardous waste projects are multi-layer caps. A multi-media cap would typically include a layer of clay or sand, a synthetic liner or geotextile fabric, and a 1- to 2-foot layer of sand. A layer of rip-rap as an energy dissipation barrier to wave and tidal action effects would then be installed over the sand.

Initial Screening: In riparian and quiescent systems, the performance of a properly installed, multi-layered cap is generally excellent. There is still a need for periodic monitoring and maintenance of the cap but to a lesser extent than a single media cap. In high energy environments, scouring of the cap especially during exceptional tidal events and storm surges would be an on-going concern. This type of cap would require more restrictions on future use of the Site. Existing environmental conditions will need to be considered in the predesign phase to best evaluate the practical application in the intertidal and subtidal zones of the beach areas surrounding the landfill. However, this type of cap has the advantage of reducing infiltration, in addition to minimizing exposure. Therefore, this option is retained.

5.3.1.4 Removal

Removal options involve the physical removal of contaminated sediment, with the intention of subsequent treatment and/or disposal either on or off the site. Areas subject to excavation/dredging will be backfilled to grade with appropriate clean fill. This category includes excavation or dredging. It is also a preliminary or support technology as a part of *ex situ* treatment and disposal options that first require removal of the contaminated media.

Excavation/Dredging

Description: Excavation refers to the use of construction equipment such as long arm backhoes or clamshells that are typically used to handle submerged or intertidal sediments. Excavation is often associated with work conducted "in the dry" through use of temporary containment barriers and dewatering of sediments, which occurs from within a confined area. This technology process would require the use of barriers (i.e., sheet piling) and pumps to allow for the dewatering of sediments prior to removal. Excavation could also be used to access contamination source areas to provide a means for physical removal of subsurface landfill materials present in the surrounding inter-tidal areas.

Dredging refers to the removal of submerged sediments via fixed placed or maneuverable floating hydraulic or mechanical (perforated or sealed clamshell) units. Sediments are removed "in the wet" and subjected to dewatering. The solids are then stockpiled for disposal. Practical application of dredging would be for use in sub-tidal areas that remain fully inundated at low tide and support the draft of barges, tugs and tending craft for the dredge.

Both excavation and in-water dredging would require the use of turbidity curtains to contain suspended sediments during removal.

Initial Screening: Excavation or dredging of sediments and historic incinerator landfill debris would be required as the initial material handling step in numerous remedial alternatives. The excavation areas would be replaced by clean sand backfill, capping layers or rip-rap, which would serve as a physical barrier to wave energy and a dissipation shield to prevent continued erosion of historic landfill materials into the marine environment. Excavation/dredging is retained for contaminated beach, intertidal and sub-tidal sediments.

5.3.1.5 *Ex Situ* Treatment

Treatment technologies may be implemented *ex situ* (i.e., after excavation/dredging of contaminated sediment). The process options for *ex situ* treatment technologies that were evaluated include: reuse/recycling, solidification/stabilization, thermal desorption, incineration, biodegradation, and soil washing. As discussed previously, these treatment technologies were considered only for off-site treatment prior to disposal; no on-site treatment was considered due to the physical constraints of the project site.

Reuse/Recycling

Description: This category of process options includes the processing of removed contaminated sediments for use as part of a process to produce a usable end product. Potential process options include: cold batch asphalt (on- or off-site), hot mix asphalt batching, brick manufacturing, cement manufacturing, and use as back fill in the beach excavation areas. Excavated sediments would need to be dewatered, and solid waste including wood, glass, brick, rock, and metallic debris (i.e., engine blocks, chain and pipe fragments, etc.) would have to be sorted and removed. Because the contamination by PAHs and metals are associated with fine grained sedimentary material, concentrations in the sorted, dewatered sands may not allow for use other than as daily cover at an off-site solid waste disposal facility.

Initial Screening: Depending on the levels of contamination in the removed sediment, it may be feasible to reuse or recycle the materials for beneficial reuse. Therefore, this option is retained for further evaluation.

Solidification/Stabilization

Description: Stabilization is a process whereby contaminated media are converted into a stable cement-type matrix in which contaminants are bound or trapped and become immobile. Generally, cementing additives are used, with other reagents as necessary to stabilize the organic constituents present in the contaminated media (i.e., sediments). A pug mill is used to thoroughly mix the impacted material with the additives.

Initial Screening: This process would be effective for stabilizing contaminants in the impacted sediment prior to disposal. This technology would immobilize contaminants in the sediment matrix and would require long-term monitoring at the point of disposal. Dewatering and sorting of cobble and boulders from the finer sediments would be required as preparation for the solidification process. This option is retained for further evaluation.

Thermal Desorption

Description: Thermal desorption technology is a thermal stripping process. Dewatered, debris-depleted sediments are introduced into an enclosed heated chamber using a heated screw or belt conveyor. Direct or indirect heating methods are used to volatilize organics from the soil. The off-gas containing the thermally stripped compounds is then combusted in an afterburner, adsorbed in a carbon adsorption unit or treated by catalytic oxidation designed to ensure removal of these compounds to acceptable levels. Typical operating temperatures for thermal stripping of organics are 400°F to 900°F; however, higher temperatures are achievable. Operating temperatures are selected based on the hydrocarbons present in the soil.

Initial Screening: The sediments would require debris removal, screening and dewatering as feedstock preparation for this process. The off-gas could potentially require the use of air pollution control devices. The residue will contain metals that would require additional treatment such as stabilization prior to disposal. This technology is not effective in the removal of metals from environmental media. Therefore, technology is not retained as a process option.

Incineration

Description: Incineration is a thermal destruction method which can be used to destroy combustible waste materials including organic contaminants in dewatered sediments. Incineration systems such as a multiple hearth, rotary kiln, infrared and fluidized bed can treat highly-contaminated material at high temperatures (1200°F to 1800°F in the primary chamber and at 1400°F to 2400°F in the secondary chamber). Infrared incineration systems are used primarily for solids, sludges or sediments.

Initial Screening: High temperature incineration is suitable for removal of volatile and semi-volatile organics in contaminated solid media. The off-gas could potentially require the use of air pollution control devices. The residue will contain metals that would require additional treatment such as stabilization prior to disposal. This technology is not effective in the removal of metals from environmental media. Therefore, technology is not retained as a process option.

Biodegradation

Description: Biological treatment involves the use of native microbes or selectively adapted bacteria to degrade a variety of organic compounds. The biological processes usually involve the addition of microbes, nutrients, oxygen, and moisture. The microbial action serves to effectively degrade the organic constituents. Several options for implementing this approach on-site for excavated materials exist, including: constructing a bio pile, land farming, or composting. In order to minimize odors from this process, heavy polyethylene sheeting may be used as a cover.

Initial Screening: Aerobic biodegradation has been demonstrated to be effective on the organic constituents present at the Site (i.e., PAHs). Some of the heavier organics would require lengthy time frames to degrade. The residue would contain metals in excess of the sediment quality guidelines, which may require additional treatment prior to or following biological treatment. Metals are a significant group of contaminants in the sediments, and biodegradation would not be an effective process for these constituents. Therefore, biodegradation is not retained as a process option.

Sediment Washing

Description: Washing of excavated sediment involves processing the impacted material in a reactor vessel or other treatment unit, in conjunction with a reagent solution designed to remove the organic and metal constituents from the native material. The optimum reagent and reaction time would require the performance of bench and pilot studies to optimize the process.

Initial Screening: Significant feedstock preparation (i.e., particle size separation) is required for this process option. The low solubility of certain higher-ringed PAHs could prevent effective treatment via this process option. Large volumes of aqueous wastes would also be generated and would require further treatment and disposal. This process option is not retained.

5.3.1.6 Disposal

This category of remedial process options refers to disposal of impacted sediment on- or off-site, with or without any treatment. The remedial technologies are on-site (upland) disposal and off-site disposal. As discussed previously, on-site treatment is not considered feasible, so on-site disposal is limited to non-hazardous materials that can be isolated in the on-site disposal area. Sediment with contaminant levels requiring treatment prior to disposal, or with hazardous levels of contamination, would need to be disposed off-site.

On-Site Disposal Area

Description: Impacted sediments would be removed and then disposed of in an on-site, upland disposal area. The historic incinerator landfill area would be used as the on-site upland disposal area. Non-hazardous sediments could be disposed at this location.

Initial Screening: For sediments with low levels of contamination, on site disposal is a cost-effective solution to protect the sediment environment and mitigate exposures. This process option is retained for further evaluation.

Off-Site Disposal Area

Description: Sediments classified as hazardous (if any) would be transported to a regulated disposal facility and properly treated and disposed. Non-hazardous sediments could potentially be disposed directly at an off-site non-hazardous disposal facility or reused (e.g., as landfill cover) after treatment if appropriate and in accordance with NYSDEC rules.

Initial Screening: Off-site disposal to an appropriate hazardous or non-hazardous permitted disposal facility either directly or after *ex situ* treatment is a viable option. Hazardous, and non-hazardous materials may be encountered during remedial operations. These materials would have to be managed appropriately and therefore this option is retained for disposal of contaminated sediment.

5.3.2 Selection of Process Options

Process options are evaluated on the basis of overall remedial effectiveness, technical implementability, and cost relative to site-specific conditions, contaminant types, and contaminant concentrations (see Section 3.3.2 for a detailed explanation of the evaluation benchmarks).

The initially screened and accepted sediment process options were evaluated qualitatively. Comparisons were made within each technology type by assessing the effectiveness, implementability and cost of each process option as low, moderate, or high relative to other process options within the technology type. Based on this evaluation, specific process options were selected for development of media-specific remedial alternatives. Process options that were not selected are still technically feasible and may be substituted for the selected process option during remedial design. The evaluation and selection of process options for sediments are presented in Table 5-4.

5.3.3 Development of Alternatives

Based on the screening and evaluation of technologies and process options, the following media-specific remedial alternatives were developed for sediments around the historic incinerator landfill area in the southeastern portion of the Island:

- Alternative SD-1: No Further Action
- Alternative SD-2: No Further Action with Site Management (Limited Action)
- Alternative SD-3: Removal of COCs in Sediment Based on Habitat Impacts
- Alternative SD-4: Removal of COCs in Sediment in Excess of NYSDEC SGVs

5.3.4 Preliminary Screening of Alternatives

Preliminary screening was not performed due to the relatively small number of feasible alternatives developed for sediments at the Site. All four of the alternatives developed in Section 5.3.3 underwent detailed evaluation as described in Section 6.0.

6.0 DETAILED ANALYSIS OF ALTERNATIVES FOR SEDIMENT

6.1 Detailed Analysis of Alternatives

This section presents a detailed description and evaluation (with respect to the seven criteria described in Section 2.0) of the four remedial alternatives for sediments previously developed in Section 5.3.3.

6.1.1 Alternative SD-1: No Further Action

The No Further Action alternative includes no active remediation of the sediments at the Site. All contaminated sediments would be left in place with no treatment or controls to prevent continued erosion of historic landfill debris and future exposure to contaminated media. Periodic reviews would be performed to assess any changes in the risk to human health and the environment posed by the Site. This alternative is developed as a basis of comparison for other alternatives.

6.1.1.1 Overall Protection of Human Health and the Environment

The No Further Action alternative would not remove, contain, or treat the contaminants present in the sediments surrounding the historic incinerator landfill area. Therefore, potential risks to human health and the environment resulting from the presence of contaminated sediments would remain unchanged. Toxic or negative effects on benthic communities within the intertidal and shallow sub-tidal will continue unabated. Risks and negative effects on indigenous marine communities from direct contact with contaminated sediment would also persist. In addition, there would be the continued potential for migration of contaminants and historic landfill debris to erode into the intertidal and shallow sub-tidal habitat.

6.1.1.2 Compliance with SCGs

The No Further Action alternative does not comply with chemical-specific SCGs since no action would be taken to address contaminants in sediments exceeding the NYSDEC Sediment Quality Criteria.

6.1.1.3 Short-Term Impacts and Effectiveness

Under the No Further Action alternative, there would be no short-term impacts from remediation activities to workers or the environment. No construction would be required for implementation of this alternative. Workers conducting periodic reviews would potentially be exposed to contaminated sediments. A HASP is in place for the property that requires use of PPE to minimize the risks of direct contact. This alternative would not result in any short-term improvement over current conditions. Impacts to the marine environment would continue unabated. As no design or construction activities are required for this alternative, it would take no time to implement.

6.1.1.4 Long-Term Effectiveness

The No Further Action alternative would have no long-term effectiveness and/or permanence. The magnitude of human health and ecological risks would be the same following implementation of this alternative. No engineering controls would be implemented to manage the remaining contaminated material.

6.1.1.5 Reduction of Toxicity, Mobility, and/or Volume

This alternative would not involve any containment, removal, treatment, or disposal of the contaminated sediments. Therefore, this alternative would not provide any reduction in the toxicity, mobility, and/or volume of contaminants. Toxic or negative effects on the intertidal and shallow sub-tidal habitats would continue unabated, but may change as a result of natural processes.

6.1.1.6 Feasibility

There are no technical feasibility concerns with this alternative. The effectiveness of the remedy would be evaluated in periodic reviews, and implementation of this alternative would not preclude further remedial action in the future. However, future activities may require revisiting the SI/RAA process.

There are no administrative feasibility concerns with this alternative. As this alternative involves no construction activities, availability of resources and use of proven technologies is not applicable. Consulting services are readily available for periodic reviews. Coordination with regulatory agencies would be required for making decisions regarding any future remedial alternatives. However, there are no concerns with the ability or time required to interact with regulatory agencies. No restoration of any habitat areas would be required and no post restoration monitoring for the recovery of natural areas would be required.

6.1.1.7 Cost

There is no capital cost or annual O&M cost for the No Further Action alternative. Small periodic costs associated with site reviews to assess current conditions of the sediments may be incurred.

6.1.2 Alternative SD-2: No Further Action with Site Management (Limited Action)

This alternative includes no active remediation at the Site. The sediments posing a potential threat to human health and/or the environment would be left in place with no treatment. Limited administrative and engineering controls would be implemented to prevent future exposure to contaminated media.

Under this alternative, deed restrictions and/or environmental easements would be implemented to restrict future use of the beach area. Access restrictions (e.g., landward fencing) and signs (as necessary) would be established. A HASP and Site Management Plan would be developed and implemented to describe (for example) adequate control measures and PPE/monitoring to be implemented during intrusive activities. Periodic reviews would also be performed to assess changes in the potential risk to human health and the environment posed by the Site.

6.1.2.1 Overall Protection of Human Health and the Environment

This alternative would not remove, contain, or treat the contaminated sediment. Risks to human health resulting from contaminated sediment above NYSDEC Sediment Quality Criteria would be mitigated by institutional controls. Deed restrictions and/or environmental easements and proper implementation of Site plans would lessen risks to human health. Fencing and signs would also help mitigate potential risks associated with direct contact exposure for humans. However, these options would not mitigate risks to the environment. There is the continued potential for migration of contaminants into the marine environment, and impacts to the intertidal and sub-tidal marine communities would likely continue.

6.1.2.2 Compliance with SCGs

This alternative does not comply with chemical-specific SCGs since no active remediation would be taken to address concentrations in excess of NYSDEC Sediment Quality Criteria. Action- and location-specific SCGs are not triggered, since no on-site remedial activities would be performed.

6.1.2.3 Short-Term Impacts and Effectiveness

There would be minimal short-term impacts to workers and the environment from remedy implementation under this alternative. Minimal construction (i.e., fencing, signage, etc.) would be required for implementation. Through development and implementation of a HASP, direct contact risks for human health would be minimized (e.g., use of PPE would be required during intrusive activities). A Site Management Plan would also help to mitigate risks. However, these options would not mitigate risks to the environment. The time required to implement this alternative would be approximately 6 months.

6.1.2.4 Long-Term Effectiveness

Potential human health risks would be reduced by institutional and engineering controls following implementation of Alternative SD-2. Risks to the environment would continue unabated.

Limited controls would be implemented to manage the remaining contaminated material, consisting of fencing, restricting future use, and prohibiting the use of the beach areas surrounding the historic incinerator landfill area. These controls would be effective at mitigating human health risks, though there is the potential for violation of these controls. Environmental impacts would not be mitigated by the alternative. Risks at the Site would be re-evaluated periodically.

6.1.2.5 Reduction of Toxicity, Mobility, and/or Volume

This alternative would not involve any containment, removal, treatment, or disposal of the contaminated sediments. Therefore, Alternative SD-2 would not provide any reduction in the toxicity, mobility, and/or volume of contaminants. Impacts to the environment would continue unabated.

6.1.2.6 Feasibility

There are no technical feasibility concerns associated with this alternative for sediment. The effectiveness of the remedy would be evaluated periodically. As this alternative involves limited construction activities (e.g., fence and sign installation), availability of resources and use of proven technologies is not a concern. Consulting services are readily available for negotiation and implementation of deed restrictions and/or environmental easements and preparation of plans. Services are also available for conducting periodic reviews. This alternative would potentially require limited permitting and no restoration monitoring.

6.1.2.7 Cost

The capital cost associated with negotiation and implementation of the required institutional controls is $863,000. O&M cost to maintain this alternative is estimated to be $66,000 per year. The net present cost of the alternative, based on a 30-year period of performance and a 3% discount rate, is $2.2M.

6.1.3 Alternative SD-3: Removal of COCs in Sediments Exhibiting Observed Impacts on Indigenous Biota

Previous investigations and site reconnaissance activities identified historic landfill waste and sediment contamination on the Island. The FWIA Step IIC Toxic Effects Analysis identified contamination by PAHs and/or metals exceeding LEL and SELs, degraded benthic communities in the intertidal and sub-tidal environments, and toxic effects based on whole sediment toxicity testing in the intertidal and sub-tidal zones of the southeastern portion of the Island (Tetra Tech, EC, 2016). This alternative considers removal in those areas where impacts were observed. In 2014, NYSDEC (2014) issued updated guidance for screening, classifying and assessing sediment contamination in New York State. These Sediment Guidance Values (SGVs) will be used for consideration as remedial goals for remedial actions in sediments. Class A sediment concentrations are similar to the LELs applied in the SI (Tetra Tech EC, 2012).

Alternative SD-3 would include the removal of approximately 1.86 acres of visible historic incinerator landfill waste contaminated sediments and then backfill. The sediments would be disposed on-site in the upland disposal area above tidal influence and capped. Some material may also be disposed off-site as part of this alternative. Alternative SD-3 would include physical removal of visible landfill material on exposed bedrock and cobble/boulder areas and visible landfill material and fine sediments from the intertidal zone, wetland adjacent area with limited excavation of sub-tidal sediments in areas where significant impacts on benthic communities were observed (samples SL57, SL58 and SL60). Removal will include up to 2 feet of sediments and all visible contamination in these areas (Tetra Tech, 2011). Figure 6-1 shows the aerial extent of the excavation area for this alternative. All intertidal and high beach areas will be subject to excavation under Alternative SD-3. The areas of sub-tidal sediments to be removed would include those materials from areas of SI sampling locations SL57, SL58 and SL60 only (see Figure 6-1).

In this alternative, surface media dominated by bedrock or boulder and cobble habitats would have visible historic landfill related debris removed based on visual inspection. All visible landfill and fine sediment material will be removed from within the remedial footprint. Visible landfill material on rock outcrops will also be removed. Removed fine sediment materials within the excavation footprint would be disposed at the existing on-site upland disposal area. Contaminated material would be added to the historic incinerator landfill area/engineered upland disposal area described for Alternatives SL-3 and SL-4 for soil. Those alternatives would involve multi-media capping of the historic incinerator landfill area/ upland disposal area subsequent to addition of contaminated soils and sediments to reduce infiltration and exposure to existing contaminated material. Excavated areas will be backfilled to grade with clean sediments meeting applicable salt water SGVs. Particle size and placement of the clean fill will be based on native material size and wave energies present on the beach and shoreline areas.

From the three beach areas, a total of 162,042 square feet (sf) of surface sediments will be removed. Fine grained sediments will be excavated to a depth of approximately 2 feet in all beach areas or to refusal (i.e., bedrock or boulders). Post-remediation confirmatory sampling to ensure that RAOs have been met is included as part of this alternative in areas where sediment would be removed. For estimating purposes, it was assumed that 20% of the excavated sediment would be characterized as hazardous and require shipment off the Island. Once stabilized and an graded, the on-site disposal area will be restored.

In addition to the above, an area of limited removal of surface soils/sediments (0-0.5 ft.) will also occur in the area of the former skeet range (SR02, SR02N, SR02S and SL03). If additional delineation identifies further impacts from this area as being present from historical skeet range use the final area will be delineated during the predesign phase.

Final depth and horizontal delineation of the sediment to be removed will await the predesign investigation. Current sediment data are limited to surface sediments and on extent of fill and contamination present. Current estimates are moderately uncertain and are based on professional judgment using the available data from the SI. All landfill debris from the rocky intertidal areas will be removed. Where fines containing landfill material area are removed, appropriate replacement substrate (i.e., coarse sand and cobbles) will be used applied to restore the marine intertidal areas to grade. Final backfill volumes will be determined during the predesign investigation.

The total volume of sediments to be removed as part of this alternative would be approximately 6,002 CY. Sediments would be allowed to dewater by gravity filtration, and any water would be collected and would need to be sampled and analyzed for treatment/disposal.

6.1.3.1 Overall Protection of Human Health and the Environment

Alternative SD-3 would remove historic landfill-related debris from the beaches, and intertidal and shallow sub-tidal sediments from areas where impacts to marine communities were observed. This alternative would remove source areas (historic landfill-related wastes) and contaminated sediments in the high beach and intertidal areas surrounding the historic incinerator landfill area. The excavation would be limited to fine sediment areas where impacts to marine communities were noted.

In this alternative, select areas of the sub-tidal habitat would continue to have concentrations above NYSDEC SGVs. The potential risks to human health and the environment resulting from the presence of contaminants left in place would be reduced by the planned excavation and the installation of a stabilized rip-rap cap. Installation of a rip-rap/boulder barrier within the excavation areas would reduce contaminant migration and stabilize the near-shore sediments. In addition, it would de-energize tidal and storm surge wave action.

Deed restrictions and/or environmental easements in conjunction with the development and implementation of a HASP would also help mitigate risks to human health. Development and implementation of a Habitat Restoration Plan and Cap Area Management Plan would help maintain the protectiveness of this alternative.

6.1.3.2 Compliance with SCGs

This alternative would not fully comply with chemical-specific SCGs because some contaminated sediments above the NYSDEC SGGs would remain in the shallow sub-tidal habitats. Excavation and disposal of contaminated material would be performed in accordance with all applicable action- and location-specific SCGs.

6.1.3.3 Short-Term Impacts and Effectiveness

This alternative would involve substantial on-site construction activities and transportation of contaminated sediment to the upland disposal area (along with the potential for off-site disposal of hazardous-level materials). There would be significant risks typically associated with construction activities, including movement of heavy equipment. These risks would be addressed by developing and implementing a HASP to provide protection for on-site workers. In addition, appropriate engineering controls (i.e., controlling access, etc.) would be needed. The conservation of cobble and boulder substrates and limits of excavation would reduce the overall impacts of the remedial action and the quantities requiring removal. The timeframe required for implementation of this alternative is approximately 8 to 10 months.

6.1.3.4 Long-Term Effectiveness

The sediment removal within the excavation areas to 2 feet bss in the excavation areas would have moderate long-term effectiveness and/or permanence in conjunction with source removal and capping. The magnitude of potential human health and ecological risks would be mitigated by (1) removing a source of contamination and contaminated sediments, and (2) constructing rip-rap and boulder capping to stabilize the near shoreline area of the excavation area. These measures would act to prevent direct contact with contaminated sediments. Institutional controls would be implemented to manage remaining contaminated material, consisting of restricting future use (i.e., redevelopment). The long-term effectiveness of Alternative SD-3 is dependent on proper construction and maintenance of the capped areas, and implementation of a Site Management Plan that manages consolidated sediment/soils beneath the final cover. The magnitude of human health and ecological risks would be significantly reduced across the Island following implementation of this alternative.

6.1.3.5 Reduction of Toxicity, Mobility, and/or Volume

Removal of contaminated surficial sediments would reduce the potential for migration of contaminants. There would be a reduction in the volume of contaminated media remaining at the Site following remedy implementation as sediments above criteria levels in the top 2 feet would be removed in the beach, intertidal and sub-tidal areas. There may be a further reduction in toxicity, mobility and/or volume if sediment transported off-site are treated prior to disposal.

6.1.3.6 Feasibility

Technical Feasibility: Near-shore sediment excavation, transportation, disposal, and capping are conventional technologies that are typically easy to implement. However, due to the geographic location of the Island, these technologies are somewhat more difficult to implement. Sediment excavation depth would not extend below approximately 2 feet bss; therefore, technical challenges are not anticipated and conventional equipment can be used.

Based on historic information, the majority of underground utilities on the Island are abandoned; however; there is a Con Edison-owned utility corridor on the southwestern side of the Island. Although not anticipated to impact sediment removal, demarcation via utility mark-outs may be required. It is anticipated that sediment excavation would require dewatering of the sediments. Water treatment would likely be required prior to discharge to surface water.

Administrative Feasibility: Administratively, this alternative would be relatively easy to implement. An acceptable transportation plan for excavated materials to be transported to the on-site upland disposal area and/or off-site would be established. Coordination with local authorities would be required to establish an acceptable transportation plan for transportation of backfill and cap materials to the Island and, if necessary, off-site transportation of hazardous-level sediments. Coordination with regulatory agencies would also be required for periodic reviews. However, there are no concerns with the ability or time required to interact with local and regulatory agencies.

Availability of Services and Materials: Equipment, labor, and materials are available for construction components of this alternative. Consulting services are readily available for negotiation and implementation of deed restrictions and/or environmental easements, and preparation of the HASP, Site Management Plan, Habitat Restoration Plan and applicable transportation plans. Services are also available for conducting periodic reviews and performing cap maintenance activities. Restoration of the intertidal, subtidal, wetland adjacent areas and wetlands affected by this alternative would require a post restoration monitoring period to assess success of the recovery of the affected regulated areas.

6.1.3.7 Cost

The estimated capital cost associated with Alternative SD-3, including implementation of required institutional controls, is $4.1M. O&M cost to maintain this alternative is estimated to be $50,000 per year. The net present cost of the alternative, based on a 30-year period of performance and a 3% discount rate, is $5.2M. See Appendix A for details.

6.1.4 Alternative SD-4: Removal of COCs in Sediment in Excess of NYSDEC SGVs

Alternative SD-4 would include the removal of sources of contamination (i.e., historic landfill debris, ash/cinder, fine sediments) within the intertidal and shallow sub tidal areas; removal of surficial sediments (up to 2 feet bss) exceeding NYSDEC LELs (Tetra Tech EC, 2012); and removal of associated ash/cinder material from shallow sub-tidal areas, intertidal areas and high beach areas (the area between the vegetation line to MHW).

In addition, cobble and boulder fields including fines present between boulder and rock outcroppings within the area of influence of the historic incinerator landfill will be cleared of visible landfill debris and impacted fine grained sediments. Historic landfill material present on exposed bedrock will also be removed; no further action on bedrock outcroppings will occur. For estimating purposes, it was assumed that 20% of the excavated sediment would be characterized as hazardous and require shipment off the island.

In addition to the above area, a limited removal of surface soils/sediments (0-0.5 ft.) will also occur within the area of the former skeet range (SR02, SR02N10, SR02S10 and SL03). Additional delineation may be needed to identify the final extent of this removal area. This delineation will occur as part of the predesign phase.

Final depth and horizontal delineation of the sediment to be removed from the beach, intertidal and subtidal areas will await the predesign investigation. Current sediment data are limited to surface sediments and visual identification of landfill material in the near surface area of the intertidal and subtidal zones. Current estimates on depth of landfill material present in the intertidal and subtidal zones are uncertain and are based on professional judgment using available data from the SI. All landfill related material from the rocky intertidal areas will be removed using manual and/or mechanical techniques. Where fines containing landfill material are removed, appropriate replacement substrate will be used to restore the marine intertidal and subtidal areas to grade. Final backfill volumes will be estimated during the predesign investigation.

Of the constituents detected in surficial sediments, cadmium, chromium, copper, lead, mercury, nickel, zinc, acenaphthylene, benzo(a)pyrene, benzo(a)anthracene, and Total PAHs were identified as exceeding LELs and SELs and co-occurring at stations with observed biological effects in the Step IIC analysis in the high beach, intertidal and shallow sub-tidal habitats surrounding the historic incinerator landfill (Tetra Tech EC, 2012a, 2016).

As part of this alternative, fine grained surface sediments to an estimated depth of 2 feet bss or refusal (i.e., bedrock or boulders) would be excavated to the horizontal extent of SGV exceedances for metals (cadmium, chromium, copper, lead, and/or mercury) and/or Total PAHs in all areas from the shallow sub-tidal perimeter to the high beach line paralleling the existing line of vegetative cover as shown on Figure 6-2. This action would include the displacement or washing of boulder and cobble substrates for removal of any fine grained material beneath these substrates.

The area of influence is defined by the sea ward perimeter of sediment stations SL01, SL57 - SL59 on the west beach area, SL60 - SL62 in central beach area and SL12, SL63 – SL65 and SL15 in the western beach area (Figure 6-2). In total from among the three beach areas, an area of 99,752 sf of surface sediments will be removed. Based upon the given extent of removal, a total area of 2.29 acres of material will be removed.

In addition to the landfill area, a limited removal of surface soils/sediments (0-0.5 ft.) will also occur in the area of the former skeet range (SR02, SR02N10, SR02S10 and SL03). Boundaries of this removal will be determined as part of the predesign phase.

The residual historic landfill debris and sediment would be mechanically excavated and disposed of on-site at the upland disposal area. Sediments would need to be dewatered and consolidated prior to upland disposal. The sediments would be allowed to dewater by gravity filtration, and any water would be collected and would need to be sampled and analyzed for treatment/disposal. The total volume of sediment to be removed as part of this alternative would be approximately 7,389 CY.

Any hazardous materials encountered during the work would be managed in accordance with the appropriate protocols for these materials. For estimating purposes, it was assumed that approximately 20% of the excavated sediment will require shipment off the Island as hazardous.

Post-remediation confirmatory sampling is included as part of this alternative in areas where sediment would be removed. Post-remediation sampling would be performed to ensure that remedial design objectives have been met.

After dewatering, the non-hazardous excavated sediments will be disposed at the on-site upland disposal area. A multi-media cap would be constructed (as described in soil alternatives SD-3, SD-4) to reduce exposure to human and ecological receptors, infiltration, and contaminant migration.

Prior to placement of contaminated sediments in the upland disposal area, a vertical barrier wall would be constructed to ensure content stability. A detailed design of the vertical barrier wall may require additional investigation/assessment activities, and the final location and design would be determined during the remedial design phase of the Project. The barrier wall technology selected for this analysis is assumed to use a manufactured concrete block barrier to prevent contaminant migration, but could include grouted barrier sections in locations where these are found to be more cost-effective to interface with existing features.

Clean sand backfill would replace all areas where surface sediments are removed. The placement of clean backfill in the top 24 inches of the excavated areas would serve as a protective, permeable cap. To stabilize the intertidal and sub-tidal backfill areas and prevent further erosion of observable material from entering the marine environment, a permeable cap covered by a uniform layer of rip-rap stone will be placed over the intertidal zone, with scattered boulders to stabilize the beach area and promote macro fouling habitat. The purpose of the stabilized cap is to protect potential human and ecological receptors from exposure to contaminants in sediments, minimize further erosion of the shoreline while providing stable hard substrates for the development of macro-fouling communities in the near shore environment. To the extent practical, remnant boulder and cobble substrates will be reused as part of the rip rap feature. Detailed specifications/requirements for the backfill, permeable cap, and rip-rap and boulder cover will be developed as part of the design. For estimating purposes, a unit area and volume equivalent to the excavation area was utilized.

Also included in this alternative are institutional controls consisting of deed and access restrictions, environmental easements, development and implementation of a HASP, and development and implementation of Habitat Restoration and Cap Area Management Plans (included within the Site Management Plan). Periodic reviews would also be performed to assess any changes in the risk to human health and the environment posed by the Site.

6.1.4.1 Overall Protection of Human Health and the Environment

This alternative would remove source areas (historic landfill-related wastes) and contaminated sediments in the surrounding beach areas to the maximum extent practicable. The potential risks to human health and the environment resulting from the presence of contaminants left in place at concentrations above cleanup levels would be reduced by the engineered cap. Installation of a rip-rap/hard substrate barrier within the excavation areas would reduce contaminant migration and stabilize the near-shore sediments. Deed restrictions and/or environmental easements in conjunction with the development and implementation of a HASP would help mitigate risks to human receptors. Development and implementation of Habitat Restoration and Cap Area Management Plans would provide continued protectiveness of this alternative.

6.1.4.2 Compliance with SCGs

Alternative SD-4 would comply with chemical-specific SCGs to 2 feet bss because residual historic landfill material and contaminated sediments would be removed from the beach areas. Excavation and disposal of contaminated material would be performed in accordance with all applicable action- and location-specific SCGs.

6.1.4.3 Short-Term Impacts and Effectiveness

This alternative would involve substantial on-site construction activities, including the transportation of contaminated sediments and historic landfill materials to the upland disposal area (and potentially off-site if present at hazardous levels). There would be a moderate risk of exposure to contaminants that may be mobilized during these activities. There would also be significant risks typically associated with construction activities, including movement of heavy equipment. Risks would be addressed by developing and implementing a HASP to provide protection for on-site workers. In addition, appropriate engineering controls (i.e., controlling access, etc.) would be needed. The timeframe required for implementation of this alternative is approximately 8 to 12 months.

6.1.4.4 Long-Term Effectiveness

Sediment removal to SGV-based remedial goals to 2 feet bss in conjunction with source removal, capping, and stabilization of the shoreline would have significant long-term effectiveness and/or permanence. The magnitude of potential human health and ecological risks would be mitigated by (1) removing a source of contamination (contaminated historic landfill-related debris and contaminated sediments); (2) preventing contaminant migration to adjoining marine habitats; and (3) stabilizing the shoreline sediments using rip-rap/boulders. Institutional controls would be implemented to manage remaining contaminated material, restricting future use. The long-term effectiveness of this alternative is dependent on removal of sediments, placement of backfill, proper construction of a vertical barrier wall, proper construction and maintenance of the capped areas, and implementation of a Cap Area Management Plan. The magnitude of human health and ecological risks would be significantly reduced across the Island following implementation of this alternative.

6.1.4.5 Reduction of Toxicity, Mobility, and/or Volume

Removal of residual historic landfill materials and contaminated sediment, capping, and installation of a rip-rap barrier would reduce the potential for migration of contaminants into the adjoining marine habitats. Contaminated sediments in the top 2 feet of the area extending from the shallow sub-tidal sampling points to the vegetation line on the high beaches around the historic incinerator landfill (Figure 6-2) would be removed in all areas except the historic incinerator landfill (to be engineered as the upland disposal area). Additional material in excess of 2 feet may be removed depending upon the extent of landfill material that has migrated into the adjoining marine habitats. This action would reduce/eliminate infiltration and mobility of contamination in the marine environment. The quantity of contaminated media at the historic incinerator landfill area would increase; however, the mobility of contamination in the upland disposal area would be reduced by installation of a barrier wall and a multi-media cap to minimize infiltration.

6.1.4.6 Feasibility

Technical Feasibility: Excavation, transportation, disposal, and capping are conventional technologies that are typically easy to implement. However, due to the geographic location of the Site, even conventional technologies are somewhat more difficult to implement given the isolated geography of the Island. The majority of excavated sediments will be transported to the on-site upland disposal area (assumed non-hazardous), minimizing the amount of materials to be transported off the Island. The excavated material will be disposed above tidal influences on the island.

Sediment excavation is not planned to extend below approximately 2 feet bss; therefore, technical challenges are not anticipated and conventional equipment can be used. If historic landfill materials are encountered below the planned 2 feet of excavation depth, then additional material may be moved and disposed in the upland disposal area.

Based on historic information, the majority of underground utilities on the Island are abandoned; however; there is a Con Edison-owned utility corridor on the southwestern side of the Island. Although not anticipated to impact sediment removal, demarcation via utility mark-outs will be required. Excavated sediments will require dewatering prior to disposal. Treatment of collected water from the sediments would be required prior to discharge to surface water.

Administrative Feasibility: Administratively, this alternative would be relatively easy to implement. Transportation of contaminated material to the upland disposal area would be relatively easy. An acceptable transportation plan for hazardous waste to be transported from the Island to an appropriate off-site disposal facility would need to be established. For estimation purposes, 20% of the sediment volume was considered as being classified as hazardous. Coordination with local authorities would also be required to establish an acceptable transportation plan for delivery of backfill, rip-rap materials, and capping materials to the Island. Coordination with regulatory agencies would also be required for periodic reviews. However, there are no concerns with the ability or time required to interact with local and regulatory agencies. Permitting would be required for discharge of treated dewatering liquids.

Availability of Services and Materials: Equipment, labor, and materials are available for all constructional components of this alternative. Consulting services are readily available for negotiation and implementation of deed restrictions and/or environmental easements, and development of plans. Services are also available for conducting periodic reviews and performing cap maintenance activities. Restoration of the intertidal, subtidal, wetland adjacent areas and wetlands affected by this alternative would require a post restoration monitoring period to assess success of the recovery of the restored regulated areas.

6.1.4.7 Cost

The estimated capital cost associated with Alternative SD-4, including implementation of required institutional controls, is $4.6M. O&M cost to maintain this alternative is estimated to be $60,000 per year. The net present cost of the alternative, based on a 30-year period of performance and a 3% discount rate, is $5.8M. See Appendix A for details.

6.2 Comparative Analysis of Alternatives

The four alternatives for sediments discussed in Section 6.1 were compared using the evaluation criteria discussed in Section 2.0. Summarized results of this comparative analysis are presented in the following subsections.

6.2.1 Overall Protection of Human Health and the Environment

Alternatives SD-3 and SD-4 are the most protective of human health and the environment. Alternative SD-4 is the most protective, since it would remove surface sediments and historic landfill debris (up to 2 feet bss) from the high beach, intertidal and sub-tidal areas to NYSDEC SGVs. SD-3 would be protective; this alternative includes (1) conservation of the rocky cobble and boulder substrates through only visual removal of historic landfill material and debris in these habitats and (2) a more limited excavation of intertidal and sub-tidal sediments, to only those areas where negative effects as observed in benthic community metrics and toxic effects in toxicity testing were noted in the sediment quality triad assessment.

Alternativea SD-1 and SD-2 would prevent human exposure to some degree, but neither provides any removal or treatment that significantly reduces migration of debris from the historic incinerator landfill area nor addresses contaminant in surrounding sediments. Impacts to the environment under this alternative would go unabated. Alternative SD-1 is the least protective, since it would not remove or treat contaminants nor reduce the risk of human or environmental exposure.

6.2.2 Compliance with SCGs

Chemical-specific SCGs would be achieved only to depths of 2 feet bss in Alternatives SD-3 and SD-4. Alternative SD-4 would remove all debris and sediments to the NYSDEC SGVs to 2 feet bss. This alternative would leave contamination above these values below 2 feet bss. For Alternative SD-3 sediments, would be left in place at concentrations exceeding the NYSDEC SGVs at select sub-tidal stations. Alternatives SD-1 and SD-2 would not remove contamination from the Site.

6.2.3 Short-Term Impacts and Effectiveness

Alternatives SD-1 and SD-2 would have the lowest short-term impact. There would be no potential risks to workers or the public during implementation of these alternatives, since no active remediation would be performed. There would no effectiveness in addressing or abating risks posed to the environment in either of these alternatives.

Alternatives SD-3 and SD-4 would have comparable short-term impacts during implementation. Both alternatives involve the removal of historic landfill-related debris, the excavation of contaminated sediments, and the transportation of contaminated materials to an on-site disposal area. Excavation of sediments and cobble and boulder areas would have higher short-term impacts for Alternative SD-4 given the larger extent of habitat disturbance. These impacts would be reduced for Alterative SD-3 which will focus on removal on fine material in and around the cobble and boulder habitats present.

Cap construction, barrier wall installation and sediment stabilization would also disturb existing habitats during implementation of these two alternatives. Alternatives SD-3 and SD-4 also include handling and off-site disposal of hazardous-level wastes encountered during the activities. Of the two, Alternative SD-4 would have somewhat higher short-term impacts because this alternative would involve the handling of the greatest quantity of material (approximately 7,400 CY for SD-4 in comparison to approximately 6,000 CY for SD-3). Risks to workers and the public would be minimal and would be mitigated through appropriate health and safety and transportation procedures, and engineering controls, as necessary.

6.2.4 Long-Term Effectiveness

The historic landfill debris and sediment removal based on observed biological and toxicological impacts and exceedance of NYSDEC SGVswould have moderate long-term effectiveness and/or permanence in conjunction with source removal, capping, and construction of a barrier wall for the upland disposal area. The magnitude of potential human health and ecological risks would be mitigated by (1) removing a source of contamination and contaminated sediments; (2) reducing contaminant migration to the marine environment; and (3) stabilization of the shoreline to prevent further erosion of historic landfill materials into the adjacent waters.

Institutional controls would be implemented to manage remaining contaminated material, consisting of restricting future use and access. The long-term effectiveness of Alternative SD-3 or SD-4 is dependent on proper removal of historic landfill debris and contaminated sediment, proper construction of capped areas, and implementation of a Cap Area Management Plan. The magnitude of human health and ecological risks would be significantly reduced across the Island following implementation of either of these alternatives.

Alternatives SD-1 and SD-2 would not provide long term effectiveness as there would be minimal mitigation of risks to human health or the environment.

6.2.5 Reduction of Toxicity, Mobility, and/or Volume

Alternatives SD-3 and SD-4 offer significant reduction in toxicity, mobility, and/or volume of historic incinerator landfill debris and contaminated sediment. These alternatives include the excavation and removal of historic landfill waste and contaminated sediments from the high beach (areas above MHW line to vegetation line), intertidal and sub-tidal zones reducing toxicity, mobility and impacted media from the marine environment. Alternatives SD-1 and SD-2 offer no reduction in mobility, toxicity, or volume.

6.2.6 Feasibility

All of the alternatives evaluated are technically feasible. Alternative SD-1 is the easiest to implement, since no remedial activities would be employed in this alternative. Alternative SD-2 would also be easy to implement, involving only institutional and engineering controls. The two remaining alternatives would be relatively difficult to implement due to the geographic restrictions of working on an Island.

Services, equipment, and materials are available for all alternatives. Alternative SD-1 requires no materials and only limited services. Limited materials and services for implementing institutional controls would be needed for Alternative SD-2. Alternatives SD-3 and SD-4 would require excavation, backfilling, stabilization, and capping materials. The quantity of materials required under Alternative SD-4 would be somewhat larger than that of Alternative SD-3.

All of the alternatives evaluated are administratively feasible. Alternatives SD-1 and SD-2 would be the easiest to implement (short-term) since no on-Island removal activities would be performed. Alternatives SD-3 and SD-4 involve construction activities and associated administrative activities (e.g., permitting, public participation, transportation coordination, etc.). Long-term institutional management (e.g., monitoring, reporting, public coordination) would be associated with all of the alternatives except SD-1.

6.2.7 Cost

Alternative SD-1 would have no capital costs and small, periodic O&M costs, associated only with periodic reviews. Alternative SD-2 has the next lowest capital and O&M costs for implementation of institutional controls. Alternatives SD-3 and SD-4 have the highest capital and O&M costs, associated with removal of historic landfill material and sediments, cap maintenance, and monitoring. Alternative SD-3 has a lesser cost than SD-4 based on quantity of material to be removed, handled, capped, etc. Overall, the ranking of the alternatives based on net present value (capital and O&M) from lowest to highest is: Alternatives SD-1, SD-2, SD-3 and SD-4.

7.0 SELECTION OF PREFERRED REMEDIAL ALTERNATIVE

This section presents the selected preferred alternatives for soil and sediment at the Island based on the evaluations presented in the previous sections.

Alternative SL-3 (Contaminated Soil Removal to Commercial Use SCOs, On-Site Disposal, and Multi-Media Capping) was selected after assessment of the soil alternatives and in regard to the potential future use of the Island for passive recreation (parkland). Removal of the sources of contamination and known contamination in soil (up to 1 foot bgs), in addition to the construction of a vertical barrier wall and multi-media cap, will mitigate risks to human health and the environment and provide protection against further migration and transfer into other media. The inclusion of institutional controls will provide overall long-term support for the alternative.

Based on the evaluation of sediment alternatives, SD-3 (Historic Landfill Source Removal, Contaminated Sediment Removal in Habitat Impacted Areas, On-Site Disposal, and Multi-Media Capping of Disposal Area) has been selected. Removal of the sources of contamination and known impacted sediments in combination with conservation of existing bedrock/boulder intertidal habitat will provide protection against further migration and transfer into the marine environment. The inclusion of institutional controls will provide overall long-term support for the alternative.

Multi-media capping in the upland areas will be used to stabilize and isolate the landfill material and placed sediments from around the landfill. Multi-media capping such as coarse sand or armor stone may be used to stabilize the intertidal zone surrounding the landfill area and if so, will be incorporated into the Habitat Restoration Plan. Construction of the multi-media cap will vary based on purpose and environmental constraints present. This alternative will be retained pending further analysis of sheer force requirements and wave energy constraints in the predesign phase for intertidal sediments.

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TABLES

TABLE 3-1
CONTAMINANTS OF CONCERN FOR SOIL

Organics	*Metals*
PAHs	Arsenic
Acenaphthene	Barium
Anthracene	Cadmium
Benzo(a)anthracene	Chromium
Benzo(a)pyrene	Copper
Benzo(b)fluoranthene	Lead
Benzo(k)fluoranthene	Magnesium
Chrysene	Mercury
Dibenzo(a,h)anthracene	
Fluoranthene	
Indeno(1,2,3-cd)pyrene	
Phenanthrene	
Pyrene	
Pesticides	
4,4-DDE	
4,4-DDT	

TABLE 3-2
POTENTIAL SCG-BASED REMEDIAL GOALS FOR SOIL

COCs	*Unrestricted Use [USCOs] (mg/kg)*	*Restricted-Residential Use [RRSCOs] (mg/kg)*	*Commercial Use [CSCOs] (mg/kg)*	*Protection of Ecological Resources SCOs [EcoSCOs] (mg/kg)*
Acenaphthene	20	100	500	20
Anthracene	100	100	500	Not Specified (NS)
Benzo(a)anthracene	1	1	5.6	NS
Benzo(a)pyrene	1	1	1	2.6
Benzo(b)fluoranthene	1	1	5.6	NS
Benzo(k)fluoranthene	0.8	3.9	56	NS
Chrysene	1	3.9	56	NS
Dibenzo(a,h)anthracene	0.33	0.33	0.56	NS
Fluoranthene	100	100	500	NS
Indeno(1,2,3-cd)pyrene	0.5	0.50	5.6	NS
Phenanthrene	100	100	500	NS
Pyrene	100	100	500	NS
4,4-DDE	0.0033	8.9	62	0.0033
4,4-DDT	0.0033	7.9	47	0.0033
Arsenic	13	16	16	13
Barium	350	400	400	433
Cadmium	2.5	4.3	9.3	4
Chromium	30	110	1,500	41
Copper	50	270	270	50
Lead	63	400	1,000	63
Manganese	1,600	2,000	10,000	1,600
Mercury	0.18	0.81	2.8	0.18

TABLE 3-3
SCREENING OF SOIL TECHNOLOGIES AND PROCESS OPTIONS

GRAs	***Remedial Technology Types***	***Process Options***	***Technical Feasibility***
No Further Action	No Further Action	Monitoring and Site Reviews	Retained
Limited Action	Access Restrictions	Access Restrictions	Retained
	Institutional Controls	Deed Restrictions and/or environmental easements	Retained
		Health and Safety Plan and Soil Management Plan	Retained
	Monitoring	Monitoring and Site Reviews	Retained
Containment	Capping	Permeable Soil	Retained
		Clay	Retained
		Asphalt	Retained
		Multi-Media	Retained
	Barrier Walls	Sheet Piling	Retained
		Slurry Walls	Retained
		Grouting	Retained
Removal/Treatment/ Disposal	Removal	Excavation	Retained
	In Situ Treatment	Soil Flushing/Washing	Not Retained
		Stabilization	Not Retained
		Biodegradation	Not Retained
		Oxidation	Not Retained
		Thermal Treatment	Not Retained
	Ex Situ Treatment	Reuse/Recycling	Retained
		Stabilization/Solidification	Retained
		Thermal Desorption	Retained
		Incineration	Retained
		Biodegradation	Retained
		Soil Flushing/Washing	Not Retained
		Chemical Redox	Retained
	Disposal	On-Site Landfill	Retained
		Off-Site Disposal	Retained

TABLE 3-4 (Sheet 1 of 3)
SELECTION OF SOIL PROCESS OPTIONS

Process Option	*Effectiveness*	*Implementability*	*Cost*
***No FurtherAction**	Does not meet RAOs	Easily implemented	Very low cost
Limited Action			
*Deed restrictions and/or environmental easements	Prevents exposure to site contaminants	Easily implemented	Low cost
*Access Restrictions	Prevents exposure to site contaminants	Easily implemented	Low cost
*Health and Safety Plan and Soil Management Plan	Protects workers during future activities and manages soil	Easily implemented	Low cost
*Monitoring and Site Reviews	Monitors site conditions	Easily implemented	Moderate cost
Containment			
Permeable Soil Capping	Prevents exposure to site contaminants	Implementable	Low cost
Clay Capping	Prevents exposure to site contaminants and reduces contaminant migration	Implementable	Moderate cost
Asphalt Capping	Prevents exposure to site contaminants and reduces contaminant migration	Implementable	Moderate cost
*Multi-Media Capping	Prevents exposure to site contaminants and reduces contaminant migration	Implementable	Moderate cost
*Sheet Piling	Does not effectively inhibit migration when pathway to underlying bedrock exists; may be used around on-site disposal area and for dewatering purposes	Implementable	Moderate to High cost
Slurry Walls	Does not effectively inhibit migration when pathway to underlying bedrock exists; may be used around on-site disposal area	Implementable	Moderate to High cost

Grouting	Does not effectively inhibit migration when pathway to underlying bedrock exists; may be used around on-site disposal area	Implementable	Moderate to High cost

TABLE 3-4 (Sheet 2 of 3)
SELECTION OF SOIL PROCESS OPTIONS

Process Option	*Effectiveness*	*Implementability*	*Cost*
Removal			
*Excavation	Effective for contaminant removal for subsequent treatment and disposal	Implementable at shallow depths; more complex for deeper contamination	Low to high cost, depending on required depth
***Ex Situ* Treatment**			
Recycling/Reuse	Effective for the reuse of slightly impacted site soils and other materials	Easily implemented; several options available	Low cost
Stabilization/ Solidification	Moderately effective for immobilization of organic and inorganic site contaminants; no destruction	Moderate to implement; must identify disposal location for stabilized contaminants	Moderate cost
Thermal Desorption	Effective for destruction of organic constituents prior to disposal	Moderate to difficult to implement due to geographic location	High cost
Incineration	Effective for destruction of organic contaminants	Moderate to difficult to implement due to geographic location	Very high cost
Biodegradation	Effective for destruction of organic contaminants	Easy to moderate to implement; reduces the need for transportation but may require a lengthy timeframe	Low to moderate cost
Chemical Redox	Moderately effective for destruction of inorganic contaminants	Moderate to difficult to implement, and is equipment intensive	Moderate to high cost

TABLE 3-4 (Sheet 3 of 3)
SELECTION OF SOIL PROCESS OPTIONS

Process Option	*Effectiveness*	*Implementability*	*Cost*
Disposal			
*On-Site Landfill	Effective for final disposal of treated soil	Easy to implement; on-site landfill already exists	Low cost
*Off-Site Landfill	Effective for final disposal of treated soil	Difficult to implement due to geographic location; requires transportation coordination	Moderate to High cost

*Process options that have been selected for development of remedial alternatives. Non-selected process options are not included in remedial alternatives, but are technically feasible and may be used during design as alternatives to the selected process options.

TABLE 5-1
CONTAMINANTS OF CONCERN FOR SEDIMENT

Organics	*Metals*
PAHs	Cadmium
Acenaphthene	Chromium
Benzo(a)anthracene	Copper
Benzo(a)pyrene	Iron
Dibenzo(a,h)anthracene	Lead
Total PAHs	Mercury
	Nickel
	Zinc

TABLE 5-2
POTENTIAL SGV-BASED REMEDIAL GOALS FOR SEDIMENT

COCs	***NYSDEC Class A (mg/Kg)***
Total PAHs1	4.0
Cadmium	1.2
Chromium	81.0
Copper	34.0
Iron	20,000
Lead	47.0
Mercury	0.15
Nickel	21.0
Zinc	150.0

Notes: Acenaphthene, Benzo(a)anthracene, Benzo(a)pyrene and Dibenzo(a,h)anthracene collectively addressed in Total PAH term

TABLE 5-3
SCREENING OF SEDIMENT TECHNOLOGIES AND PROCESS OPTIONS

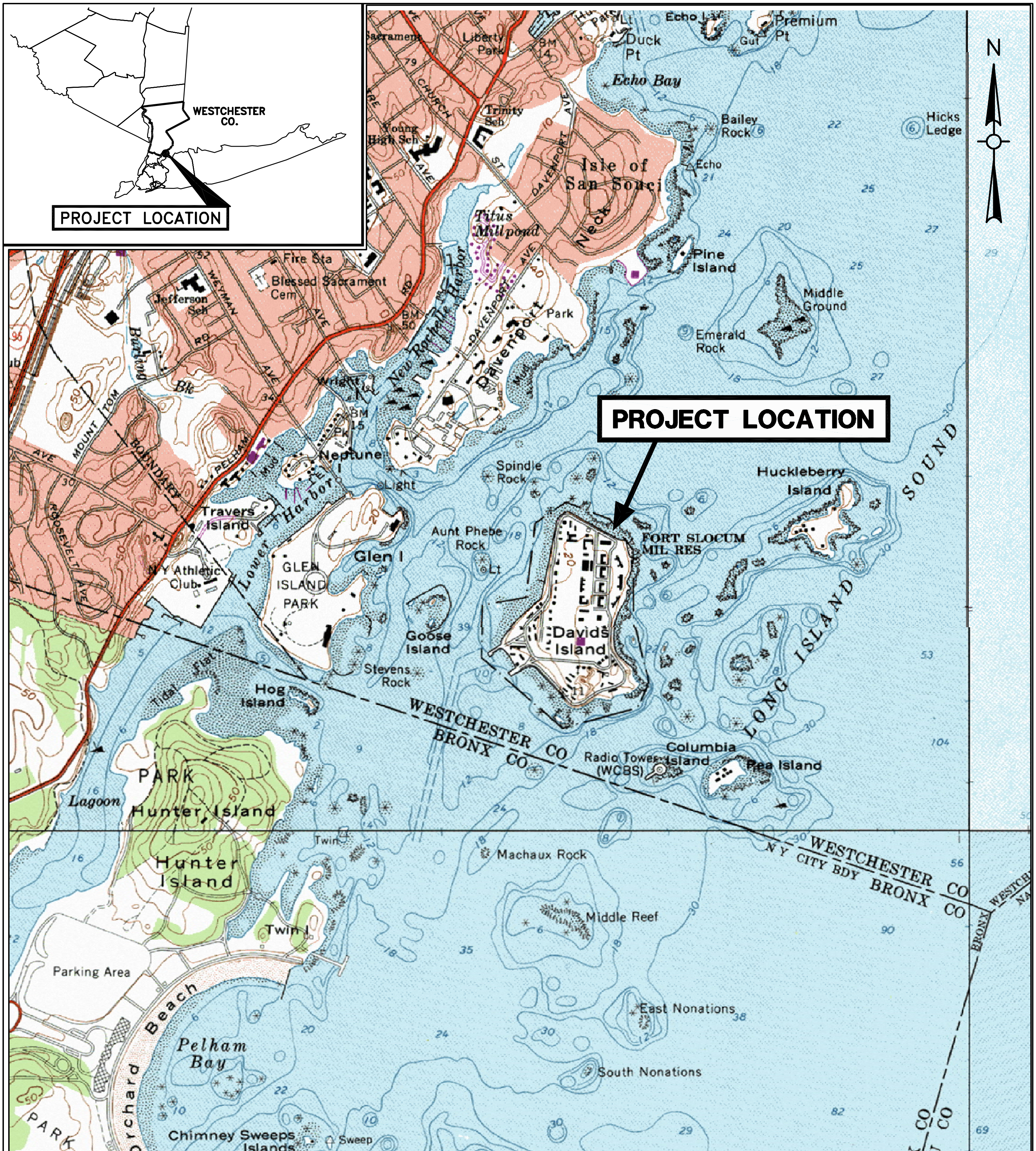
GRAs	*Remedial Technology Types*	*Process Options*	*Technical Feasibility*
No Further Action	No Further Action	Monitoring and Site Reviews	Retained
Limited Action	Access Restrictions	Access Restrictions	Retained
	Institutional Controls	Deed Restrictions and/or Environmental Easements	Retained
		Health and Safety Plan and Sediment Management Plan	Retained
	Monitoring	Monitoring and Site Reviews	Retained
Containment	Capping	Permeable Cap	Not Retained
		Multi-Media	Retained
Removal/Treatment/ Disposal	Removal	Excavation/Dredging	Retained
	Ex Situ Treatment	Reuse/Recycling	Retained
		Stabilization/ Solidification	Retained
		Thermal Desorption	Not Retained
		Incineration	Not Retained
		Biodegradation	Not Retained
		Sediment Flushing/ Washing	Not Retained
	Disposal	On-Site Disposal	Retained
		Off-Site Disposal	Retained

TABLE 5-4
SELECTION OF SEDIMENT PROCESS OPTIONS

Process Option	*Effectiveness*	*Implementability*	*Cost*
***No Further Action**	Does not meet RAOs	Easily implemented	Very low cost
Limited Action			
*Deed restrictions and/or environmental easements	Prevents exposure to site contaminants	Easily implemented	Low cost
*Access Restrictions	Prevents exposure to site contaminants	Easily implemented	Low cost
*Health and Safety Plan and Sediment Management Plan	Protects workers during future activities and manages soil	Easily implemented	Low cost
*Monitoring and Site Reviews	Monitors site conditions	Easily implemented	Moderate cost
Containment			
*Permeable Cap	Prevents exposure to site contaminants	Not Implementable	Low cost
Multi-Media Capping	Prevents exposure to site contaminants and reduces contaminant migration	Implementable	Moderate cost
Removal			
*Excavation/dredging	Effective for contaminant removal for subsequent treatment and disposal	Implementable at shallow depths; more complex for deeper contamination	Low to high cost, depending on required depth
***Ex Situ* Treatment**			
Recycling/Reuse	Effective for the reuse of slightly impacted sediments and other materials	Implementable but requires sorting, debris removal from sediments	Moderate to low cost
Stabilization/ Solidification	Moderately effective for immobilization of organic and inorganic site contaminants; no destruction	Moderate to implement; must dewater sediments and remove landfill related debris; identify disposal location for stabilized contaminants	Moderate cost
Disposal			
*On-Site Disposal	Effective for final disposal of untreated/treated sediments	Easy to implement; on-site landfill already exists; addresses all contaminants	Low cost
*Off-Site Disposal	Effective for final disposal of treated sediment	Difficult to implement due to geographic location; requires transportation coordination	Moderate to high cost

*Process options that have been selected for development of remedial alternatives. Non-selected process options are not included in remedial alternatives, but are technically feasible and may be used during design as alternatives to the selected process options.

FIGURES



0 2000 4000

SCALE IN FEET

TETRA TECH EC, INC.

Source:
USGS 7.5 Minute Series Topographic Maps: Mount Vernon, NY, 1966, photorevised 1979, Sea Cliff, NY, 1968, photorevised 1979, Mamaroneck, NY–CT, 1967, photoinspected 1975, and Flushing NY, 1966, photorevised 1979

FIGURE 1-1

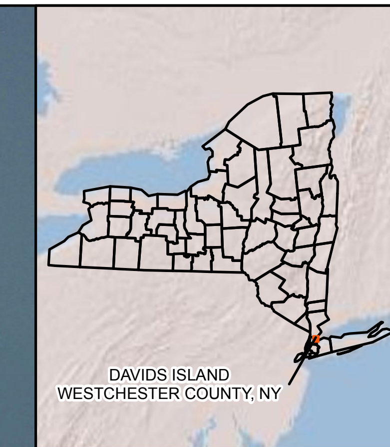
DAVIDS ISLAND

NEW ROCHELLE, NEW YORK

PROJECT LOCATION MAP

SCALE: AS SHOWN

CADDFILE: 2880–A001.DWG



Legend

- CON. EDISON PROPERTY
- FORMER STRUCTURE
- PATH OR ROAD
- ADJACENT AREA
- TIDAL WETLAND BOUNDARY
- APPROXIMATE EXTENT OF INCINERATOR LANDFILL AREA

Feet

0 50 100 200 300 400

FIGURE 1-2

GENERAL LAYOUT

AUGUST 2011

WESTCHESTER COUNTY, NEW YORK

T:\GIS\Davids Island\Geodata\Spatial\MXD\Figure 1_2 General Layout.mxd

FIGURE 1-3A

BENZO(A)PYRENE DISTRIBUTION IN SURFACE SOILS

PREPARED FOR:

PREPARED BY:

DAVIDS ISLAND
ENVIRONMENTAL RESTORATION PROJECT

WESTCHESTER COUNTY, NEW YORK

Path: T:\GIS\Davids_Island\Geodata\Spatial\MXD\Isopleths_040208\Arsenic.mxd

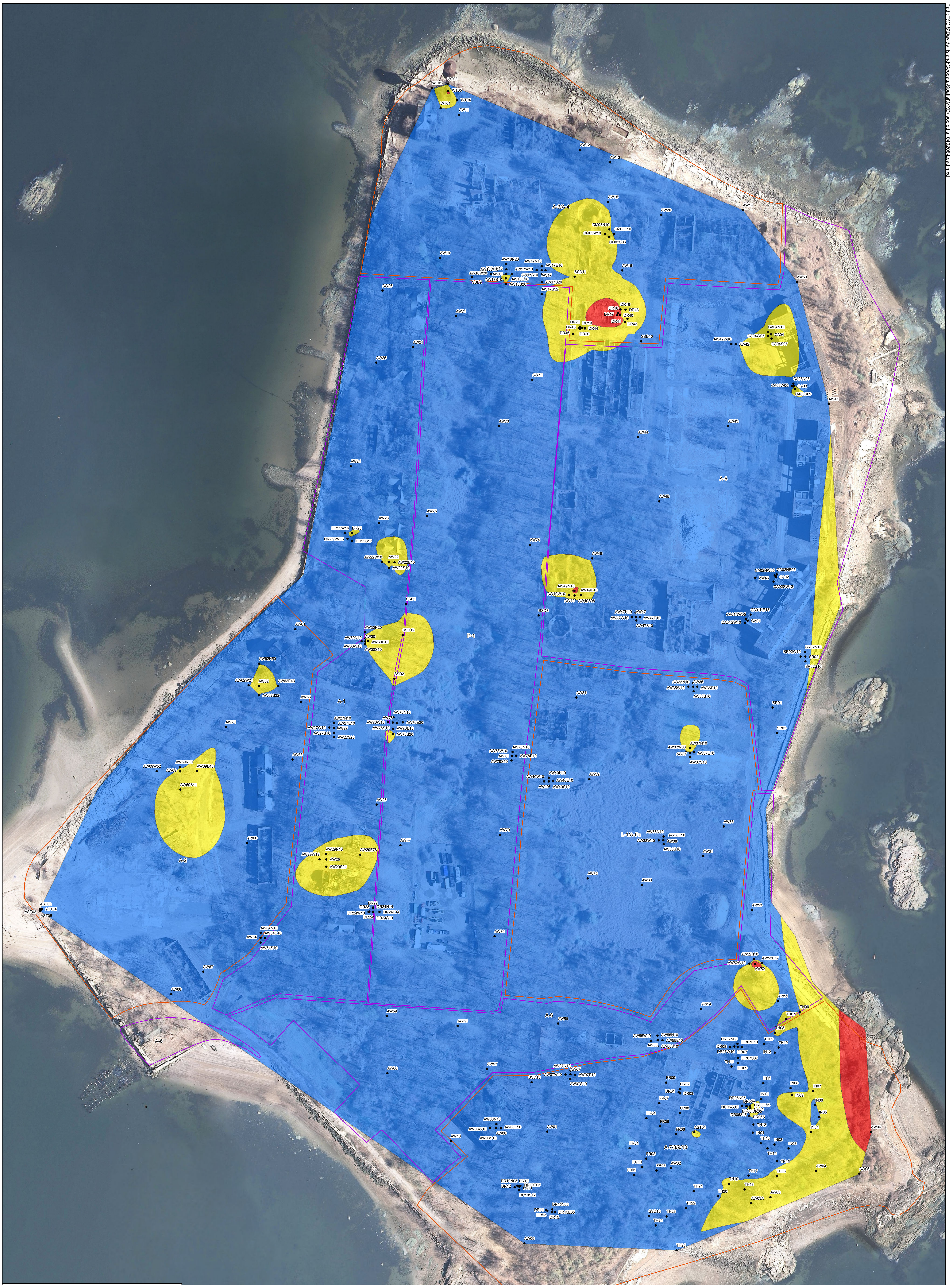


FIGURE 1-3C

LEAD DISTRIBUTION
IN SURFACE SOILS

PREPARED FOR:

PREPARED BY:

DAVIDS ISLAND
ENVIRONMENTAL RESTORATION PROJECT

WESTCHESTER COUNTY, NEW YORK

- LEAD SAMPLE LOCATION
- KNOWN OR HIGH PROBABILITY OF CONTAMINATION
- LITTLE KNOWN OR LOW PROBABILITY OF CONTAMINATION

LEAD CONCENTRATION

mg/kg

- 8.76 - 399
- 400 - 3,999 (RRSCO is 400 mg/kg)
- > 3,999

0 20 40 80 Meters

0 125 250 Feet

FIGURE 1-3D

MERCURY DISTRIBUTION IN SURFACE SOILS

PREPARED FOR: PREPARED BY:

DAVIDS ISLAND
ENVIRONMENTAL RESTORATION PROJECT

WESTCHESTER COUNTY, NEW YORK

Legend

- ESTIMATED FOOTPRINT OF CONSOLIDATED AREA
- VERTICAL BARRIER WALL
- INTERPOLATED MEAN LOW WATER MARK (MLW)
- INTERPOLATED MEAN HIGH WATER MARK (MHW)
- HORIZONTAL EXTENT OF CONSTITUENT CONCENTRATIONS ABOVE COMMERCIAL USE SCOs
- HORIZONTAL EXTENT OF CONSTITUENT CONCENTRATIONS IN UPLAND SOILS WITHIN WETLAND ADJACENT AREAS ABOVE PROTECTION OF ECOLOGICAL RESOURCES SCOS.
- KNOWN EXTENT OF INCINERATOR LANDFILL AREA

SOURCE:
(c) 2010 Microsoft Corporation and its data suppliers.

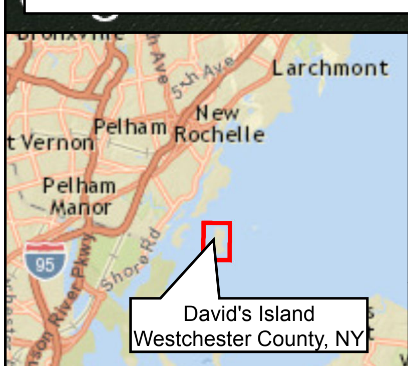
TETRA TECH

FIGURE 4-1

ALTERNATIVE SL-3:
EXCAVATION TO NYSDEC
COMMERCIAL USE SCOs

SEPTEMBER 2012

WESTCHESTER COUNTY, NEW YORK



Legend

- ESTIMATED FOOTPRINT OF CONSOLIDATED AREA
- VERTICAL BARRIER WALL
- INTERPOLATED MEAN LOW WATER MARK (MLW)
- INTERPOLATED MEAN HIGH WATER MARK (MHW)
- HORIZONTAL EXTENT OF CONSTITUENT CONCENTRATIONS ABOVE RESTRICTED RESIDENTIAL USE SCOs
- HORIZONTAL EXTENT OF CONSTITUENT CONCENTRATIONS IN UPLAND SOILS WITHIN WETLAND ADJACENT AREAS ABOVE PROTECTION OF ECOLOGICAL RESOURCES SCOS.
- KNOWN EXTENT OF INCINERATOR LANDFILL AREA

SOURCE:
(c) 2010 Microsoft Corporation and its data suppliers.

TETRA TECH

FIGURE 4-2

ALTERNATIVE SL-4:
EXCAVATION TO NYSDEC
COMMERCIAL USE SCOs

SEPTEMBER 2012

WESTCHESTER COUNTY, NEW YORK

Path: T:\GIS\Davids_Island\Geodata\Spatial\MXD\2016_Updates\Isopleths\Figure_4_2_Isopleths_20160818.mxd

Legend

HORIZONTAL EXTENT OF CONSTITUENT CONCENTRATIONS ABOVE UNRESTRICTED USE SCOs

KNOWN EXTENT OF INCINERATOR LANDFILL AREA

SOURCE:
NYS Digital Ortho-imagery Program (NYSDOP), 2009 imagery in Westchester County

TETRA TECH

FIGURE 4-3

ALTERNATIVE SL-5:
EXCAVATION TO NYSDEC
UNRESTRICTED USE SCOs

MAY 2012

WESTCHESTER COUNTY, NEW YORK

Path: T:\GIS\Davids_Island\Geodata\Spatial\MXD\Isopleths_042712\Isopleths.mxd

LEGEND

- MEAN HIGH WATER
- MEAN HIGHER HIGH WATER
- REMOVAL ALTERNATIVE SD-3
- KNOWN EXTENT OF INCINERATOR LANDFILL AREA
- SITE INVESTIGATION SEDIMENT STATIONS
- SITE INVESTIGATION INTERTIDAL SEDIMENT TRIAD LOCATIONS
- SITE INVESTIGATION SUBTIDAL SEDIMENT TRIAD LOCATIONS

- AVOID BOULDER/COBBLE SUBSTRATES
- METAL DEBRIS RECOVERY AND RECYCLING
- EXCAVATE SEDIMENTS IN AREAS OF OBSERVED NEGATIVE TRIAD EFFECTS
- EXCAVATE TO 2 FT BELOW SEDIMENT SURFACE

SOURCE:
NYS Digital Ortho-imagery Program (NYSDOP)
2009 imagery in Westchester County

Feet
0 50 100

TETRA TECH

FIGURE 6-1

ALTERNATIVE SD-3:
HABITAT-BASED EXCAVATION

MAY 2012

WESTCHESTER COUNTY, NEW YORK

LEGEND

- MEAN HIGH WATER
- MEAN HIGHER HIGH WATER
- REMOVAL ALTERNATIVE SD-4
- KNOWN EXTENT OF INCINERATOR LANDFILL AREA
- SITE INVESTIGATION SEDIMENT STATIONS
- SITE INVESTIGATION INTERTIDAL SEDIMENT TRIAD LOCATIONS
- SITE INVESTIGATION SUBTIDAL SEDIMENT TRIAD LOCATIONS

- SURFICIAL LANDFILL DEBRIS REMOVAL/ RECYCLING
- REMOVE BOULDER/COBBLE FIELDS, WASH FINE SEDIMENT
- EXCAVATE FINE SEDIMENTS TO 2 FT BELOW SEDIMENT SURFACE
- EXCAVATE ALL STATIONS EXCEEDING NYSDEC LEL AROUND LANDFILL BEACHES

SOURCE:
NYS Digital Ortho-imagery Program (NYSDOP)
2009 imagery in Westchester County

Feet
0 50 100

TETRA TECH

FIGURE 6-2

REMOVAL ALTERNATIVE SD-4:
EXCAVATION AREA

MAY 2012

WESTCHESTER COUNTY, NEW YORK

APPENDICES

Appendix A – Cost Estimates for Remedial Alternatives

Table A-1
Davids Island Environmental Restoration Project
Remedial Alternative Cost Estimate - Alternative SL3

Cost Item	Unit of Measure	Unit Rate	Estimated Quantity	Estimated Cost	Notes
Mobilization	Ea	$ 350,000	1	$ 350,000	
Site Facilities	Month	$ 75,000	5	$ 375,000	
Install/Maintain Pollution Controls	LS	$ 225,000	1	$ 225,000	
Clearing & Grubbing	Acres	$ 2,250	10.8	$ 24,300	
Surface Soil Removal to Upland Disposal	CY	$ 70	17424	$ 1,219,680	
Disposal Off-Island - Non-Hazardous	CY	$ 143	0	$ -	
Soil Removal to Off Site Hazardous Disposal	CY	$ 275	3485	$ 958,320	
Turbidity Curtain	LF	$ 250	0	$ -	
Sediment Removal to Upland Disposal	CY	$ 135	0	$ -	
Hazardous Sediment Removal to Off Site Disposal	CY	$ 350	0	$ -	
Imported Loose Rock Riprap	CY	$ 155	0	$ -	
Vertical Barrier Wall	LF	$ 650	1500	$ 975,000	
Multi Media Capping of Upland Disposal	SY	$ 55	17778	$ 977,778	
Backfill using Site Material	CY	$ 35	4356	$ 152,460	
Backfill using Imported Material	CY	$ 155	13068	$ 2,025,540	
Post Excavation Sampling	Ea	$ 2,300	499	$ 1,146,596	
Fence	LF	$ 75	2000	$ 150,000	
Site Restoration	LS	$ 150,000	1	$ 150,000	
Seeding & Mulch	acres	$ 3,500	15	$ 52,500	
Demob	Ea	$ 150,000	1	$ 150,000	
			Subtotal	**$ 8,932,174**	
			Contingency	**$ 1,786,435**	20% est. contingency
			Engineering (10%)	**$ 893,217**	
			Legal & Administrative (5%)	**$ 446,609**	
			Total Estimated Capital Cost	**$ 12,058,435**	
			Annual O&M Cost	**$ 133,028**	
			NPV O&M Cost	**$ 2,607,403**	Assumes 3% ROR
			NPV 5-Year Reviews	**$ 73,832**	Assumes 3% ROR
			Total NPV	**$ 14,739,669**	

Table A-2
Davids Island Environmental Restoration Project
Remedial Alternative Cost Estimate - Alternative SL4

Cost Item	Unit of Measure	Unit Rate	Estimated Quantity	Estimated Cost	Notes
Mobilization	Ea	$ 350,000	1	$ 350,000	
Site Facilities	Month	$ 75,000	7	$ 525,000	
Install/Maintain Pollution Controls	LS	$ 225,000	1	$ 225,000	
Clearing & Grubbing	Acres	$ 2,250	14.8	$ 33,300	
Surface Soil Removal to Upland Disposal	CY	$ 70	47755	$ 3,342,827	
Disposal Off-Island - Non-Hazardous	CY	$ 143	0	$ -	
Soil Removal to Off Site Hazardous Disposal	CY	$ 275	4775	$ 1,313,253	
Turbidity Curtain	LF	$ 250	0	$ -	
Sediment Removal to Upland Disposal	CY	$ 135	0	$ -	
Hazardous Sediment Removal to Off Site Disposal	CY	$ 350	0	$ -	
Imported Loose Rock Riprap	CY	$ 155	0	$ -	
Vertical Barrier Wall	LF	$ 650	1500	$ 975,000	
Multi Media Capping of Upland Disposal	SY	$ 55	30625	$ 1,684,375	
Backfill using Site Material	CY	$ 35	11939	$ 417,853	
Backfill using Imported Material	CY	$ 155	35816	$ 5,551,480	
Post Excavation Sampling	Ea	$ 2,300	716	$ 1,647,536	
Fence	LF	$ 75	2000	$ 150,000	
Site Restoration	LS	$ 150,000	1	$ 150,000	
Seeding & Mulch	acres	$ 3,500	15	$ 52,500	
Demob	Ea	$ 150,000	1	$ 150,000	
			Subtotal	**$ 16,568,124**	
			Contingency	**$ 1,656,812**	10% est. contingency
			Engineering (10%)	**$ 1,656,812**	
			Legal & Administrative (5%)	**$ 828,406**	
			Total Estimated Capital Cost	**$ 20,710,155**	
			Annual O&M Cost	**$ 203,688**	
			NPV O&M Cost	**$ 3,992,365**	Assumes 3% ROR
			NPV 5-Year Reviews	**$ 73,832**	Assumes 3% ROR
			Total NPV	**$ 24,776,352**	

Table A-3
Davids Island Environmental Restoration Project
Remedial Alternative Cost Estimate - Alternative SL5

Cost Item	Unit of Measure	Unit Rate	Estimated Quantity	Estimated Cost	Notes
Mobilization	Ea	$ 350,000	1	$ 350,000	
Site Facilities	Month	$ 75,000	20	$ 1,500,000	
Install/Maintain Pollution Controls	LS	$ 225,000	1	$ 225,000	
Clearing & Grubbing	Acres	$ 2,250	59.4	$ 133,650	
Surface Soil Removal to Upland Disposal	CY	$ 70	0	$ -	
Disposal Off-Island - Non-Hazardous	CY	$ 143	383328	$ 54,761,143	
Soil Removal to Off Site Hazardous Disposal	CY	$ 275	19166	$ 5,270,760	
Turbidity Curtain	LF	$ 250	0	$ -	
Sediment Removal to Upland Disposal	CY	$ 135	0	$ -	
Hazardous Sediment Removal to Off Site Disposal	CY	$ 350	0	$ -	
Imported Loose Rock Riprap	CY	$ 155	0	$ -	
Vertical Barrier Wall	LF	$ 650	0	$ -	
Multi Media Capping of Upland Disposal	SY	$ 55	0	$ -	
Backfill using Site Material	CY	$ 35	47916	$ 1,677,060	
Backfill using Imported Material	CY	$ 155	143748	$ 22,280,940	
Post Excavation Sampling	Ea	$ 2,300	2875	$ 6,612,408	
Fence	LF	$ 75	2000	$ 150,000	
Site Restoration	LS	$ 150,000	1	$ 150,000	
Seeding & Mulch	acres	$ 3,500	15	$ 52,500	
Demob	Ea	$ 150,000	1	$ 150,000	
			Subtotal	**$ 93,313,461**	
			Contingency	**$ 4,665,673**	5% est. contingency
			Engineering (10%)	**$ 9,331,346**	
			Legal & Administrative (5%)	**$ 4,665,673**	
			Total Estimated Capital Cost	**$ 111,976,153**	
			Annual O&M Cost	**$ 35,250**	
			NPV O&M Cost	**$ 690,916**	Assumes 3% ROR
			NPV 5-Year Reviews	**$ 73,832**	Assumes 3% ROR
			Total NPV	**$ 112,740,900**	

Table A-4
Davids Island Environmental Restoration Project
Remedial Alternative Cost Estimate - Alternative SD3

Cost Item	Unit of Measure	Unit Rate	Estimated Quantity	Estimated Cost	Notes
Mobilization	Ea	$ 350,000	1	$ 350,000	
Site Facilities	Month	$ 75,000	3	$ 225,000	
Install/Maintain Pollution Controls	LS	$ 225,000	0	$ -	
Clearing & Grubbing	Acres	$ 2,250	0	$ -	
Surface Soil Removal to Upland Disposal	CY	$ 70	0	$ -	
Disposal Off-Island - Non-Hazardous	CY	$ 143	0	$ -	
Soil Removal to Off Site Hazardous Disposal	CY	$ 275	0	$ -	
Turbidity Curtain	LF	$ 250	1000	$ 250,000	
Sediment Removal to Upland Disposal	CY	$ 135	6002	$ 810,216	
Hazardous Sediment Removal to Off Site Disposal	CY	$ 350	0	$ -	
Imported Loose Rock Riprap	CY	$ 155	6002	$ 930,248	
Vertical Barrier Wall	LF	$ 650	0	$ -	
Multi Media Capping of Upland Disposal	SY	$ 55	0	$ -	
Backfill using Site Material	CY	$ 35	0	$ -	
Backfill using Imported Material	CY	$ 155	0	$ -	
Post Excavation Sampling	Ea	$ 2,300	90	$ 207,055	
Fence	LF	$ 75	0	$ -	
Site Restoration	LS	$ 150,000	1	$ 150,000	
Seeding & Mulch	acres	$ 3,500	0	$ -	
Demob	Ea	$ 150,000	1	$ 150,000	
			Subtotal	**$ 3,072,519**	
			Contingency	**$ 614,504**	20% est. contingency
			Engineering (10%)	**$ 307,252**	
			Legal & Administrative (5%)	**$ 153,626**	
			Total Estimated Capital Cost	**$ 4,147,901**	
			Annual O&M Cost	**$ 50,000**	
			NPV O&M Cost	**$ 980,022**	Assumes 3% ROR
			NPV 5-Year Reviews	**$ 73,832**	Assumes 3% ROR
			Total NPV	**$ 5,201,755**	

Table A-5
Davids Island Environmental Restoration Project
Remedial Alternative Cost Estimate - Alternative SD4

Cost Item	Unit of Measure	Unit Rate	Estimated Quantity	Estimated Cost	Notes
Mobilization	Ea	$ 350,000	1	$ 350,000	
Site Facilities	Month	$ 75,000	3	$ 225,000	
Install/Maintain Pollution Controls	LS	$ 225,000	0	$ -	
Clearing & Grubbing	Acres	$ 2,250	0	$ -	
Surface Soil Removal to Upland Disposal	CY	$ 70	0	$ -	
Disposal Off-Island - Non-Hazardous	CY	$ 143	0	$ -	
Soil Removal to Off Site Hazardous Disposal	CY	$ 275	0	$ -	
Turbidity Curtain	LF	$ 250	1000	$ 250,000	
Sediment Removal to Upland Disposal	CY	$ 135	7389	$ 997,524	
Hazardous Sediment Removal to Off Site Disposal	CY	$ 350	0	$ -	
Imported Loose Rock Riprap	CY	$ 155	7389	$ 1,145,305	
Vertical Barrier Wall	LF	$ 650	0	$ -	
Multi Media Capping of Upland Disposal	SY	$ 55	0	$ -	
Backfill using Site Material	CY	$ 35	0	$ -	
Backfill using Imported Material	CY	$ 155	0	$ -	
Post Excavation Sampling	Ea	$ 2,300	111	$ 254,923	
Fence	LF	$ 75	0	$ -	
Site Restoration	LS	$ 150,000	0	$ -	
Seeding & Mulch	acres	$ 3,500	0	$ -	
Demob	Ea	$ 150,000	1	$ 150,000	
			Subtotal	**$ 3,372,752**	
			Contingency	**$ 674,550**	20% est. contingency
			Engineering (10%)	**$ 337,275**	
		Legal & Administrative (5%)		**$ 168,638**	
		Total Estimated Capital Cost		**$ 4,553,215**	
			Annual O&M Cost	**$ 60,000**	
			NPV O&M Cost	**$ 1,176,026**	Assumes 3% ROR
			NPV 5-Year Reviews	**$ 73,832**	Assumes 3% ROR
			Total NPV	**$ 5,803,073**	

Appendix B – Cost Estimate for Four-Stage Development

Table B-1
Davids Island Environmental Restoration Project
Remedial Alternative Cost Estimate - Alternatives SL3 and SD3 - Multiple Mobilizations

Cost Item	Unit of Measure	Unit Rate	Mob 1 Quantity	Mob 1 Estimated Cost	Mob 2 Quantity	Mob 2 Estimated Cost	Mob 3 Quantity	Mob 3 Estimated Cost	Mob 4 Quantity	Mob 4 Estimated Cost	Mob 5 Quantity	Mob 5 Estimated Cost	Notes
Mobilization	Ea	$ 350,000	1	$ 350,000	1	$ 350,000	1	$ 350,000	1	$ 350,000	1	$ 350,000	
Site Facilities	Month	$ 75,000	3	$ 225,000	3	$ 225,000	3	$ 225,000	3	$ 225,000	3	$ 225,000	
Install/Maintain Pollution Controls	LS	$ 225,000	0.2	$ 40,838	0.2	$ 51,078	0.4	$ 99,371	0.1	$ 33,713		$ -	
Clearing & Grubbing	Acres	$ 2,250	2.0	$ 4,411	2.5	$ 5,516	4.8	$ 10,732	1.6	$ 3,641			
Surface Soil Removal to Upland Disposal	CY	$ 70	3,163	$ 221,376	3,955	$ 276,883	7,695	$ 538,672	2,611	$ 182,749			
Disposal Off-Island - Non-Hazardous	CY	$ 143	-	$ -	-	$ -	-	$ -	-	$ -			
Soil Removal to Off Site Hazardous Disposal	CY	$ 275	633	$ 173,938.59	791	$ 217,550.75	1539	$ 423,242.06	522	$ 143,588.60			
Turbidity Curtain	LF	$ 250									1,000	$ 250,000	
Sediment Removal to Upland Disposal	CY	$ 135									6,002	$ 810,216	
Hazardous Sediment Removal to Off Site Disposal	CY	$ 350									-	$ -	
Imported Loose Rock Riprap	CY	$ 155									6,002	$ 930,248	
Vertical Barrier Wall	LF	$ 650	1500	$ 975,000									
Multi Media Capping of Upland Disposal	SY	$ 55	3872	$ 276,854	4843	$ 319,634	9422	$ 621,843	3196	$ 193,385			
Backfill using Site Material	CY	$ 35	791	$ 27,672	989	$ 34,610	1924	$ 67,334	653	$ 22,844			
Backfill using Imported Material	CY	$ 155	2372	$ 367,643	2967	$ 459,823	5771	$ 894,580	1958	$ 303,494			
Post Excavation Sampling	Ea	$ 2,300	32	$ 72,738	40	$ 90,976	77	$ 176,992	26	$ 60,046			
Fence	LF	$ 75	363	$ 27,226	454	$ 34,052	883	$ 66,248	300	$ 22,475			
Site Restoration	LS	$ 150,000	0.2	$ 32,671	0.3	$ 40,862	0.5	$ 79,497	0.2	$ 26,970	1	$ 150,000	
Seeding & Mulch	acres	$ 3,500	3	$ 9,529	3	$ 11,918	7	$ 23,187	2	$ 7,866			
Demob	Ea	$ 150,000	1	$ 150,000	1	$ 150,000	1	$ 150,000	1	$ 150,000	1	$ 150,000	
			Subtotal	**$ 2,954,895**		**$ 2,267,903**		**$ 3,726,697**		**$ 1,725,772**		**$ 2,865,464**	
			Contingency	**$ 590,979**		**$ 453,581**		**$ 745,339**		**$ 345,154**		**$ 573,093**	20% est. contingency
			Engineering (10%)	**$ 295,490**		**$ 226,790**		**$ 372,670**		**$ 172,577**		**$ 286,546**	
			Legal & Administrative (5%)	**$ 147,745**		**$ 113,395**		**$ 186,335**		**$ 86,289**		**$ 143,273**	
			Total Estimated Capital Cost	**$ 3,989,109**		**$ 3,061,669**		**$ 5,031,042**		**$ 2,329,792**		**$ 3,868,376**	
			Annual O&M Cost	**$ 34,628**		**$ 40,647**		**$ 79,077**		**$ 25,070**		**$ 50,000**	
			NPV O&M Cost	**$ 678,722**		**$ 796,692**		**$ 1,549,953**		**$ 491,377**		**$ 980,022**	Assumes 3% ROR
			NPV 5-Year Reviews	**$ -**		**$ -**		**$ -**		**$ 73,832**		**$ 73,832**	Assumes 3% ROR
			Total NPV	**$ 4,667,831**		**$ 3,858,361**		**$ 6,580,994**		**$ 2,895,000**		**$ 4,922,230**	