FINAL
FEASIBILITY STUDY FOR
HAZARDOUS TOXIC AND RADIOACTIVE WASTE PROJECT
IONA ISLAND NAVAL AMMUNITION DEPOT
FORMERLY USED DEFENSE SITE
STONY POINT, ROCKLAND COUNTY, NEW YORK

March 2026

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µg/dL	Microgram(s) per deciliter
95UCL	95 percent upper confidence limit of the mean
ALM	Adult lead model
AM	Amino
AOC	Area of concern
ARAR	Applicable or Relevant and Appropriate Requirement
AST	Aboveground storage tank
ASTM	American Society for Testing and Materials
BERA	Baseline Ecological Risk Assessment
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and xylene
CEC	Cation-exchange capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminants of concern
COPC	Contaminant of potential concern
CWA	Clean Water Act
DERP	Defense Environmental Restoration Program
DNT	Dinitrotoluene
DoD	Department of Defense
DU	Decision unit
EcoSSL	Ecological soil screening level
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
FS	Feasibility Study
FUDS	Formerly Used Defense Site
GRA	General response actions
GSA	General Services Administration
HHRA	Human health risk assessment
HQ	Hazard quotient
HTRW	Hazardous toxic and radioactive waste
ISM	Incremental sampling methodology
ISS	In situ solidification/stabilization
LUC	Land Use Control

mg/kg	Milligram(s) per kilogram
mg/L	Milligrams per liter
N/A	Not applicable
Navy	U.S. Navy
NC	Not completed
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
O&M	Operations and maintenance
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PIPC	Palisades Interstate Park Commission
PP	Proposed Plan
PPE	Personal protective equipment
PRG	Preliminary Remediation Goal
QAPP	Quality Assurance Project Plan
RAO	Remedial Action Objective
RI	Remedial Investigation
RSLERA	Refined Screening-Level Ecological Risk Assessment
SCO	Soil Cleanup Objective
SLERA	Screening-level ecological risk assessment
TAL	Target analyte list
TBC	To Be Considered
TNT	Trinitrotoluene
TOC	Total organic carbon
UFP	Uniform Federal Policy
USACE	U.S. Army Corps of Engineers
USAGC	U.S. Army Geospatial Center

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EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers prepared a Feasibility Study (FS) for the Iona Island Naval Ammunition Depot Formerly Used Defense Site (FUDS), located in Stony Point, Rockland County, New York, in support of the Hazardous Toxic and Radioactive Waste project (FUDS Project Number C02NY074402).

The Iona Island Naval Ammunition Depot FUDS (referred to as the Property) consists of approximately 124 acres of land and inland water (**Figure ES-1**). The U.S. Navy (Navy) used the Property as an Ammunition Depot from 1900 to 1947, with the major effort consisting of assembling naval ammunition for World War II. Although no ammunition was manufactured at Iona Island, various types of explosives were assembled at the Property. Activities included preparing, assembling, maintaining, inspecting, and testing ammunition; storing bulk explosives, ammunition, and ordnance material; and issuing ammunition to the fleet, shore establishments, armed merchantmen, transport, and district forces (U.S. Army Geospatial Center 2018).

The former depot was excessed by the Navy in 1957 and transferred to the General Services Administration. The General Services Administration conveyed the FUDS property to the Palisades Interstate Park Commission (PIPC) in 1965. The majority of buildings and structures, including building foundations, were demolished and removed by PIPC between November 1965 and December 1973 (U.S. Army Geospatial Center 2018). The PIPC currently utilizes a portion of Iona Island as a storage facility; however, the property is closed to the public and use is restricted for park purposes only.

This FS was developed using historical information, site characterization data, analytical data, and the conclusions as documented in the *Final Hazardous Toxic and Radioactive Waste Remedial Investigation Report, Iona Island Naval Ammunition Depot FUDS, June 2024* (USACE 2024b). The Remedial Investigation concluded that the portion of this FUDS known as the Former Dump Area and the Iona Island Hudson River shoreline in its immediate vicinity posed unacceptable risk to human health and/or ecological receptors (**Figure ES-1**). It is possible that collection of additional site-specific data as part of a Baseline Ecological Risk Assessment (BERA) could refine the risk conclusions of the Screening-Level Ecological Risk Assessment, which overestimates risk to ecological receptors. However, the site soil and sediment lead concentrations, as well as exposure doses based on those concentrations, were much higher than concentrations and doses at which effects to receptors are likely. For this reason, the collection of additional site-specific information to support a BERA will not change the ecological risk findings, nor will the completion of a BERA result in different risk conclusions. Therefore, the risks in this part of the Property are sufficient to warrant proceeding to the FS without the completion of a BERA.

ES.1 FEASIBILITY STUDY

The ultimate objective for the Property is to complete a Record of Decision which addresses remaining project risks at the FUDS, in compliance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, that will protect human health and the environment. Once the ROD has been implemented, the remedial action is complete and a

Remedial Action Completion Report is finalized, the project is at closeout. At this, which is the stage at which the Department of Defense has completed required response actions at an eligible FUDS project. At this point, no additional environmental restoration funds will be expended on the project. Project closeout occurs when environmental restoration goals have been achieved that allow unlimited use and unrestricted exposure of the project area (e.g., no five-year reviews are required). All closeout activities are conducted in the last phase of work on the project when no further action is determined. Based on the results of the Remedial Investigation, remedial action is needed to address risk to human health and the environment resulting from exposure to lead from a limited area of contaminated soil within the Former Dump Area and Hudson River shoreline in its immediate vicinity (**Figure ES-1**).

ES.1.1 Feasibility Study Objectives

The primary objective of the FS is to ensure appropriate remedial alternatives are developed and evaluated so that relevant information concerning the remedial action options are available to decision makers and an appropriate remedy can be selected per Title 40 of the Code of Federal Regulations (CFR) 300.430(e). This FS includes the development of remedial action objectives (RAOs), the screening of available technologies, the incorporation of technologies into remedial alternatives, and an evaluation of remedial alternatives.

ES.1.2 Screening of Technologies and Development of Response Alternatives

Lead is a primary contaminant of concern (COC) for surface and subsurface soil in the Former Dump Area and adjacent shoreline sediments of the Hudson River. The RAOs used to evaluate general response actions, technologies, and remedial alternatives are:

- Prevent exposure of current and anticipated future human receptors (recreational users) to lead and other COCs present with concentrations above their respective Preliminary Remediation Goals (PRGs) within contaminated sediment in the Hudson River adjacent to the Former Dump Area.

- Prevent impacts to biota from exposure to lead and other COCs in soil present with concentrations above their respective PRGs in the Former Dump Area that could be causing toxicity or impacts from bioaccumulation through the terrestrial and benthic food chain.

- Prevent impacts to biota from ingestion/direct contact with lead and other COCs present with concentrations above their respective PRGs within Hudson River shoreline sediment adjacent to the Former Dump Area that could be causing toxicity or impacts from bioaccumulation through the benthic food chain.

- Prevent migration of lead and other COCs in soil present with concentrations above their respective PRGs from the Former Dump Area to the adjacent Hudson River Shoreline sediments. PIPC have expressed interest in maintaining the Former Dump Area as a wetland with native wetland plant species. While not an RAO, maintaining the low-lying marsh area of the Former Dump Area as a wetland with native wetland plant species is considered a post-remediation objective for the Property.

A screening of available remedial technologies was conducted to identify those that warrant further consideration based on applicability to the conditions at the Property. To address the RAOs, four potential remedial alternatives were developed for the Iona Island FUDS using the technologies that were evaluated and retained from this screening:

- Alternative 1—No action
- Alternative 2—Excavation and off-site disposal of contaminated soil and sediment as hazardous waste
- Alternative 3—Excavation, ex situ treatment, and off-site disposal of contaminated soil and sediment as non-hazardous waste
- Alternative 4— Capping of Contaminated Soil and Sediment Accompanied by Installation of a Permanent Vertical Barrier and Additional land use controls

An initial screening of the four alternatives was conducted based on the effectiveness and implementability of each option. Based on these screenings, all four alternatives were retained for further evaluation; however, Alternative 3 is the most favorable of the presented alternatives based on the evaluation criteria.

Regulatory and community acceptance is unknown at this time and will not be evaluated formally until comments on the FS and the upcoming Proposed Plan are received. The evaluation of the four alternatives in accordance with the remaining seven criteria is summarized in **Table ES-1**. The retained alternatives will be discussed with the stakeholders as part of the review of this document. Alternatives, including the preferred alternative, will be presented in the Proposed Plan.

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Table ES-1. Comparative Analysis Summary of Remedial Alternatives

Criteria	Alternative 1: No action	Alternative 2: Excavation and off-site disposal of contaminated soil and sediment as hazardous waste	Alternative 3: Excavation, ex situ treatment, and off-site disposal of contaminated soil and sediment as non-hazardous waste	Alternative 4: Capping of contaminated soil and sediment accompanied by installation of a permanent vertical barrier and additional LUCs
Overall Protection of Human Health and the Environment	Fail	Pass	Pass	Pass
Compliance With ARARs	N/A	Pass	Pass	Waiver*
Long-Term Effectiveness and Permanence	∇	∆	∆	∇
Reduction of Toxicity, Mobility, and Volume through Treatment	∇	∇	∆	∇
Short-Term Effectiveness	∇	∆	∆	∆
Implementability	∆	∆	∆	∆
Total Cost	$0	$11,845,000	$9,867,000	$10,660,000

Notes:

∆- In comparison with other alternatives, it complies well with criteria.

♦- In comparison with other alternatives, partially complies with criteria.

∇- In comparison with other alternatives, it does not comply as well with criteria.

Cost estimates are based upon 2024 dollars. Total Net Cost rounded to nearest $1,000.
* Waiver would depend on Alternatives 2 and 3 not being practicable.
ARAR = applicable or relevant and appropriate requirement
LUC = land use control
N/A = not applicable

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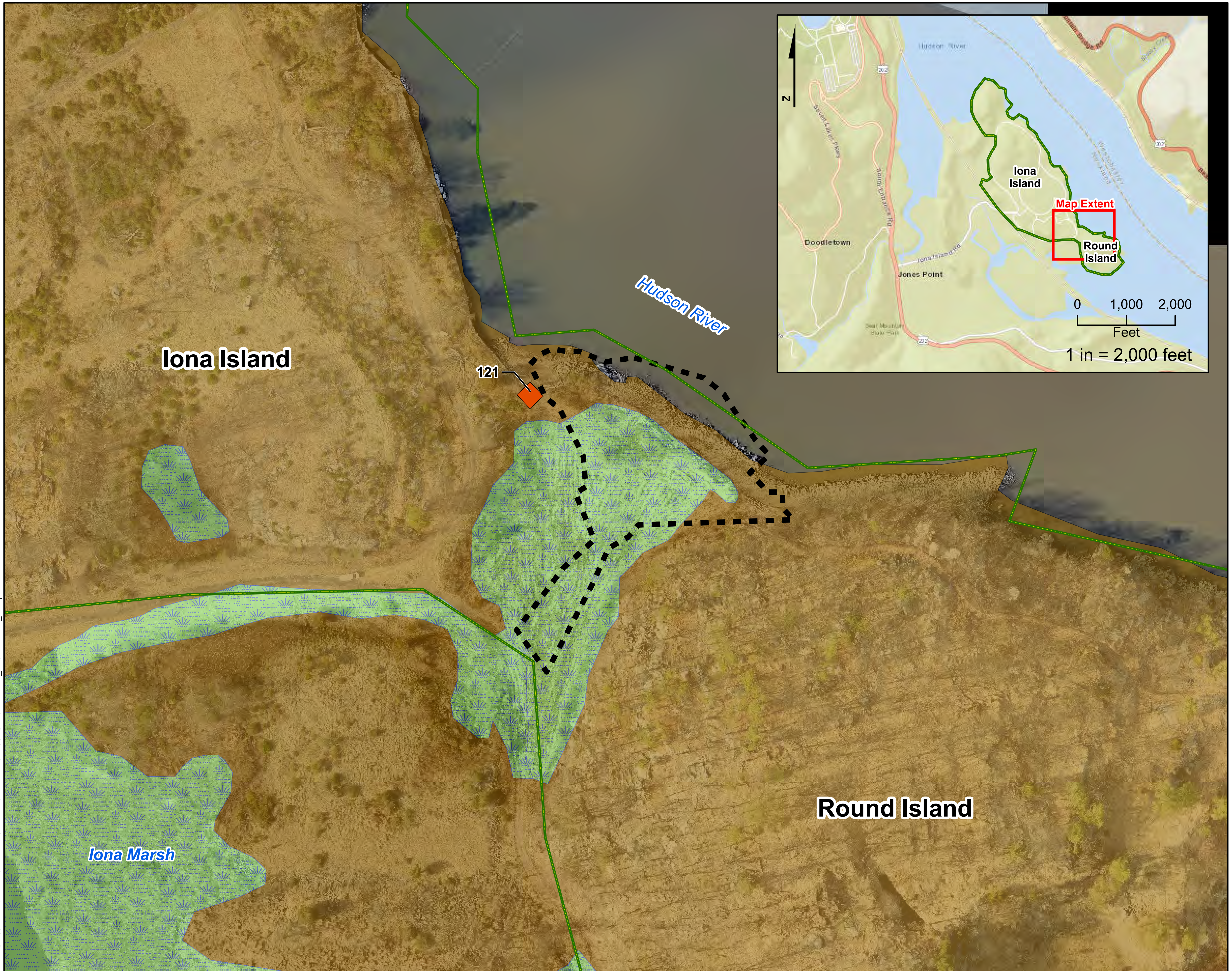

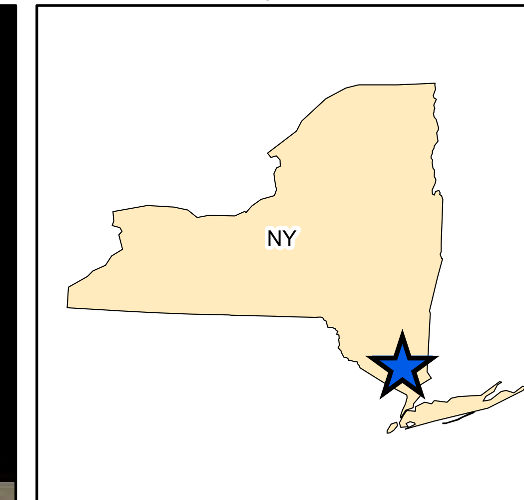

Legend

- FUDS Boundary
- Upland
- Marsh/Wetland
- Former Dumping Area
- Former Bldg 121 Incinerator

0 100 200
Feet
1 in = 100 feet
N

FIGURE ES-1
Iona Island Location and Former Dumping Area

HAZARDOUS TOXIC AND RADIOACTIVE WASTE FEASIBILITY STUDY

Source
Aerial: EA Engineering, Science, and Technology. April, 7 2020
Disturbed Ground/Fill Area and AOC Boundary: USAGC 2018
Upland and Marsh/Wetland: 2020 EA Shoreline Reconnaissance
Map Date: 4/16/2025

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1. INTRODUCTION

1.1 AUTHORIZATION

U.S. Army Corps of Engineers (USACE) is preparing a Feasibility Study (FS) for the Iona Island Naval Ammunition Depot Formerly Used Defense Site (FUDS) (**Figure 1-1**), located in Stony Point, Rockland County, New York, in support of the Hazardous Toxic and Radioactive Waste (HTRW) project (FUDS Project Number C02NY074402).

This HTRW project is being conducted under the Defense Environmental Restoration Program (DERP) (USACE 1998) for FUDS and in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendment and Reauthorization Act, and the National Oil and Hazardous Substances Contingency Plan (National Contingency Plan [NCP]). The FUDS program performs cleanup of properties that were formerly owned by, leased to, or otherwise possessed by the United States and under the jurisdiction of the Secretary of Defense prior to October 1986. Only Department of Defense (DoD)-generated eligible contamination that occurred before the transfer of the property to private owners or federal, state, or local governments is eligible for a DERP FUDS response. Types of contamination that may be eligible for a DERP FUDS response include CERCLA hazardous substances, pollutants, contaminants, military munitions, petroleum, oil, and lubricants, or unsafe conditions posed by buildings or structures. Metals that are listed as CERCLA hazardous substances under Title 40 of the Code of Federal Regulations (CFR) in Table 302.4, List of Hazardous Substances and Reportable Quantities (40 CFR 302.4, updated 23 February 2024), include antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc (U.S. Environmental Protection Agency [EPA] 2024). Metals that are not CERCLA hazardous substances (e.g., manganese) are not eligible for a DERP FUDS response.

This FS was developed using historical information, Property characterization data, analytical data, and the conclusions as documented in the *Final HTRW Remedial Investigation Report*, *Iona Island Naval Ammunition Depot FUDS, June 2024* (USACE 2024b). USACE conducted the HTRW Project Remedial Investigation (RI) with concurrence from the New York State Department of Environmental Conservation (NYSDEC), New York State Department of Health (NYSDOH), and the landowner, Palisades Interstate Park Commission (PIPC). The RI was conducted to characterize the nature and extent of hazardous substances attributable to historical DoD operations in environmental media at the Property, and to evaluate potential risk to human and ecological receptors. A human health risk assessment (HHRA) and ecological risk assessment (ERA) that included a Screening-Level Ecological Risk Assessment (SLERA) and Refined Screening-Level Ecological Risk Assessment (RSLERA) were completed as part of the RI. The findings of these risk assessments were incorporated into the HTRW Project RI Report.

The RI concluded that the portion of this FUDS known as the Former Dump Area and the adjacent Iona Island Hudson River shoreline are a source of unacceptable risk to human health and/or the environment (**Figure 1-2**). Lead is the primary Contaminant of Concern (COC) that contributes to unacceptable risk based on the results of the HHRA and ERA. The RI recommended that the

HTRW project proceed directly to an FS to evaluate the appropriate remedy to address these unacceptable risks.

1.2 PURPOSE

The ultimate objective of the Iona Island Naval Ammunition Depot FUDS Project process is to complete a Record of Decision, in compliance with CERCLA, as amended, that will lead to the protection of human health and the environment at the Property.

This FS has been prepared to serve as the mechanism for the development, screening, and detailed evaluation of remedial action alternatives to address COCs at the Iona Island Naval Ammunition Depot FUDS. The FS will ensure that appropriate remedial alternatives are developed and evaluated such that relevant information concerning the remedial action options is available to decision makers so that the most appropriate remedy can be selected. This FS was prepared in accordance with the most recent versions of the *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA 1988) and the RI conducted for the Property (USACE 2024b). This FS includes the following specific steps:

- Step 1—Identification of applicable or relevant and appropriate requirements (ARARs)
- Step 2—Identification of the remedial action objectives (RAOs) and general response actions (GRAs) for COCs in each environmental medium of interest (soil within the Former Dump Area and sediment along the Hudson River shoreline adjacent to the Former Dump Area)
- Step 3—Identification of potential treatment technologies for each medium and screening the treatment technologies based on technical feasibility, and combining the treatment technologies remaining after the technical feasibility screening process to form remedial alternatives capable of meeting the RAOs applicable to the Property
- Step 4—Screening of the remedial alternatives on the basis of effectiveness, implementability, and cost to eliminate alternatives that are not effective/in line with the long-term goals for the Property
- Step 5—Conducting a detailed analysis and screening of the remaining remedial alternatives based on the nine criteria (presented below) developed by EPA in the NCP

A detailed analysis of the four remedial alternatives will be performed with respect to the following nine NCP (40 CFR300.40.3(e)(9)) evaluation criteria:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs
- Long-Term Effectiveness

- Reduction of Toxicity, Mobility, and Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost
- State Acceptance
- Community Acceptance

Remedial alternatives described in this FS were developed and screened based on federal and state requirements determined to be ARARs, as well as To Be Considered (TBC) regulatory guidelines. This screening primarily considered the effectiveness and implementability of each technology, taking into consideration Property-specific factors and COCs. The preferred remedial alternative will be discussed with the stakeholders and formulated in a Proposed Plan (PP) that will be submitted to NYSDEC, NYSDOH, and PIPC for comment and review prior to becoming available to the public for comment.

1.3 REPORT ORGANIZATION

This FS is organized into seven sections as follows:

Section 1 Introduction—Describes the primary purpose and organization of the FS and provides a description of the Iona Island Naval Ammunition FUDS, including Property history and current usage.

Section 2 Previous Investigations—Provides a summary of previous investigations and the RI conducted at the Property.

Section 3 Remedial Action Objectives and Preliminary Remediation Goals— Provides an overview of the FS evaluation process; defines the RAOs; identifies COCs and the chemical-, location-, and action-specific ARARs; develops Preliminary Remediation Goals (PRGs) and identifies areas and volumes of media for remediation.

Section 4 Identification and Screening of Technologies—Identifies the GRAs and potential remedial technologies that may be used to address soil within the Former Dump Area and sediment on the Hudson River shoreline in its vicinity; provides preliminary screening of technologies for effectiveness and a qualitative assessment of the implementability (both technical and administrative feasibility) and general cost.

Section 5 Development and Screening of Alternatives—Identifies remedial alternatives using applicable technologies that were retained from the preliminary screening; provides screening of the alternatives, effectiveness, implementability, and cost. The screening considers land use scenarios, exposure scenarios, and accommodation of ARARs and PRGs.

***Section 6 Detailed Analysis of Alternatives*—** Presents the detailed analysis of the remedial alternatives with respect to seven of the nine NCP evaluation criteria (overall protection of human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost).

***Section 7 References*—** Presents the references included in this FS.

1.4 FUDS PROPERTY OVERVIEW

This section presents background and Property usage information for the Iona Island Naval Ammunition Depot FUDS, including Property location, history, current Property layout, and current Property usage. Information presented in this FS is summarized from the 2024 Final RI Report (USACE 2024b).

1.4.1 Property Location

The Iona Island Naval Ammunition Depot FUDS property is an approximately 124.2-acre Property located on Iona Island and Round Island along the west side of the Hudson River, in the Town of Stony Point, Rockland County, New York (**Figure 1-1**). Iona Island is located in Bear Mountain State Park on the east side of U.S. 202/Route 9W, 6 miles south/downstream of West Point Military Academy, 1 mile south/downstream of the Bear Mountain Bridge, and 41.2 miles north/upstream from the mouth of the Hudson River. Iona Island is bordered on the east by the Hudson River; on the northwest by the mouth of an expanse of shallow mudflats, called Doodletown Bight; and on the west and southwest by Iona Marsh, an intertidal marsh that occupies 1 mile between Iona Island and the mainland. Intertidal marshes along the Hudson River including Iona Marsh, and the low-lying marsh area between Iona Island and Round Island, are inundated with water twice daily during high tide and during storm events. Active River Subdivision (CSX Transportation) railroad tracks run parallel to the western shoreline of the Hudson River. The Iona Marsh Shoreline located along the west side of Iona Island is divided by the railroad embankment.

The southeastern part of Iona Island, known as Round Island, was once cut off by marshes; it was attached to Iona Island with fill in the early 20th century (NYSDEC and U.S. Department of Commerce 1992). The hill on the western side of Iona Island, south of the railroad tracks, was also once treated as separate and referred to as Courtland Island. The shoreline areas of the island and adjoining marshes are located within the Hudson River.

Iona Island is connected to the mainland by a narrow two-lane road off U.S. 202/Route 9W near Doodletown. A non-climbable steel fence on top of a rubble wall and the River Subdivision (CSX Transportation) railroad track embankment separates Iona Island and the FUDS from Iona Marsh. The FUDS is accessed by crossing active River Subdivision (CSX Transportation) railroad tracks and entering through an unmanned gate during normal working hours.

1.4.2 Property History

The U.S. Navy (Navy) used the Property as an Ammunition Depot from 1900 to 1947, with the major effort consisting of assembling naval ammunition for World War II. Although no ammunition was manufactured at Iona Island, various types of explosives were assembled on-site. Activities included preparing, assembling, maintaining, inspecting, and testing ammunition; storing bulk explosives, ammunition, and ordnance material; and issuing ammunition to the fleet, shore establishments, armed merchantmen, transport, and district forces. Round Island, the southernmost portion of the depot, was purchased by the Navy in 1942 and utilized for ammunition storage (USACE 1997). The Navy partially filled in the area between Iona Island and Round Island to provide a connection between the two islands. A 0.85-acre dump area, first identified on a 1930-dated Navy layout plan (U.S. Army Geospatial Center [USAGC] 2018) is located between Round Island and Iona Island.

After World War II, use of the island as an ammunition depot became obsolete because of lack of expansion room to accommodate new types of ammunition. In 1947, the Department of the Navy decided to deactivate the Iona Island Naval Ammunition Depot and made the property available for restricted lease. The depot was deactivated in 1951. The FUDS was re-designated as an Annex to the U.S. Naval Ammunition Depot, Earle, New Jersey, and in 1957, the government declared the Annex excess. In 1955 and 1960, the General Services Administration (GSA) utilized the Iona Island Naval Ammunition Depot FUDS through a permit for stockpiling materials such as rubber and copper. In 1960 GSA received official jurisdiction of the property, and other agencies under GSA control utilized the property for record storage during the 1960s. These agencies included the following: Maritime Administration, Atomic Energy Commission, Civil Service Commission, Army Corps of Engineers, and the Navy’s Bureau of Ships. The Maritime Administration also conducted occasional trans-shipments of heavy freight at the main wharf. On 30 March 1965, Iona Island was deemed evacuated after the last load of stockpiled materials left the property. In 1965, GSA conveyed the FUDS property to the PIPC (USACE 1997).

In 1951 when the depot was deactivated, there were 146 buildings on Iona Island (USAGC 2018). Most buildings and structures, including building foundations, were demolished and removed by PIPC between November 1965 and December 1973 (USAGC 2018). The FUDS has remained undeveloped since its transfer from DoD ownership to PIPC in 1965.

1.4.3 Current Property Layout

The majority of Iona Island is currently open space. Original structures still standing include Building 201 (Empty Projectile Magazine); Building 212 (former Marine Barracks); Building 217 (Fire Station and Labor Office), Building 222 (Miscellaneous Storage Building), Building 508 (Bag Charge Magazine); and Building 603 (Pyrotechnic Magazine) (Bluestone 2018) (**Figure 1-1**). The old roads in the main part of the former depot are still accessible by vehicle. The island is partially fenced, and the main gate is unmanned, which allows for limited access to Iona Island from Bear Mountain State Park.

A former Navy dumping area (hereinafter referred to as the Former Dump Area) is confined to a low-lying, tidally influenced marsh area between Iona and Round Island. This area is bounded to the northeast by the Hudson River and to the southwest by a fill area (believed to be building demolition debris) emplaced by the PIPC following Navy transfer of the FUDS in 1965. The fill area between Round Island and Iona Island is vegetated, and the root mass allows the area to be traversable by foot.

1.4.4 Current Property Land Use

Iona Island is currently under the administration of the PIPC and maintained by staff of Bear Mountain State Park. In 1965, when GSA conveyed the property to the PIPC, it was under a "restrictive clause" (park purposes only) (USACE 1995). Property access is limited to authorized employees of Bear Mountain State Park who use a few of the remaining buildings for storage, to researchers who work in the marsh areas, and to guided tour groups six to eight times per year between May and October. Building 222 (Store House) is utilized by Bear Mountain State Park for shipping and receiving. Building 212 is in disrepair, but it has not been demolished due to concerns with asbestos. Public use of the island is limited to educational outings and history tours. The island has been historically used for camping, including by the Boy Scouts. Boating along the Hudson River is open to the public, and with no fencing along the shoreline of Iona Island, there is potential for recreational users of the Hudson River to access the island via the shoreline.

Land use surrounding Iona Island is recreational and military, with Bear Mountain State Park along the western shore of the Hudson River and Camp Smith Military Reservation along the eastern shore. The Property is also surrounded by the Iona Island/Doodletown Bird Conservation Area (NYSDEC 2017). For the portions of the adjacent Bear Mountain State Park that are open to the public, recreational opportunities include hiking, boating, and bird watching. There is no public canoeing or kayaking allowed in the marshes surrounding Iona Island. Access to the marsh is limited to guided canoe and kayak trips.

Iona Island is part of the much larger Hudson River National Estuarine Research Reserve and Significant Coastal Fish and Wildlife Habitat Area, managed under New York's Coastal Management Program. The Iona Island Marsh was designated a National Natural Landmark in 1974 by the National Park Service (NPS).

1.4.5 Future Property Land Use

PIPC historically developed plans for construction of a recreational park, and while some stormwater sewers were partially installed, these plans were not fully executed. The past developer plans for constructing an environmental center/nature center were also not fully approved or implemented.

Anticipated passive future use for the Property includes camping, kayaking, hiking, and bird watching. While there are no current construction plans, other than the possibility of converting existing buildings for use or constructing new storehouses, future construction of restrooms and a shower house for campers is possible (USACE 2024a). Regulators have expressed interest in maintaining the area between Iona and Round Island (location of the Former Dump Area) as a wetland with native wetland plant species (USACE 2024a). Therefore, consideration of restoring the wetland with native wetland species will be given high priority for this site and will factor into the alternative evaluation.

1.4.6 Utilities

Subsurface utilities information at the Iona Island Naval Ammunition Depot FUDS is not available. Two potential sewer discharge pipes were identified in historical installation layout maps from 1934 and 1947 (USAGC 2018). One 10-inch diameter discharge pipe reportedly extended offshore into the Hudson River in the area between Iona Island and Round Island (**Figure 1-2**). A second discharge pipe identified as an outfall sewer on trestle reportedly extended off the shoreline in the area southeast of Building 201.

In the 1990s, a water supply line that supplied Iona Island broke (near NYS Route 9W) on the causeway. Bear Mountain State Park did not repair the waterline break, and a bedrock well was installed (March 1997) behind the existing storehouse (Building 222). During well installation, bedrock fracking was used to get the well to yield water. Per Charlie Tonneson, Bear Mountain Park Engineering Department, this new well is not treated and is used for non-potable purposes only (bottled water is brought on Iona Island for drinking purposes).

1.5 FS PROJECT TEAM MEMBERS AND COMMUNITY INVOLVEMENT

The U.S. Army is DoD's lead agent for the FUDS Program for the cleanup of Properties under DERP. USACE executes the FUDS Program on behalf of the U.S. Army and DoD with lead agency authority under CERCLA.

- USACE Baltimore District and USACE New England District—Responsible for executing the project.

Additional stakeholders include PIPC, NYSDEC, and NYSDOH:

- PIPC—Owns the property, which is maintained by Bear Mountain State Park.
- NYSDEC and NYSDOH—Provide regulatory oversight of the environmental restoration work at the Property to ensure compliance with applicable New York State laws. NYSDEC has acted as the lead regulatory agency. Both NYSDEC and NYSDOH have been active participants throughout the RI.

Following the completion of the FS, a PP will be prepared and presented for public review. A public meeting will be held to present the PP and answer questions from the public. Following the public comment period on the PP, a Record of Decision (ROD) will be prepared to memorialize the selected alternative for the Iona Island Naval Ammunition Depot FUDS.

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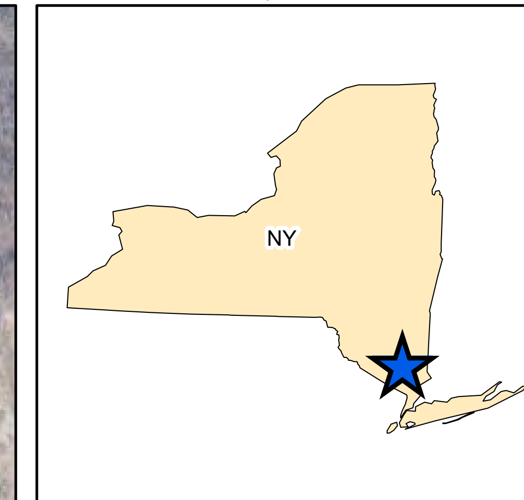
VICINITY MAP



Legend

- FUDS Boundary
- Buildings
- Surface Water Flow Direction

0 400 800
Feet
1 in = 400 feet
N

FIGURE 1-1
Former Iona Island Naval Ammunition Depot FUDS Location and Layout

HAZARDOUS TOXIC AND RADIOACTIVE WASTE FEASIBILITY STUDY

Source
Aerial: EA Engineering, Science, and Technology. April, 7 2020
Disturbed Ground/Fill Area and AOC Boundary: USAGC 2018
Upland and Marsh/Wetland: 2020 EA Shoreline Reconnaissance
Map Date: 4/16/2025

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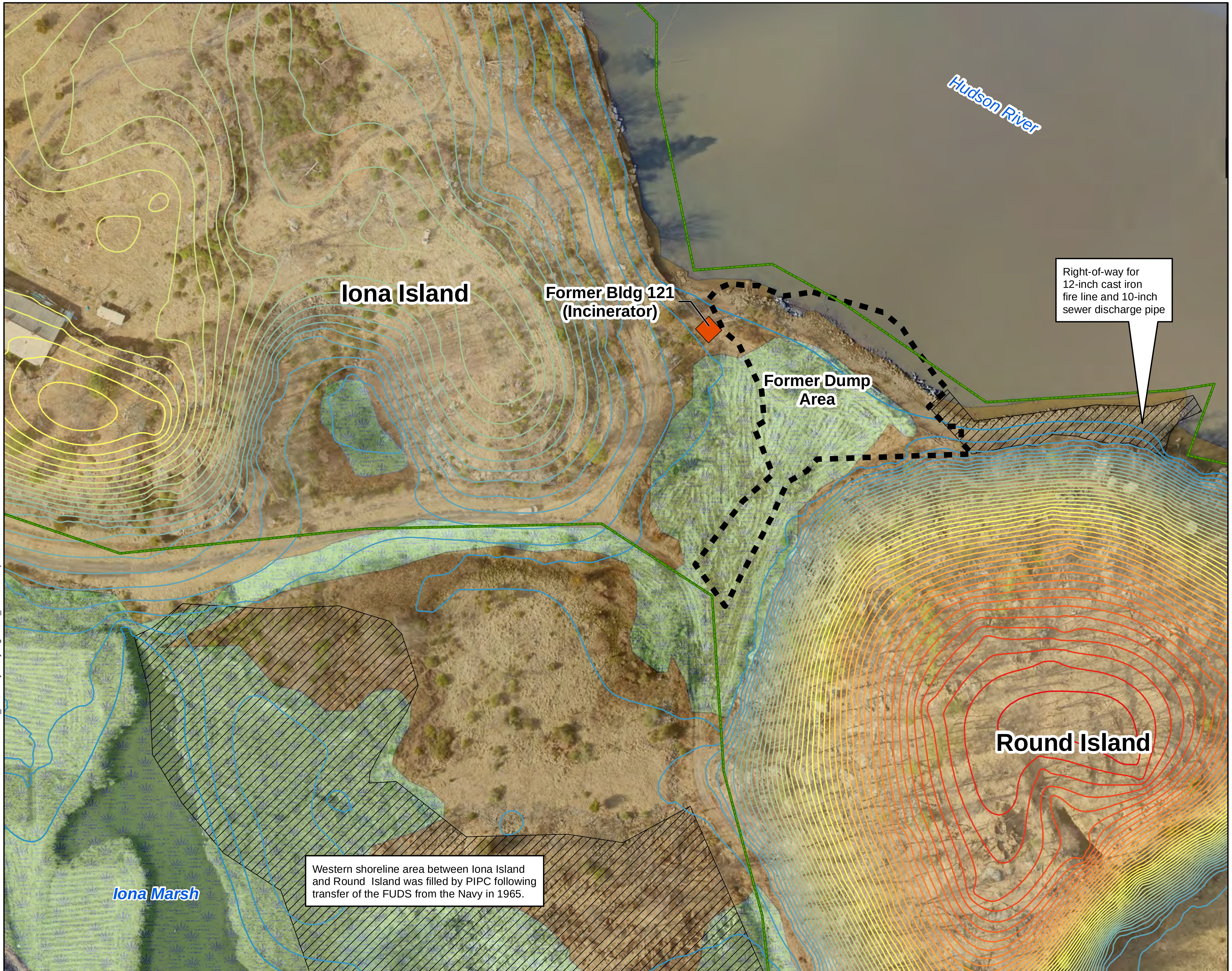

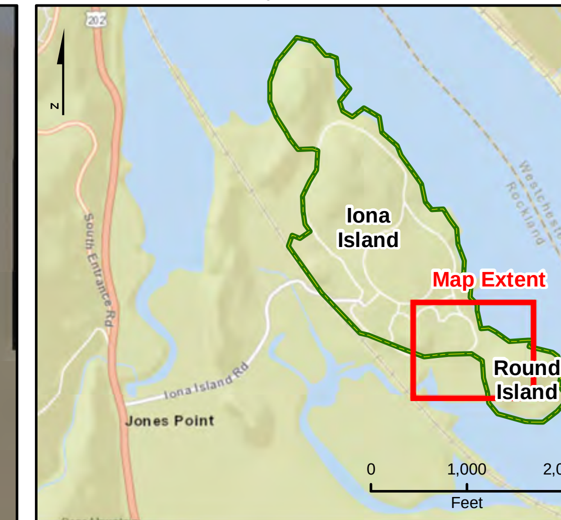

Legend

- FUDS Boundary
- Upland
- Marsh/Wetland
- Former Dump Area
- Former Bldg 121 Incinerator
- Disturbed Ground/Fill Area

2-Foot Topographic Contour Gradations

(Feet above mean sea level (amsl)

High : 84 ft amsl

Low : 0 ft amsl

0 100 200

Feet

1 in = 100 feet

N

FIGURE 1-2
Former Dump Area

HAZARDOUS TOXIC AND RADIOACTIVE WASTE FEASIBILITY STUDY

EA®

Source
Aerial: EA Engineering, Science, and Technology. April, 7 2020
Disturbed Ground/Fill Area and AOC Boundary: USAGC 2018
Upland and Marsh/Wetland: 2020 EA Shoreline Reconnaissance
Map Date: 7/18/2024

\\lovetonGIS\GISdata\Federal\Northeast\NewYork\IonaIsland\MXD\HTRW_FeasibilityStudy\Figure1-2_FormerDumpArea.mxd

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2. PREVIOUS INVESTIGATIONS

This section presents a summary of previous investigations and the RI conducted at the Iona Island Naval Ammunition Depot FUDS.

2.1 PREVIOUS INVESTIGATIONS

A thorough review of previous investigations performed at the Property was presented in the RI (USACE 2024). Relevant documents reviewed included:

- 1996 Data Collection Activities (Greeley-Polhemus Group, Inc. [Greeley-Polhemus] 1997)
- 2007 Site Inspection (Alion Science and Technology Corporation [Alion] 2008)

2.1.1 1996 Data Collection Activities (Greeley-Polhemus 1997)

USACE contractor (Greeley-Polhemus and Smith Technology Corporation) conducted surface soil sampling (**Figure 2-1**). Metals, semi-volatile organic compounds (primarily 2,4-dinitrotoluene [DNT], 2,6-DNT, and polycyclic aromatic hydrocarbons [PAHs]), and polychlorinated biphenyls (PCBs) were detected in soil samples. Maximum concentrations of metals (barium, cadmium, total chromium, lead, mercury, and silver) were detected in the samples collected in the low-lying area between Iona and Round Island near Former Building 121 (Incinerator) and within the footprint of the Former Dump Area. Analytical results tables are included in **Appendix A**.

The soil sampling report recommended evaluating site risks based on the Relative Risk Site Evaluation Program and conducting additional sampling to further delineate metals and semivolatile organic compound contamination (Greeley-Polhemus 1997).

2.1.2 2007 Military Munitions Response Program Site Inspection (Alion 2008)

USACE contractor (Alion and EA [subcontractor]) conducted a Military Munitions Response Program (MMRP) Site Inspection, which included on-site and background sampling of surface soil and sediment for munitions constituents (metals including antimony, copper, lead, nickel, and zinc, and explosives residues including 2,4,6- Trinitrotoluene (TNT); 4-amino (AM)-2,6- DNT, 2-AM-4,6-DNT, 2,4-DNT, 2,6-DNT, 2-nitrotoluene, 3-nitrotoluene, 4-nitrotoluene, and nitroglycerin) (**Figure 2-1**). Two explosives (2,4,6-TNT and 4-AM-2,6-DNT) were detected at one location, II-EA-SS-02-08, in the central portion of the Iona Island Naval Ammunition Depot FUDS, but at concentrations below applicable human health and ecological screening criteria in one of the 18 surface soil samples (II-EA-SS-02-08). The other 10 explosives were not detected above the limits of detection, which were confirmed to be below the project action limits. There were no explosives detected in the sediment samples (Alion 2008). Analytical results tables are included in **Appendix A**.

Screening-level human health and ecological risk assessments were performed by comparing the 2007 munitions constituents results to the 2004 EPA Region 9 PRGs based upon a cancer risk level of 1E-06 and non-cancer hazard quotient of 0.1 (residential and industrial for soil and sediment); ecological screening data were compared to MacDonald et al. (2000) for sediment and EPA (2007) ecological soil screening levels, as well as site-specific background concentrations. Lead concentrations exceeded both site-specific background concentrations and human health screening criteria, while antimony, copper, lead, nickel, and zinc concentrations exceeded site-specific background concentrations and ecological screening criteria. The Final Site Inspection Report recommended that a RI/FS be performed based on the potential for risks to human health and ecological receptors from metals in surface soil and sediment (Alion 2008).

2.2 REMEDIAL INVESTIGATION

The HTRW Project RI (USACE 2024b) was conducted to characterize the nature and extent of hazardous substances in environmental media attributable to past DoD activities, as well as to evaluate potential risk to human health and ecological receptors.

Based on previous documents, aerial photographs, and available information, 19 areas of concern (AOCs) were identified as eligible for further investigation in the HTRW Project RI. These FUDS-eligible AOCs encompass the locations/footprints of former buildings/structures where contaminants related to the former buildings/structures and/or historical processes conducted during the site's commission as an ammunition depot may be present. These AOCs included 16 former buildings, the locations/footprints of four former aboveground storage tanks (ASTs), a former dump area, two former coal storage areas, and the locations/footprints of three former transformer locations (**Figure 2-2**).

The ASTs themselves are not AOCs. The FUDS-eligible AOCs are the former AST locations/footprints. The ASTs were removed, but the sites were not formally closed and were not included in the Containerized HTRW project at the Property (C02NY074401), which was closed out in 2012. At the two former coal storage areas, the PAH detections owing to particles of coal are not addressed under CERCLA, as coal is considered a product rather than a hazardous waste. However, PAH detections released from coal particles and absorbed on to (e.g., subsurface) soils is actionable under CERCLA. The chemical analyses that were done during previous investigations did not distinguish PAH contamination absorbed on to soils from PAHs in coal particles. Similarly, the three former transformers themselves are not AOCs. The FUDS-eligible AOCs are the former transformer locations/footprints. Although the transformers may have contained PCBs, a FUDS response is not normally undertaken unless there is evidence of transformer leakage/spills prior to transfer from DoD jurisdiction. There is no record of transformer leakage/spills, and confirmation via sampling of soil for PCBs was not previously conducted at the locations/footprints of the former transformers.

A review of additional former buildings was conducted during preparation of the HTRW Project RI Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP) (USACE 2020) to identify locations where filling or possible spilling of explosives-containing materials could have occurred. Seven former explosives storage and filling operations buildings were identified for further evaluation in the HTRW Project to confirm the presence/absence of explosives constituents in soil and to evaluate potential exposure risk from remaining explosives residues to human and ecological receptors.

Previous investigations indicated that contaminants of potential concern (COPCs) were likely mobilized beyond the footprints of the AOCs during demolition of former buildings/structures and reworking of surface and subsurface soil. Previous discrete analytical sample data were evaluated during development of the UFP-QAPP (USACE 2020) to identify analytes in soil and sediment with concentrations above EPA screening criteria at the time of UFP-QAPP development and background concentrations. When the UFP-QAPP was developed, the screening criteria used were EPA Industrial and/or Residential Soil Regional Screening Levels (RSLs) (updated May 2020) for human receptors and EPA Ecological Soil Screening Levels (EcoSSLs) (February 2005 through April 2008) and/or EPA Region 4 Marine/Estuarine Sediment Screening Benchmarks (EPA 2018) for ecological receptors. Those areas where COPCs were previously detected in surface and/or subsurface soil at concentrations above screening criteria and background concentrations were included for further evaluation in the HTRW Project RI (**Figure 2-2**).

A two-phased approach was employed during the HTRW Project RI to facilitate data collection, evaluation, and discussion. Each phase included field investigation activities with collection of samples for on-site field screening and off-site laboratory analysis, followed by data validation, evaluation of data usability, data analysis, and evaluation of potential impacts to human and ecological receptors. Both a HHRA and an ERA (including a SLERA and RSLERA) were completed as part of the RI. The HHRA and ERA used data from Phases I and II to evaluate whether FUDS-eligible Property-related contaminants posed unacceptable risk to human health or terrestrial and aquatic ecological receptors. Phase I and Phase II field activities and results of the HHRA and ERA are summarized in the subsections below.

The HTRW Project RI Report (USACE 2024b) was completed in June 2024.

2.2.1 Phase I

Phase I of the HTRW Project RI was conducted to: (1) evaluate the presence/absence and/or nature and extent of hazardous substances in on-site soil within the FUDS boundary, (2) evaluate the source-pathway-receptor interactions, and (3) evaluate the subsequent risk to human and ecological receptors. A UFP-QAPP presenting the approach for Phase I was finalized in January 2020 (USACE 2020). Phase I field activities were completed in March and April 2020 and consisted of on-site and background incremental sampling methodology (ISM) soil sampling and a shoreline reconnaissance along Iona Island to evaluate the source-pathway-receptor interactions.

A total of 30 on-site Phase I Decision Units (DUs) encompassing approximately 25 acres of Iona Island were sampled to evaluate COPCs in soil (**Figure 2-2**). These DUs encompassed AOCs, former explosive storage and filling operations buildings, and locations where elevated concentrations of contaminants were detected during previous investigations. Of the 30 DUs, 27 were established in the upland area of Iona Island where upland soil is present (DU-1 through DU-7, DU-9 through DU-16, DU-20, DU-21 through DU-23, DU-25, and EXDU-1 through EXDU-7). The remaining three DUs (approximately 3 acres total) encompassed the Former Dump

Area within the low-lying marsh area between Iona and Round Island where hydric soil was present (DU-17, DU-18, and DU-19). In addition, background sampling was conducted at eight non-contiguous background DUs (BADU-1 through BADU-8) established in Bear Mountain State Park outside the influence of the Iona Island Naval Ammunition Depot FUDS to establish regional background concentrations of metals and PAHs in soil (**Figure 2-3**).

ISM samples at each on-site DU were collected in triplicate (initial ISM sample plus two replicates) for the purpose of calculating the 95 percent upper confidence limit of the mean (95UCL) at each DU using statistical tests. Single incremental samples were collected from each background DU, to provide a background dataset of eight ISM samples.

Surface soil ISM samples were collected from depths of 0 to 6 inches below ground surface (bgs) at each of the 30 on-site DUs and each background DU. Shallow subsurface soil samples (6 inches to a maximum of 36 inches bgs) were collected from five on-site DUs where soil depth was greater than 12 inches bgs (DU-17 through DU-21). At the remaining on-site DUs, shallow subsurface soil was limited to a maximum of 12 inches bgs; therefore, no subsurface soil samples were collected from these DUs. Subsurface soil was not collected at background DUs due to the presence of exposed/shallow bedrock and shallow depth to refusal (less than 12 inches bgs) throughout the DUs.

A total of 90 ISM surface soil samples (initial and replicates), 15 ISM subsurface soil samples (initial and replicates), and 8 ISM background surface soil samples were collected for laboratory analysis of target analyte list (TAL) metals, PAHs, PCBs, explosives residues; and/or benzene, toluene, ethylbenzene, and xylenes (BTEX).

Metals and PAHs were detected in upland surface soil (0 to 6 inches bgs) at concentrations above background (**Figure 2-4**). In addition, metals and PAHs were detected in hydric surface soil (0 to 6 inches bgs) and subsurface soil (6 to 36 inches bgs) throughout the low-lying marsh area between Iona and Round Island (Former Dump Area) (**Figure 2-5**). Analytical results summary tables are provided in **Appendix A**. Preliminary evaluations of analytical results indicated potential risk to human receptors as well as terrestrial ecological receptors (plants and soil invertebrates in upland soil and plants, soil invertebrates, and insectivorous birds and mammals at the Former Dump Area). Although pH data were evaluated in on-site upland and hydric soil during Phase I, additional physical parameter data (grain size, total organic carbon [TOC], cation exchange capacity [CEC], and redox potential) were needed to evaluate bioavailability of metals and PAHs to terrestrial receptors as part of the RSLERA.

A shoreline reconnaissance survey was conducted to identify potential pathways that led to the shoreline environment, evaluate whether there were barriers to overland transport from Iona Island to the shoreline, and complete a receptor and resource inventory evaluation. Contaminant migration pathways to the Hudson River and Iona Marsh shorelines were not identified within the upland area during Phase I. It was concluded that TAL metals and PAHs in upland soil were unlikely to be transported to the shoreline and be present in shoreline media at concentrations that would pose risk to human or aquatic ecological receptors. However, preferential surface water migration pathways were identified during the Phase I shoreline reconnaissance leading from the

Former Dump Area to the Hudson River and Iona Marsh shorelines (**Figure 2-6**). These pathways included tidal flux to the Hudson River and two defined surface water channels leading to Iona Marsh (riprap filled drainage swale and tidal wetland swale). Depending upon tidal flux, water can flow into the Dump Area from the Hudson River on the east, or from Iona Marsh on the west.

2.2.2 Phase II

Phase II was conducted to further evaluate contaminant migration pathways to the shoreline environment, evaluate impacts to shoreline media, evaluate potential risk to aquatic and human receptors, and support development of the HHRA and ERA. The UFP-QAPP addendum presenting the approach for Phase II was finalized in April 2022 (USACE 2022). Phase II field activities were completed in April 2022 and included:

- Analysis of physical parameters in on-site soil and sediment to evaluate bioavailability of contaminants to ecological receptors

- On-site surface water and sediment sampling for TAL metals to evaluate the potential for inorganic constituents to impact the shoreline environment adjacent to the Former Dump Area

Eight Phase I soil DUs were targeted during Phase II for physical parameter sampling, with DUs selected to provide reasonable spatial coverage/representation within each terrestrial environment across Iona Island (**Figure 2-7**). Five separate Phase I upland soil DUs (DU-4, DU-7, DU-9, DU-11, and DU-13) were selected to be representative of the upland area. Each of the three Phase I DUs within the low-lying marsh area between Iona and Round Island encompassing the Former Dump Area (DU-17, DU-18, and DU-19) were selected to be representative of hydric soil conditions. A total of 24 surface ISM soil samples (initial and replicates) were collected for analysis of physical parameters including ORP (field measurement), TOC, CEC, and grain size.

Four on-site areas were targeted during Phase II for surface water metals sampling, including the Former Dump Area and the discharge locations for the surface water migration pathway (Hudson River shoreline adjacent to the Former Dump Area and Iona Marsh at the outlets of the riprap filled drainage swale and tidal wetland swale) (**Figure 2-8**). A total of 60 on-site discrete surface water samples were collected for analysis of dissolved TAL metals to evaluate the surface water migration pathways leading from AOC #16 – Area D (Former Dump Area) to the Hudson River and Iona Marsh shorelines, with 20 samples collected from each of the following areas:

- Source area at AOC #16 – Area D (Former Dump Area) (DUMP-SW-01 through DUMP-SW-20)

- Hudson River shoreline adjacent to AOC #16 – Area D (Former Dump Area) (IHRS-SW-01 through IHRS-SW-20)

- Iona Marsh at the outlets of the Riprap Drainage Swale (RRDS-SW-01 through RRDS-SW-10) and Tidal Wetland Swale (TWS-SW-01 through TWS-SW-10)

Sediment sampling was completed using ISM at three DUs located at the ends of the preferential surface water flow pathways leading from AOC #16 – Area D in the Former Dump Area to the Hudson River and Iona Marsh shorelines (**Figure 2-9**):

- Iona Hudson River Shoreline (IHRS-DU-01) along the Hudson River shoreline adjacent to the Former Dump Area (AOC #16 – Area D) to evaluate whether metals had been transported to and accumulated in the Hudson River shoreline sediments adjacent to this area.

- Riprap Filled Drainage Swale (RRDS-DU-01) along the Iona Marsh shoreline at outlet of the riprap filled drainage swale to evaluate whether metals from the Former Dump Area (AOC #16 – Area D) had been transported via the swale to the marsh shoreline and accumulated in marsh sediment adjacent to this area.

- Tidal Wetland Swale (TWS-DU-01) along the Iona Marsh shoreline at outlet of the tidal wetland swale to evaluate whether metals from the Former Dump Area (AOC #16 – Area D) had been transported via the swale to the marsh shoreline and accumulated in marsh sediment adjacent to this area.

ISM samples at each on-site sediment DU were collected in triplicate (initial ISM sample plus two replicate samples) for the purpose of calculating 95UCLs of the mean for each DU using statistical tests. Single incremental samples were collected from each of the sampling units, to provide a background dataset of eight ISM samples for each sediment DU (eight from the Con Hook Hudson River shoreline and eight from the Con Hook Marsh shoreline). A total of nine on-site ISM sediment samples (initial and replicates) were collected for laboratory analysis of TAL metals and physical parameters including pH, oxidation-reduction potential, TOC, and grain size. In addition, three discrete sediment acid volatile sulfide/simultaneously extracted metals samplings were conducted at each on-site sediment DU to assess the potential for toxicity to sediment-dwelling organisms and to support development of the ERA.

Site-specific background surface water and sediment sampling was conducted during Phase II to determine whether metals in shoreline media at Iona Island could be attributed only to former DoD activities. Background sampling was conducted at Con Hook Island, located approximately 3 miles upstream of Iona Island on the western side of the Hudson River; Iona Island is also on the west side of the Hudson River. Con Hook Island was selected to represent background surface water and sediment concentrations as it has similar depositional environments to Iona Island, with approximately 7 acres of upland habitat and another 12 acres of a *Phragmites*-dominated tidal marsh (Con Hook Marsh) (**Figure 2-10**). Surface water and sediment samples were collected from both the Hudson River shoreline and the marsh shoreline, with a total of 40 discrete surface water samples and 16 background ISM sediment samples collected for laboratory analysis.

Phase II metals results indicated elevated concentrations of CERCLA hazardous metals in both surface water and sediment at the endpoints of contaminant migration pathways leading from the Former Dump Area to the Hudson River and Iona Marsh shorelines. Analytical results summary tables are provided in **Appendix A**. Surface water impacts were limited to select metals (arsenic, total chromium, copper, sodium, and/or zinc in each area investigated). Statistical analyses of sediment analytical results indicated that sediment along the Hudson River shoreline adjacent to the Former Dump Area was impacted compared to site-specific background, with elevated concentrations of CERCLA hazardous metals, antimony, arsenic, cadmium, total chromium, copper, lead, nickel, silver, and zinc. Conversely, the concentrations for each analyte on the Iona Marsh side at the outlets of the riprap filled drainage swales and tidal wetland swale were statistically significantly lower (by at least an order of magnitude) than concentrations along the Hudson River shoreline.

2.2.3 Human Health Risk Assessment

The HHRA identified COPCs in each soil and sediment DU based on the 95UCL on the mean concentrations that exceeded EPA residential soil RSLs (EPA 2022). Chemicals that exceeded EPA RSLs were also compared to regional background concentrations through the use of permutation tests. Chemicals that were identified above background concentrations were evaluated further in the HHRA. In soil, COPCs included mainly metals and PAHs. The PCB Aroclor 1260 was also identified as a COPC in soil within DU-18, which is located within AOC #16 – Area D (Former Dump Area). In sediment, select metals were identified as COPCs in each of the three sediment DUs. No COPCs were identified in surface water. Therefore, surface water was not evaluated further in the HHRA and no unacceptable risk concerns for human receptors exposed to Property surface water were identified.

Potential receptors evaluated in the HHRA included park personnel, researcher, construction worker, recreational user (adult, adolescent, and child), adolescent trespasser, and camper/Boy Scout. Each receptor was evaluated for exposure to each individual DU. The evaluation of analytical results (excluding lead) was performed on a DU-basis to inform potential decisions that related to each DU. Carcinogenic risks for all receptor exposures to the individual DUs were either below or within EPA's acceptable risk range of $1x10^{-6}$ to $1x10^{-4}$. The non-cancer hazard index thresholds for all receptor exposures to individual DUs were below the acceptable threshold of 1.0, except the construction worker exposure to DU-13, DU-18 and the Former Dump Exposure Area. However, a breakdown by target organ did not reveal any target organs above the acceptable threshold of 1.0 for the construction worker exposure to DU-13, DU-18, and the Former Dump Exposure Area. Therefore, the HHRA did not reveal potential concerns for carcinogenic risks or non-cancer hazards for any of the receptor exposures to each DU.

Additionally, the HHRA noted that all potential Property receptors may not remain within one DU because none of the DUs present an attractive area for any of the receptors to spend the majority of their time while on-site. It is likely that all receptors may visit various areas of Iona Island during their visit. Therefore, the HHRA evaluated all potential receptors for exposure to two exposure areas: Iona Island Exposure Area and the Former Dump Area Exposure Area. For both the Iona Island and Former Dump Area Exposure Areas, the HHRA indicated all carcinogenic risks were either below or within EPA's acceptable risk range of $1x10^{-6}$ to $1x10^{-4}$. The non-cancer hazard index thresholds were below the acceptable threshold of 1.0 for all receptors evaluated, except the construction worker exposure to the Former Dump Area Exposure Area. A breakdown by target organ did not reveal any target organs above the acceptable threshold of 1.0 for the construction worker exposure to the Former Dump Area Exposure Area. Therefore, the HHRA did not reveal potential concerns for carcinogenic risks or non-cancer hazards for any receptor's exposure to each exposure area.

Sample results (excluding lead) from the RRDS and TWS DUs on the tidal marsh side of Iona Island do not reveal adverse impacts from AOC #16 or unacceptable risk concerns for human receptors.

Lead was identified as a COPC in soil and sediment based on a comparison to EPA residential soil regional screening level in effect at the time the RI was written (400 milligrams per kilogram [mg/kg]). Lead was evaluated separately from the carcinogenic risks and non-cancer hazards through the use of EPA's adult lead model (ALM). To achieve a specific level of protectiveness, EPA has established that a typical (or hypothetical) child would have an estimated risk of no more than 5 percent exceeding the reference blood-lead level of 5 micrograms per deciliter (µg/dL) of lead. Results of the ALM for soil and sediment analytical results revealed greater than 5 percent of the population exceeded the reference blood-lead level of 5 µg/dL for the following receptors:

- Construction workers exposed to surface soil at DU-7 in the upland area; surface and subsurface soil at DU-17 and DU-18 covering the eastern portion of AOC #16 – Area D (Former Dump Area); and sediment from IHRS-DU-01 (Iona Island Hudson River shoreline adjacent to AOC #16 – Area D [Former Dump Area])

- Park personnel exposed to surface and subsurface soil at DU-17 and DU-18 and sediment within IHRS-DU-01

- Recreational users exposed to sediment within IHRS-DU-01

The HHRA determined that potential risk concerns associated with lead for the park personnel and construction workers are likely overestimated. It was noted that the Former Dump Area Exposure Area, which includes DU-17 and DU-18, is a marshy area that is covered with vegetation and subject to tidal influence that makes access difficult. The Former Dump Area was also identified as a future nature preserve/wetland area. No construction or other activities are expected in this area and actual contact with this area is minimal and unlikely to result in human health concerns. Additionally, construction worker exposure represents exposures that are usually controlled using standard health and safety protocols and personal protective equipment. Potential lead risk concerns identified for the construction workers within DU-7, DU-17, DU-18, and the Former Dump Exposure Area do not warrant further evaluation or risk management decisions within this FS.

Exposure of park personnel to one specific DU for an entire year is not an expected scenario. The park personnel are more likely to be exposed to environmental media over the entire island from activities such as grass mowing, property inspections, and general maintenance. For this reason, exposure for this receptor is better represented by a mean concentration of the DUs across the Property, which includes all DUs sampled (i.e., DU-1 through DU-7, DU-9 through DU-19, IHRS, RRDS, and TWS). It is noted that this mean concentration does not include the areas of the Property not sampled and likely overestimates the true mean lead concentration. The mean soil lead concentration across all DUs is 667 mg/kg, which reveals less than 5 percent of the population exceeds the reference blood-lead level of 5 µg/dL. The results of the ALM modeling for the mean lead concentration across all the DUs revealed no potential concerns for the park personnel exposure to lead based upon expected exposure. Therefore, the park personnel exposure to Iona Island does not warrant further evaluation or risk management decisions within this FS.

The recreational user (adult, youth, and child) exposure to lead in sediment from Iona Island Hudson River Shoreline DU did reveal significant exceedances of the acceptable blood-lead threshold. Recreational users were assumed to contact sediment 1 day per week during the warmer months, approximately 31 weeks, which resulted in an exposure frequency of 31 days per year. Unlike the expected worker exposure, the recreational user is expected to spend a significant amount of time in this area. The area is a small sand and gravel beach that is exposed at low tide where recreational users may access the island by boat or kayak. Additionally, the area can be used for fishing. While sediments in this area are generally sandy with larger grain size that may reduce particulate adherence to skin, there is potential for contact. Sample results from the Iona Island Hudson River Shoreline DU revealed potential transport of contaminants from AOC #16 (Former Dump Area) along the surface via overland runoff and erosion to shoreline sediments. As a result, there is unacceptable risk to the recreational user (adult, youth and child) exposed to the Iona Island Hudson River Shoreline DU and the adjacent shoreline sediments. Additional evaluation and/or risk management decisions are warranted for the recreator in this FS.

2.2.4 Ecological Risk Assessment

The ERA evaluated both terrestrial and aquatic receptors. After the completion of the SLERA, receptors potentially at risk were further evaluated using a site-specific RSLERA.

2.2.4.1 Terrestrial Receptors

The terrestrial exposure areas were: (1) Iona Island Exposure Area; and (2) Former Dump Exposure Area, comprised of hydric soils. Representative terrestrial receptor categories included plants, soil invertebrates, herbivorous mammals (representative species meadow vole), insectivorous birds (representative species American robin), insectivorous mammals (representative species short-tailed shrew), carnivorous birds (representative species red tailed hawk), carnivorous mammals (representative species red fox), and herptiles.

None of these common categories of terrestrial receptors were found to be at risk in the Iona Island exposure area, which does not include the Former Dump Area.

Section 8.4.7.5 of the RI concluded that two federally listed species of bats (i.e., Indiana bat and northern long-eared bat) could be at risk in the Former Dump Exposure Area, based upon use of the shrew as a surrogate. The RSLERA acknowledged that the use of the shrew (ground dwelling mammalian insectivore) as a surrogate for the bat introduced conservative high bias to the risk estimate.

Further site-specific refinements included consideration of diet, home range, and preferred habitat. The shrew consumes ground dwelling insects in close and continuous contact with contaminants in soil. It is expected to spend all of its time on site, having a home range of approximately 0.07 to 0.17 acres (EPA 1993) and its preferred habitat is forested areas rather than marshy areas inundated twice daily with water, as is the case for the Former Dump Area. In the RI, modeling these three factors from the shrew for the bat conservatively biased the risk high. Both species of bats feed almost exclusively on flying insects (e.g., moths) with some gleaning (USFWS 2025a and 2025b), and have feeding home ranges from a few hundred acres to over 1,000 acres, depending upon the species and time of year (Burgess 2012). Therefore, both bat species are expected to spend only a fraction of their time feeding over the Former Dump Area. Further attenuation of the risk findings to account for site usage by the bat supports no further evaluation for the two federally endangered species of bats.

Section 8.4.7.5 of the RI concluded that two New York state–listed species of insectivorous birds (i.e., cerulean warbler and golden-winged warbler) could be at risk from COCs present in the Former Dump Exposure Area based upon using the robin as a surrogate.

The cerulean warbler has been sighted on both Iona Island and at Bear Mountain Park immediately adjacent to Iona Island (eBird 2025). Sightings of the cerulean warbler strongly supports the golden warbler's presence as warblers favor forested landscapes comprised of young forests and shrubland patches used for nesting that are interspersed among a diversity of other forest age-classes used to raise fledglings (U.S. Department of Agriculture 2025). Both areas on Iona and Round Islands contain riparian areas that transition from aquatic areas to upland areas, adding further to the suitability of the habitat. These small birds (approximately 4.5 inches long and weighing 0.28 to 0.35 ounces) can have core areas of approximately 2.5 acres (Wunderle et al. 2024), making their use of the Dump Area probable, which is further supported by sightings. For these reasons, possible risk to warblers cannot be categorically excluded, where because of their status, value is placed upon a single bird. Additional evaluation and/or risk management decisions are warranted for these receptors in this FS.

2.2.4.2 Aquatic Receptors

The aquatic exposure areas were: (1) riprap drainage swale; (2) tidal wetland swale; and (3) Iona Island Hudson Shoreline. Representative aquatic receptor categories included plants, benthic invertebrates, zooplankton, demersal (bottom-feeding) fish, pelagic (water column) fish, herbivorous birds (representative species mallard duck), herbivorous mammals (representative species muskrat), insectivorous birds (representative species lesser scaup), piscivorous mammals (representative species river otter), piscivorous birds (representative species great blue heron), and herptiles.

No risks to common aquatic receptors were found in the riprap drainage swale or the tidal wetland swale exposure areas. For the Iona Island Hudson Shoreline sediment exposure area adjacent to the Former Dump Area, the SLERA showed that plants, benthic invertebrates, demersal fish, herptiles, and insectivorous birds were at risk from metals (antimony, cadmium, copper, lead, nickel and zinc), driven primarily by copper and lead. This risk from sediment extends to two species of federally listed endangered demersal fish (juvenile Atlantic sturgeon and juvenile short-nosed sturgeon).

The purpose of the RSLERA was to incorporate easily obtainable site-specific information to refine the ecological risk screening, so that fewer generic, conservative conclusions of ecological risk could be made. The risk conclusions of the SLERA/RSLERA after these sub-tiers of evaluation showed that the contamination associated with unacceptable risks is confined to a small area of the Property associated with the Former Dump Area, with a sharply defined lateral extent of contamination due to island topography and the Hudson River. In addition, a sharply defined vertical extent of contamination was also identified, attributable to bedrock at approximately 3 feet bgs based on test pitting and shoreline bathymetric data.

However, even with refinements, the RLSERA found unacceptable risk driven by lead due to the potential presence of federally listed endangered species of juvenile sturgeon in the Iona Island Hudson Shoreline. Sturgeon spawn in areas with clean, large rubble, such as along windswept rocky shores of islands in the river; Iona Island is such a location. The habitat where sturgeon prefer to spawn exists immediately in front of the Former Dump Area. While ongoing releases were unlikely to impact large adults, potential for adverse effects to critical life stages (i.e., eggs and newly emerged fry) cannot be categorically excluded because effects to a single individual is considered a significant adverse effect for species afforded special status. Sturgeon are federally listed species and included in an active and well monitored conservation program on the Hudson River. Although egg masses and fry were not observed directly, this does not preclude their using the ideal rocky, scoured substrate in front of the Former Dump Area as a spawning area now or in the future.

Additional evaluation and/or risk management decisions are warranted for these receptors in this FS.

2.2.5 Remedial Investigation Conclusions

The RI determined that the Former Dump Area is a potential source area from which releases to the Hudson River Shoreline have occurred and continue to occur.

Risk summaries for human and ecological receptors for the Former Dump Area and adjacent shoreline sediments in the Hudson River are presented in **Table 2-1** and **Table 2-2**. respectively.

Based on the results of the HHRA in the RI, there is unacceptable risk to the recreational user (adult, youth and child) from the Former Dump Area and the Iona Island Hudson River shoreline sediment in its immediate vicinity (**Figure 1-2**).

The Former Dump Area also represents an unacceptable risk to two New York–listed species of warblers (cerulean and golden winged) and two federally listed endangered demersal fish species (juvenile Atlantic sturgeon and juvenile short-nosed sturgeon). Both sturgeon species are federally listed, and while the New York species of special concern do not justify listing as either endangered or threatened, they warrant attention and consideration. For these four species, value is placed on an individual organism.

The RI recommended that the Former Iona Naval Ammunition Depot FUDS should proceed to an FS to evaluate the appropriate remedy to address risk to these receptors.

2.2.6 Justification for Proceeding to a Feasibility Study Without Conducting a Baseline Ecological Risk Assessment

The HHRA and ERA conducted as part of the RI concluded that human risk was limited to the recreational receptor (adult, youth and child), and that ecological risks were driven by federal/state-listed ecological receptors (two New York–listed species of warblers [cerulean and golden winged] and two federally listed endangered demersal fish species [juvenile Atlantic sturgeon and juvenile short-nosed sturgeon]) in the Former Dump Area and the Iona Island Hudson River shoreline.

Typically, the next step in the ERA process is a Baseline Ecological Risk Assessment (BERA). The BERA would refine the risk estimates of the SLERA through the collection of site-specific data to refine exposure. Cleanup programs generally use BERAs to identify and characterize the current and potential threats to the environment from a hazardous substance release. This information is then used to evaluate the ecological impacts of alternative remediation strategies and to establish clean-up levels in the selected remedy that will protect those natural resources at risk.

The decision can be made to proceed with cleanup after any tier of the ERA process, and under some circumstances, it is appropriate and preferable to clean up the site to the screening values rather than to spend time and resources determining a less conservative cleanup number (EPA 2001). Such circumstances would apply when a site is of relatively small size, where the contamination has a sharply defined boundary, or when a specific risk finding will not change even after the completion of a BERA.

The Former Dump Area and associated shoreline of the Iona Island Former Ammunition Depot is such a site. There are several characteristics that make the decision to select a remedial alternative and proceed to the FS without completing a BERA reasonable and defensible:

1. The boundaries of the area are clearly defined by topographic high points on three sides and the Hudson River on the fourth.
2. The Former Dump Area and associated shoreline areas are small in size (1.1 acres and 0.56 acres, respectively).
3. Presence of phragmites limits its ecological habitat value.
4. Tidal inundation twice daily limits the foraging windows for common terrestrial receptors, further attenuating exposure.
5. Risk is driven primarily by risk to two endangered sturgeon species (juvenile life stage), and two New York avian species of concern (warblers); circumstances where risk is evaluated at the individual rather than the population level.

6. Site soil/sediment lead concentrations and associated exposure doses were much higher than concentrations and doses at which effects to receptors are likely.
7. Conservatism in the estimation of risk in the SLERA was mitigated with the application of refinements in the RSLERA.
8. Risk conclusions are not likely to change after risk refinements are applied in a BERA to reduce risk below target risk thresholds.
9. Depth to bedrock is estimated to be 3 feet based on test pitting and shoreline bathymetric data, making the estimated volume of associated contaminated soil to be 5,344 cubic yards.
10. Accurate estimates of soil and sediment volume to be removed reduces uncertainty in the alternatives analyses.

These factors support the decision not to conduct a BERA. Execution and documentation entailed in a BERA will not reduce the risk sufficiently to allow for a finding of no further action, will delay the FS, will delay the selection of a remedial alternative, and ultimately will delay cleanup action and site closure. This approach is reasonable, technically defensible and consistent with the Science Policy Council's Risk Characterization Handbook (EPA 2000).

Table 2-1 Summary of Human Health Risks by AOC and Media Remaining at the Conclusion of the Remedial Investigation

Receptor	Media	COC	95 percentile Fetal Blood Level (µg/dL)[a]
Iona Island Hudson River Shoreline			
Adult Recreational User	Sediment	Lead	11
Adolescent Recreational User	Sediment	Lead	10.6

Notes:
[a]95 percentile Fetal Blood Level > 5 µg/dL exceeds target risk screening threshold, indicating potential unacceptable risk
µg/dL = microgram(s) per deciliter
AOC = area of concern
COC = contaminant of concern

Table 2-2 Summary of Ecological Risks by AOC and Media Remaining at the Completion of the Remedial Investigation

Media	Receptor	COC	HQ[a]	Refined HQ[b]
Former Dump Area				
Soil	Federal/State-Listed Endangered Insectivorous Bats (Indiana bat and northern long-eared bat)	Copper	7	3
		Lead	4	2
	State-Listed Insectivorous Birds (cerulean warbler and golden-winged warbler)	Copper	7	3
		Lead	15	7
Iona Island Hudson River Shoreline				
Sediment	Federally Endangered Fish (juvenile Atlantic sturgeon and juvenile short-nosed sturgeon)	Antimony	5	NC
		Cadmium	2	NC
		Copper	68	NC
		Lead	147	NC
		Nickel	3	NC
		Zinc	9	NC

Notes:
(a) HQ > 1 indicates exceedance of low effect levels, indicating unacceptable risk
(b) Refined HQ incorporates site-specific bioavailability estimate based on soil parameters (41 percent)
AOC = area of concern
COC = contaminant of concern
HQ = hazard quotient
NC = Not Completed

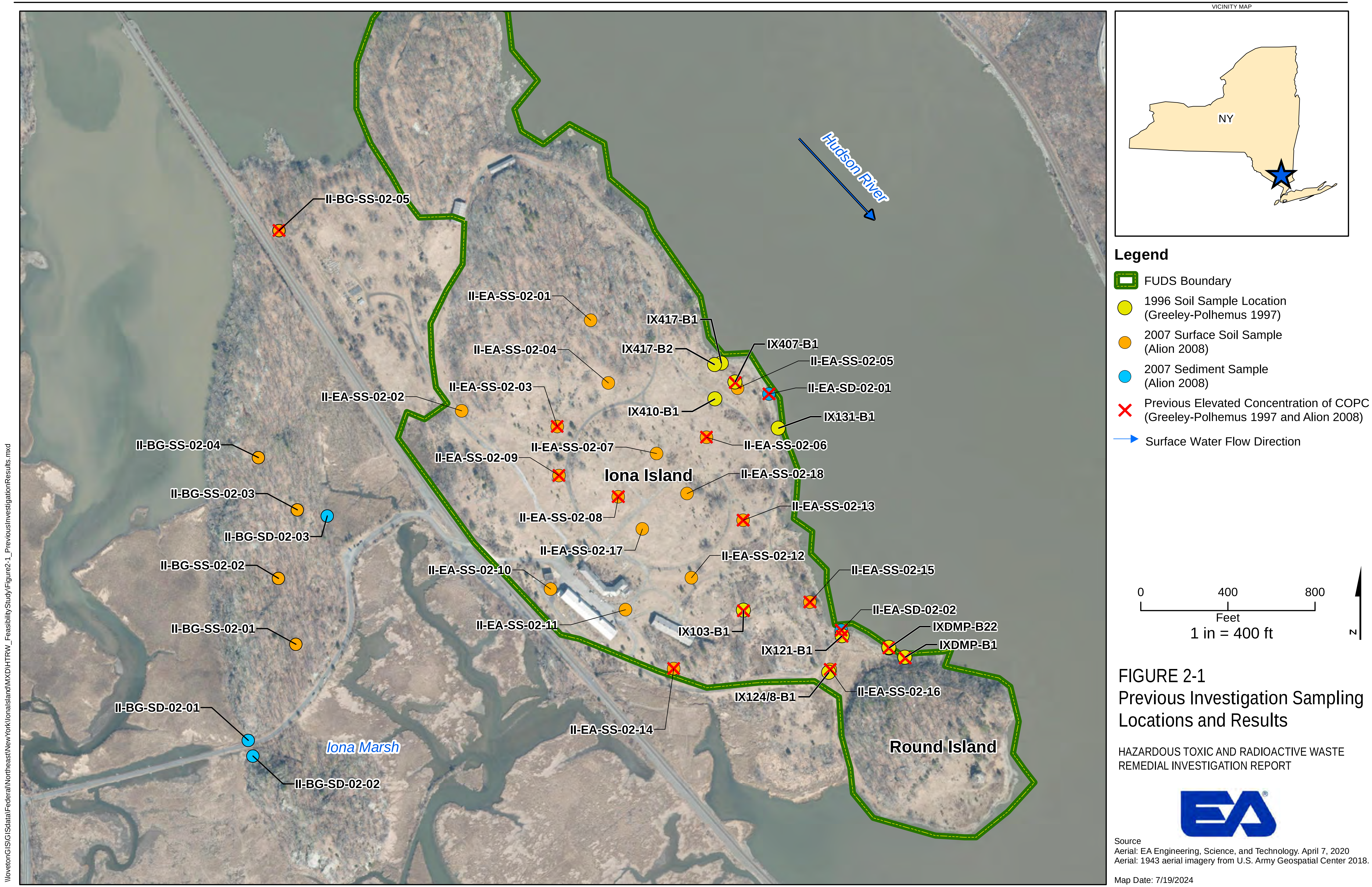

FIGURE 2-1
Previous Investigation Sampling Locations and Results

HAZARDOUS TOXIC AND RADIOACTIVE WASTE
REMEDIAL INVESTIGATION REPORT

Source
Aerial: EA Engineering, Science, and Technology. April 7, 2020
Aerial: 1943 aerial imagery from U.S. Army Geospatial Center 2018.

Map Date: 7/19/2024

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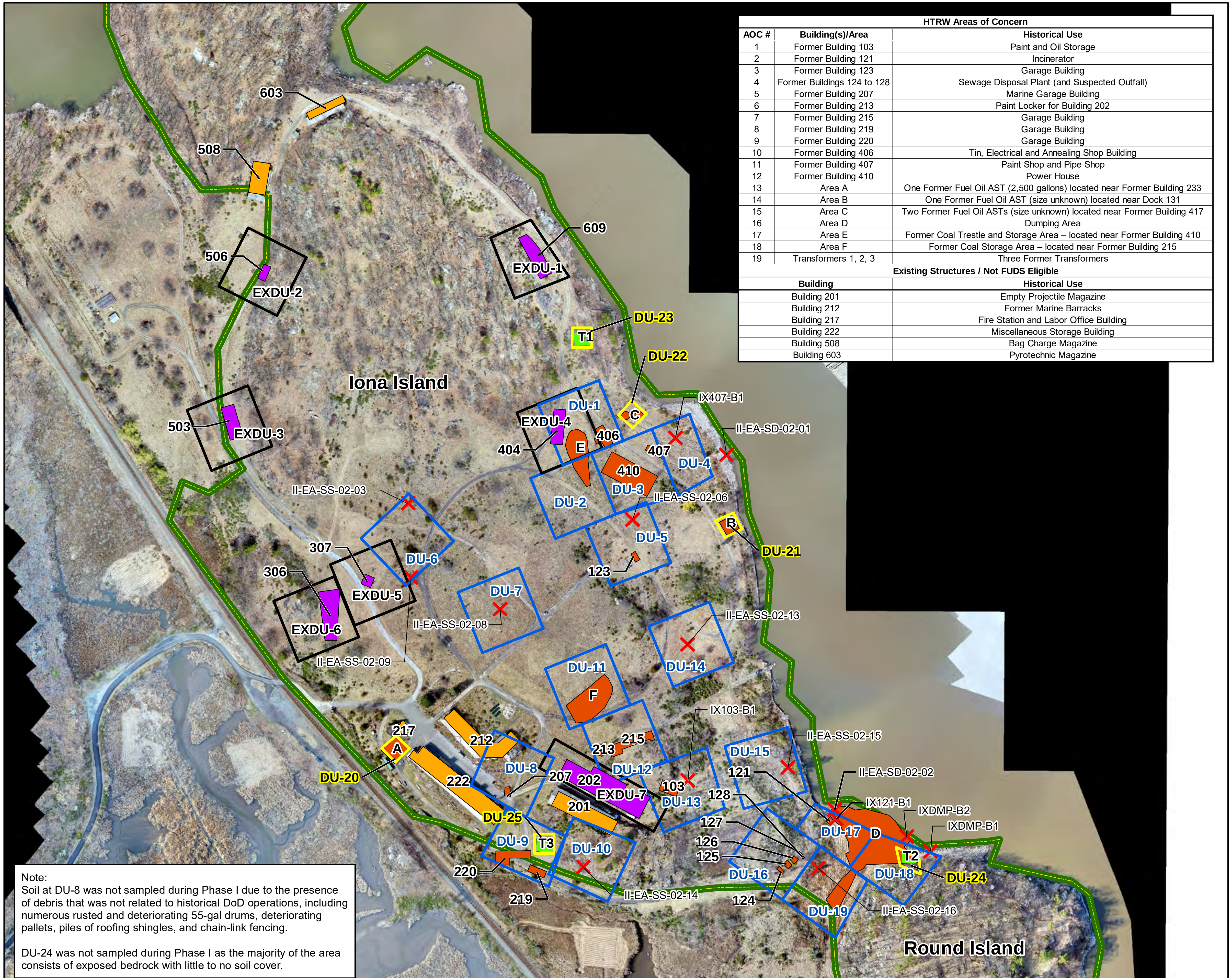


AOC #	Building(s)/Area	Historical Use
	HTRW Areas of Concern	
1	Former Building 103	Paint and Oil Storage
2	Former Building 121	Incinerator
3	Former Building 123	Garage Building
4	Former Buildings 124 to 128	Sewage Disposal Plant (and Suspected Outfall)
5	Former Building 207	Marine Garage Building
6	Former Building 213	Paint Locker for Building 202
7	Former Building 215	Garage Building
8	Former Building 219	Garage Building
9	Former Building 220	Garage Building
10	Former Building 406	Tin, Electrical and Annealing Shop Building
11	Former Building 407	Paint Shop and Pipe Shop
12	Former Building 410	Power House
13	Area A	One Former Fuel Oil AST (2,500 gallons) located near Former Building 233
14	Area B	One Former Fuel Oil AST (size unknown) located near Dock 131
15	Area C	Two Former Fuel Oil ASTs (size unknown) located near Former Building 417
16	Area D	Dumping Area
17	Area E	Former Coal Trestle and Storage Area – located near Former Building 410
18	Area F	Former Coal Storage Area – located near Former Building 215
19	Transformers 1, 2, 3	Three Former Transformers

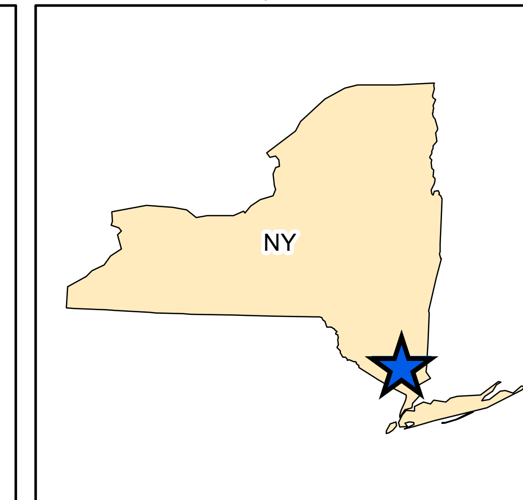
Existing Structures / Not FUDS Eligible

Building	Historical Use
Building 201	Empty Projectile Magazine
Building 212	Former Marine Barracks
Building 217	Fire Station and Labor Office Building
Building 222	Miscellaneous Storage Building
Building 508	Bag Charge Magazine
Building 603	Pyrotechnic Magazine

Note:
Soil at DU-8 was not sampled during Phase I due to the presence of debris that was not related to historical DoD operations, including numerous rusted and deteriorating 55-gal drums, deteriorating pallets, piles of roofing shingles, and chain-link fencing.

DU-24 was not sampled during Phase I as the majority of the area consists of exposed bedrock with little to no soil cover.

VICINITY MAP



Legend

- FUDS Boundary
- HTRW Project Areas of Concern
- FormerTransformers
- Former Buildings with Significant Potential for Explosive Hazard (Included in the HTRW RI pending direction of contracting offer)
- Remaining Structure (Not FUDS Eligible)
- Previous Elevated Concentration of COPC (Greeley-Polhemus 1997 and Alion 2008)
- 1-Acre DU
- 60 x 60 ft DU
- Explosives Building DU

0 300 600
Feet
1 in = 300 ft
N

FIGURE 2-2
Phase I Onsite Soil Incremental Sampling Decision Units

HAZARDOUS TOXIC AND RADIOACTIVE WASTE FEASIBILITY STUDY

Source
Aerial: EA Engineering, Science, and Technology. April, 7 2020

Map Date: 7/19/2024

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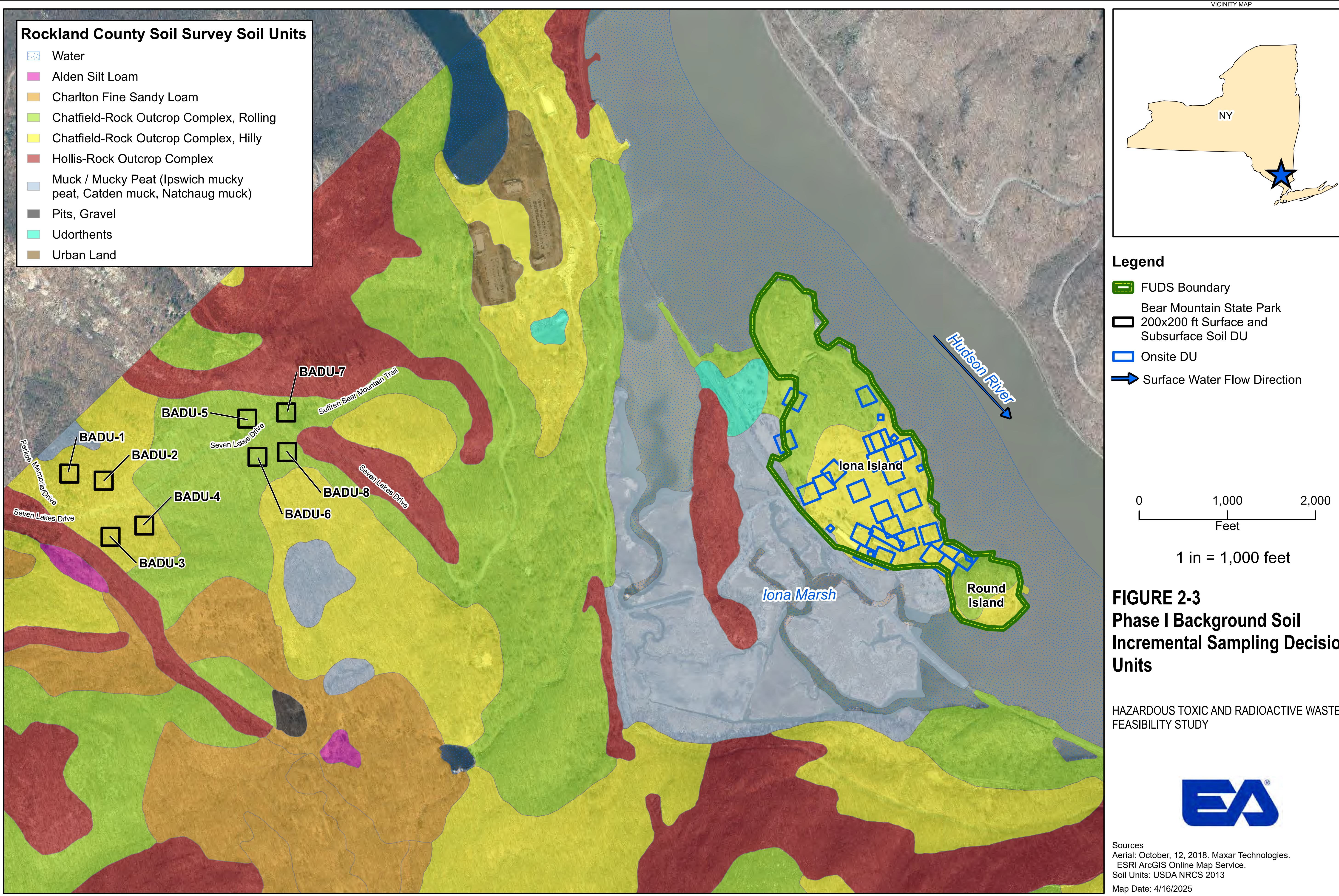

FIGURE 2-3
Phase I Background Soil Incremental Sampling Decision Units

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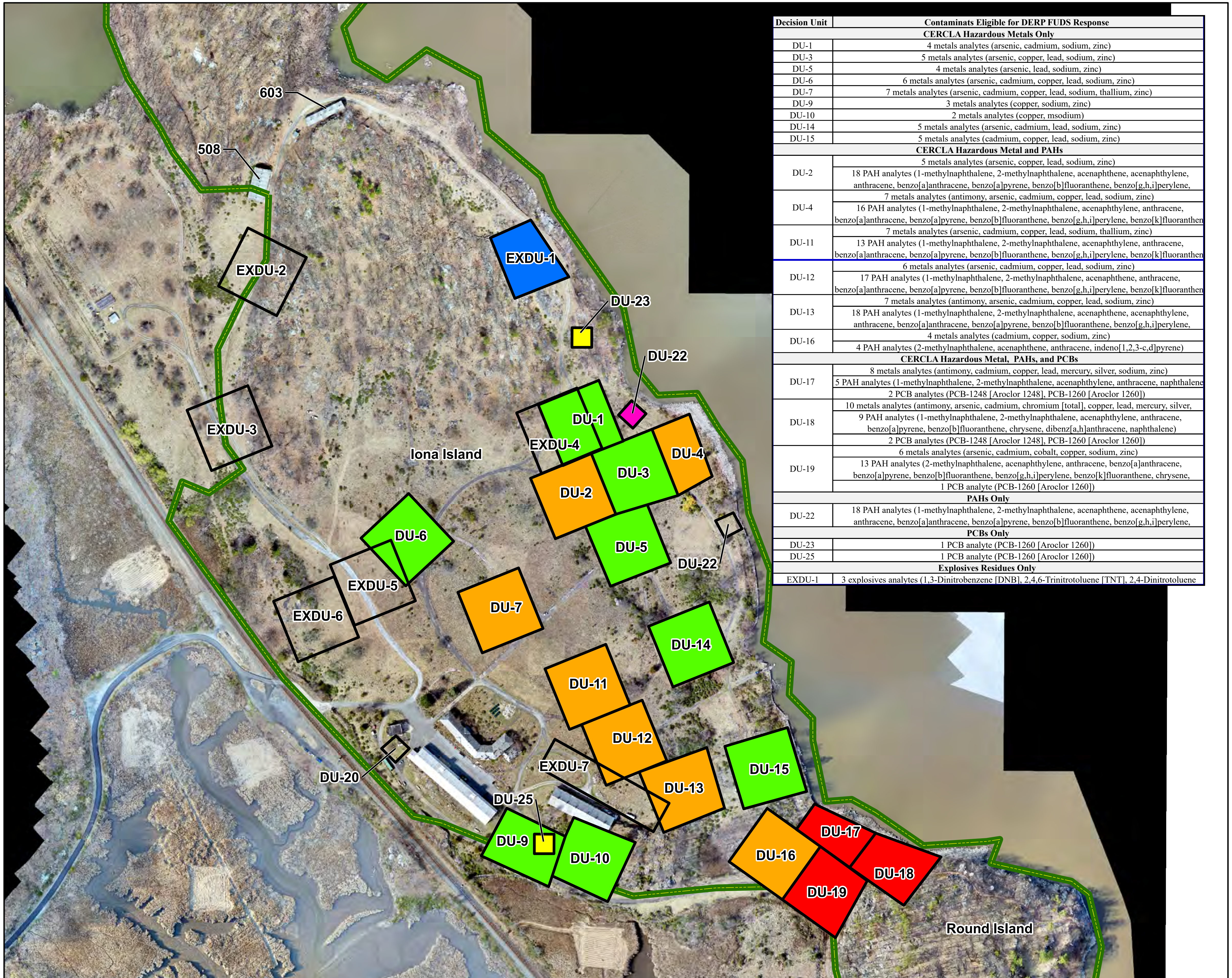
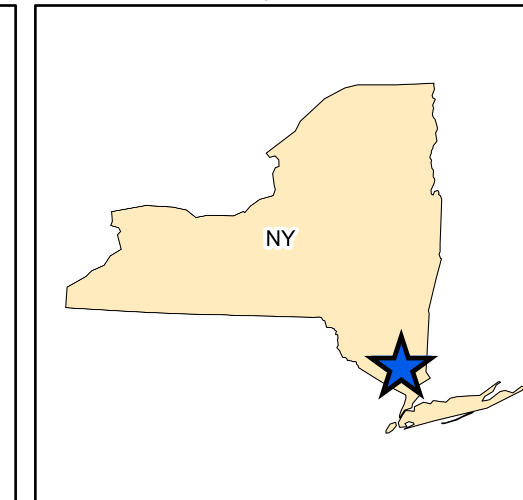


Decision Unit	Contaminats Eligible for DERP FUDS Response
CERCLA Hazardous Metals Only	
DU-1	4 metals analytes (arsenic, cadmium, sodium, zinc)
DU-3	5 metals analytes (arsenic, copper, lead, sodium, zinc)
DU-5	4 metals analytes (arsenic, lead, sodium, zinc)
DU-6	6 metals analytes (arsenic, cadmium, copper, lead, sodium, zinc)
DU-7	7 metals analytes (arsenic, cadmium, copper, lead, sodium, thallium, zinc)
DU-9	3 metals analytes (copper, sodium, zinc)
DU-10	2 metals analytes (copper, msodium)
DU-14	5 metals analytes (arsenic, cadmium, lead, sodium, zinc)
DU-15	5 metals analytes (cadmium, copper, lead, sodium, zinc)
CERCLA Hazardous Metal and PAHs	
DU-2	5 metals analytes (arsenic, copper, lead, sodium, zinc)
	18 PAH analytes (1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene,
DU-4	7 metals analytes (antimony, arsenic, cadmium, copper, lead, sodium, zinc)
	16 PAH analytes (1-methylnaphthalene, 2-methylnaphthalene, acenaphthylene, anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthen
DU-11	7 metals analytes (arsenic, cadmium, copper, lead, sodium, thallium, zinc)
	13 PAH analytes (1-methylnaphthalene, 2-methylnaphthalene, acenaphthylene, anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthen
DU-12	6 metals analytes (arsenic, cadmium, copper, lead, sodium, zinc)
	17 PAH analytes (1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthen
DU-13	7 metals analytes (antimony, arsenic, cadmium, copper, lead, sodium, zinc)
	18 PAH analytes (1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene,
DU-16	4 metals analytes (cadmium, copper, sodium, zinc)
	4 PAH analytes (2-methylnaphthalene, acenaphthene, anthracene, indeno[1,2,3-c,d]pyrene)
CERCLA Hazardous Metal, PAHs, and PCBs	
DU-17	8 metals analytes (antimony, cadmium, copper, lead, mercury, silver, sodium, zinc)
	5 PAH analytes (1-methylnaphthalene, 2-methylnaphthalene, acenaphthylene, anthracene, naphthalene
	2 PCB analytes (PCB-1248 [Aroclor 1248], PCB-1260 [Aroclor 1260])
DU-18	10 metals analytes (antimony, arsenic, cadmium, chromium [total], copper, lead, mercury, silver,
	9 PAH analytes (1-methylnaphthalene, 2-methylnaphthalene, acenaphthylene, anthracene, benzo[a]pyrene, benzo[b]fluoranthene, chrysene, dibenz[a,h]anthracene, naphthalene)
	2 PCB analytes (PCB-1248 [Aroclor 1248], PCB-1260 [Aroclor 1260])
DU-19	6 metals analytes (arsenic, cadmium, cobalt, copper, sodium, zinc)
	13 PAH analytes (2-methylnaphthalene, acenaphthylene, anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene,
	1 PCB analyte (PCB-1260 [Aroclor 1260])
PAHs Only	
DU-22	18 PAH analytes (1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene,
PCBs Only	
DU-23	1 PCB analyte (PCB-1260 [Aroclor 1260])
DU-25	1 PCB analyte (PCB-1260 [Aroclor 1260])
Explosives Residues Only	
EXDU-1	3 explosives analytes (1,3-Dinitrobenzene [DNB], 2,4,6-Trinitrotoluene [TNT], 2,4-Dinitrotoluene

VICINITY MAP



Legend

- FUDS Boundary
- CERCLA Hazardous Metals Only
- CERCLA Hazardous Metals, PAHs
- CERCLA Hazardous Metals, PAHs, PCBs
- PAHs Only
- PCBs Only
- Explosives Only
- No Contaminants

0 300 600
Feet
1:3,600
N

FIGURE 2-4
Surface Soil Contaminants Summary

HAZARDOUS TOXIC AND RADIOACTIVE WASTE FEASIBILITY STUDY

Source
Aerial: EA Engineering, Science, and Technology. April, 7 2020

Map Date: 3/4/2026

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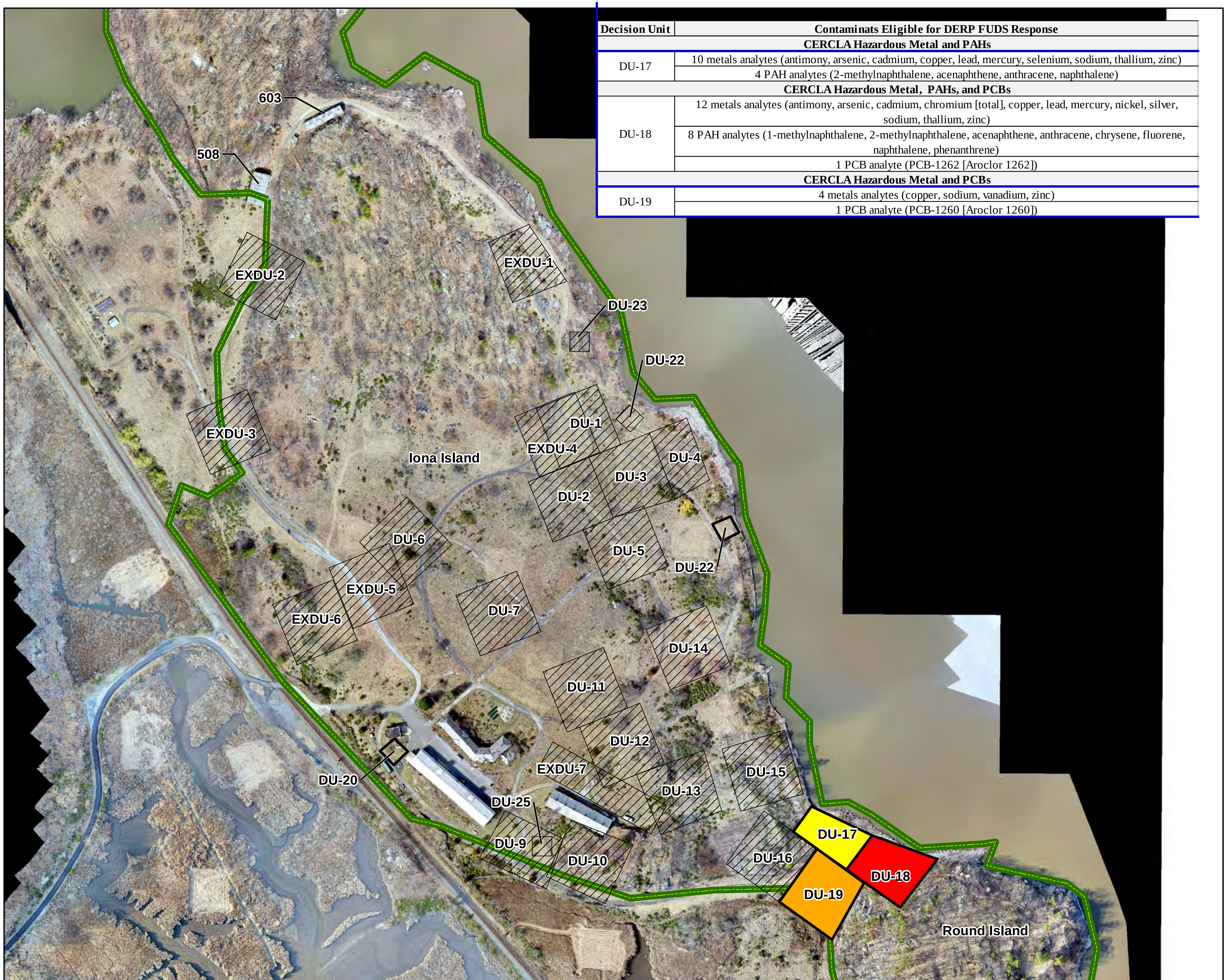
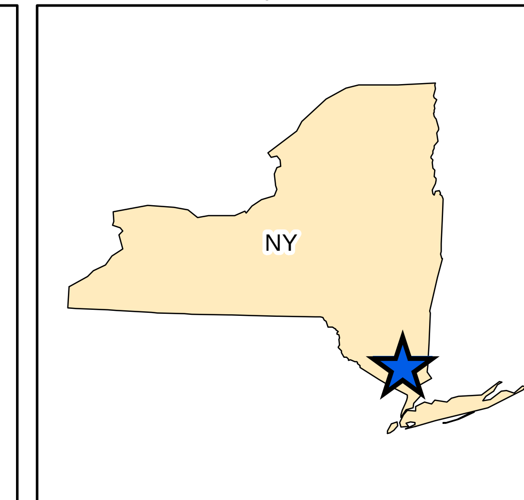


Decision Unit	Contaminats Eligible for DERP FUDS Response
CERCLA Hazardous Metal and PAHs	
DU-17	10 metals analytes (antimony, arsenic, cadmium, copper, lead, mercury, selenium, sodium, thallium, zinc)
	4 PAH analytes (2-methylnaphthalene, acenaphthene, anthracene, naphthalene)
CERCLA Hazardous Metal, PAHs, and PCBs	
DU-18	12 metals analytes (antimony, arsenic, cadmium, chromium [total], copper, lead, mercury, nickel, silver, sodium, thallium, zinc)
	8 PAH analytes (1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, anthracene, chrysene, fluorene, naphthalene, phenanthrene)
	1 PCB analyte (PCB-1262 [Aroclor 1262])
CERCLA Hazardous Metal and PCBs	
DU-19	4 metals analytes (copper, sodium, vanadium, zinc)
	1 PCB analyte (PCB-1260 [Aroclor 1260])

VICINITY MAP



Legend

- FUDS Boundary
- Not Sampled: shallow depth to refusal (less than 12 inches below ground surface)
- No Contaminants Detected
- CERCLA Hazardous Metals, PAHs, PCBs
- CERCLA Hazardous Metals, PCBs
- CERCLA Hazardous Metals, PAHs

0 300 600
Feet
1 in = 300 ft
N

FIGURE 2-5
Subsurface Soil Contaminants Summary

HAZARDOUS TOXIC AND RADIOACTIVE WASTE FEASIBILITY STUDY

Source
Aerial: EA Engineering, Science, and Technology. April, 7 2020

Map Date: 7/19/2024

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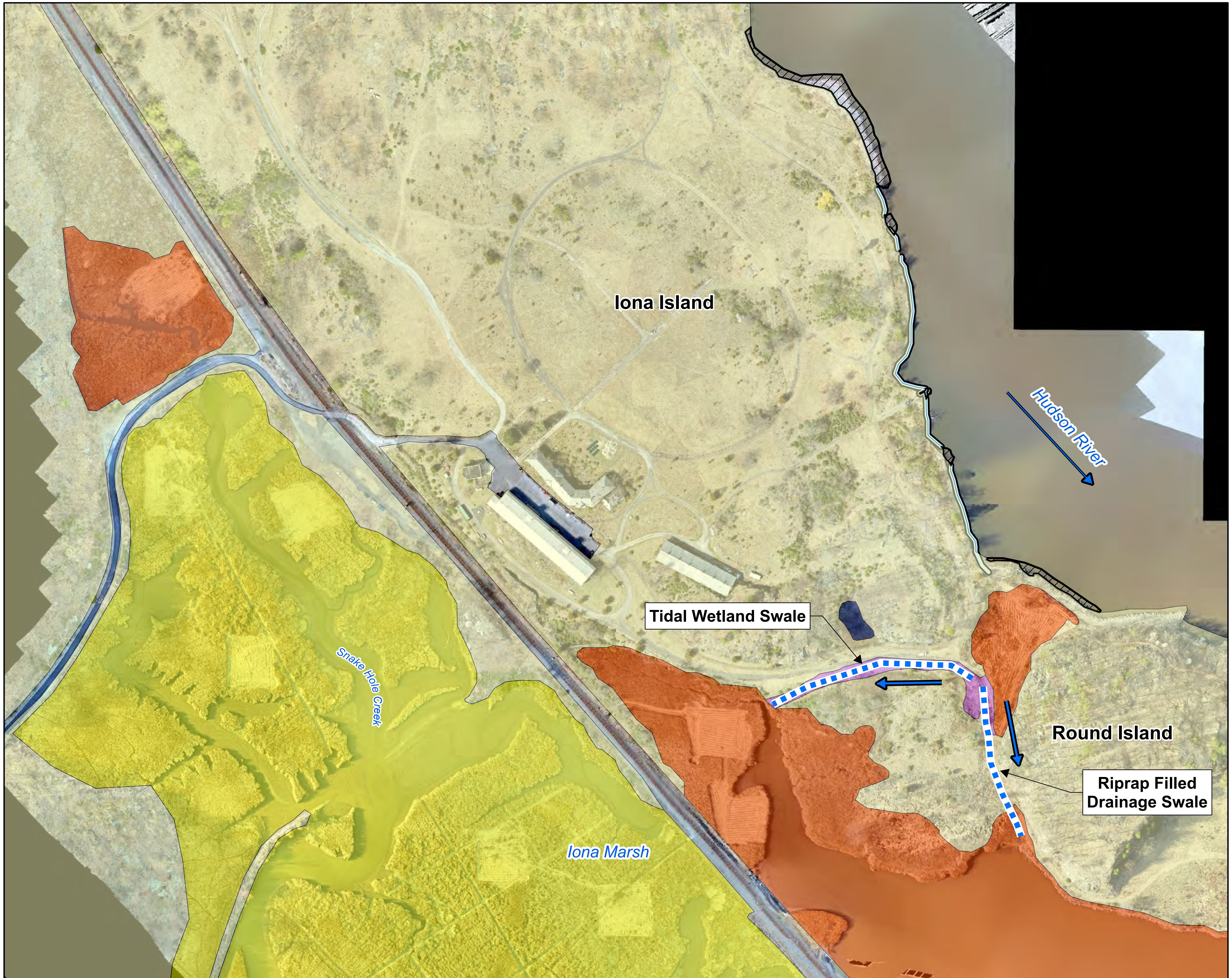

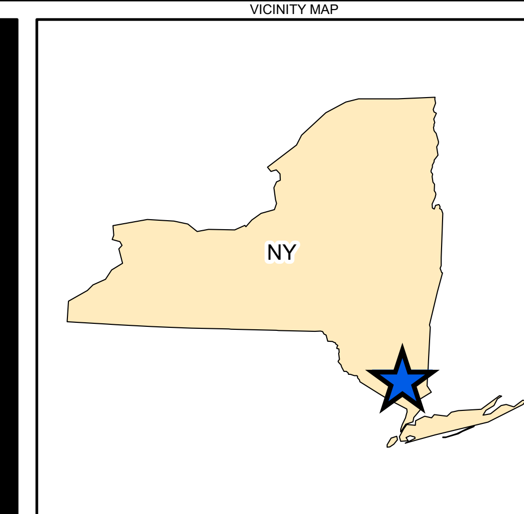

FIGURE 2-6
Phase I Shoreline Reconnaissance Observations

HAZARDOUS TOXIC AND RADIOACTIVE WASTE FEASIBILITY STUDY

Source
Aerial: EA Engineering, Science, and Technology. April, 7 2020

Map Date: 3/5/2026

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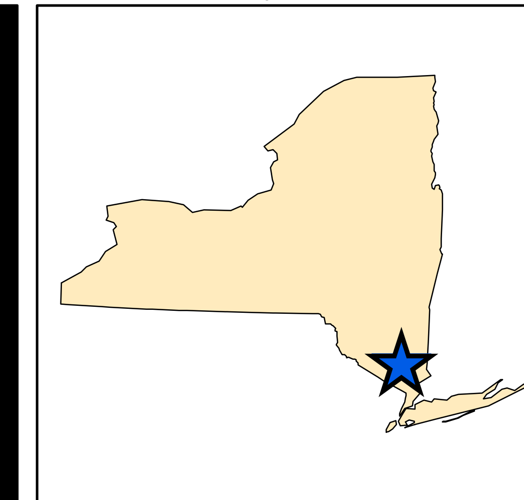
VICINITY MAP



Legend

- FUDS Boundary
- Phase I Former Building/Structure
- AOC #16 – Area D (former Dumping Area)
- Phase I Soil Decision Unit
- Upland
- Marsh/Wetland
- Surface Water Migration Pathway
- Phase II Sediment Decision Unit
- Surface Water Flow Direction

0 200 400
Feet
1 in = 220 ft
N

FIGURE 2-7
Phase II Onsite Investigation Areas

HAZARDOUS TOXIC AND RADIOACTIVE WASTE
FEASIBILITY STUDY

EA

Source
Aerial: EA Engineering, Science, and Technology. April, 7 2020
AOC Boundary: USAGC 2018
Upland and Marsh/Wetland: Cornell Cornell Institute
for Resource Information Sciences (IRIS) 2011

Map Date: 7/19/2024

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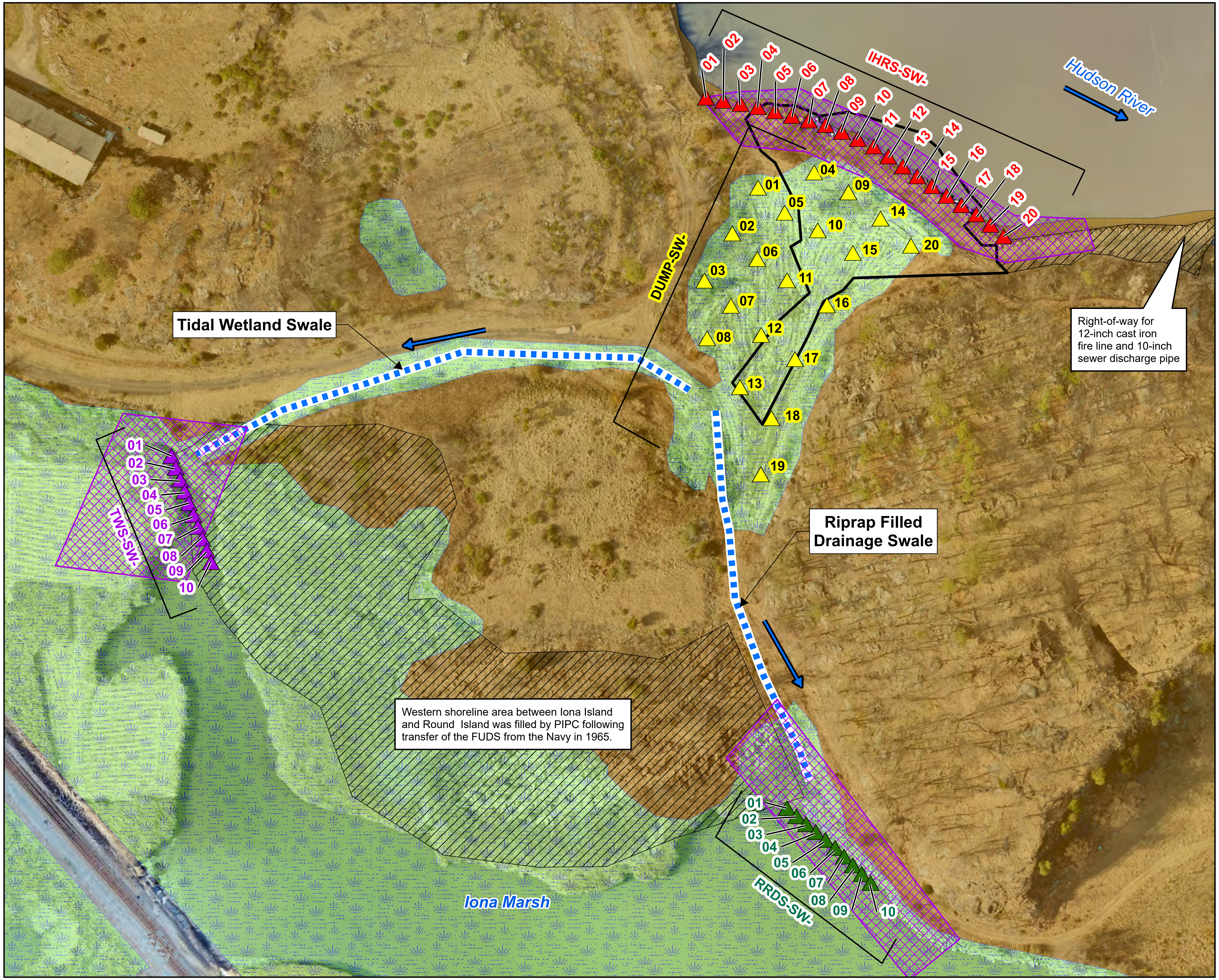
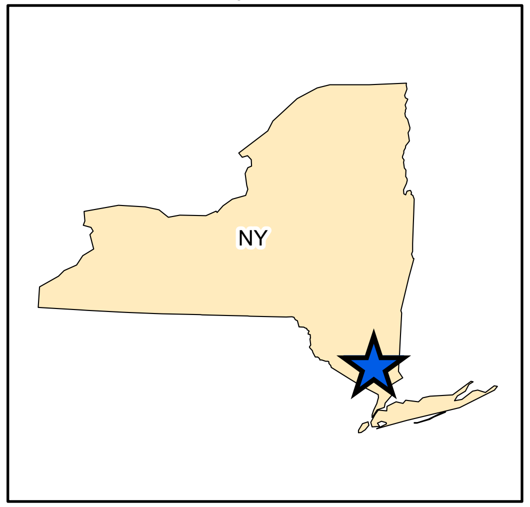


VICINITY MAP



Legend

- AOC #16 – Area D (former Dumping Area)
- Upland
- Marsh/Wetland
- ISM Sediment Decision Unit
- Surface Water Migration Pathway

Surface Water Sampling Location

- Iona Island Hudson River Shoreline
- AOC #16 – Area D (former Dumping Area)
- Iona Marsh Tidal Wetland Swale Outlet
- Iona Marsh Riprap Filled Drainage Swale Outlet
- Surface Water Flow Direction

0 100 200
Feet
1:1,200
N

FIGURE 2-8
Phase II Iona Island Surface Water Sampling Locations

HAZARDOUS TOXIC AND RADIOACTIVE WASTE FEASIBILITY STUDY

Source
Aerial and Topographic Contours: EA Engineering, Science, and Technology. April, 7 2020
Disturbed Ground/Fill Area and AOC Boundaries: USAGC 2018
Upland and Marsh/Wetland: 2020 EA Shoreline Reconnaissance
Map Date: 3/4/2026

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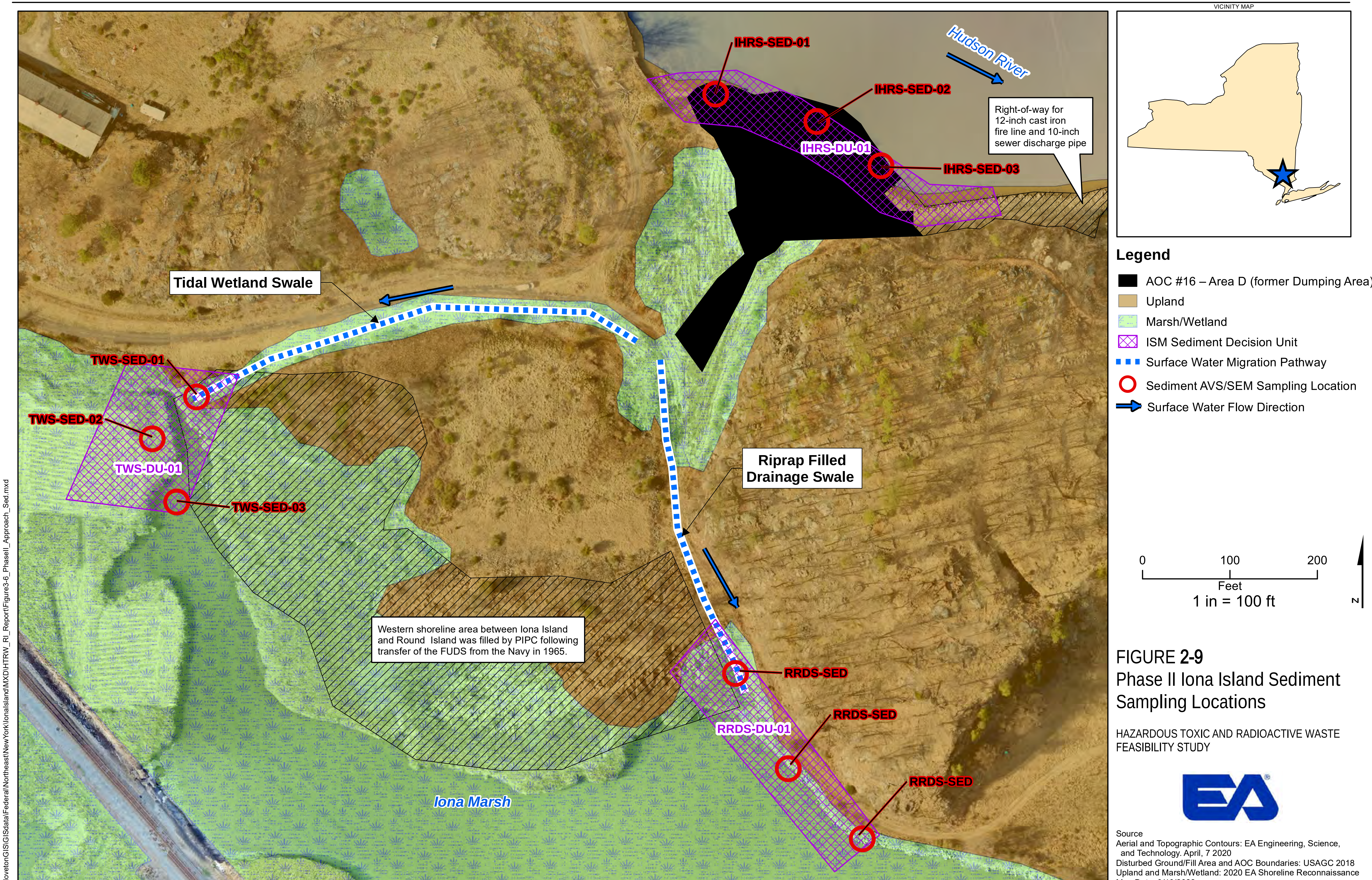

FIGURE 2-9
Phase II Iona Island Sediment Sampling Locations

HAZARDOUS TOXIC AND RADIOACTIVE WASTE FEASIBILITY STUDY

Source
Aerial and Topographic Contours: EA Engineering, Science, and Technology. April, 7 2020
Disturbed Ground/Fill Area and AOC Boundaries: USAGC 2018
Upland and Marsh/Wetland: 2020 EA Shoreline Reconnaissance
Map Date: 9/19/2022

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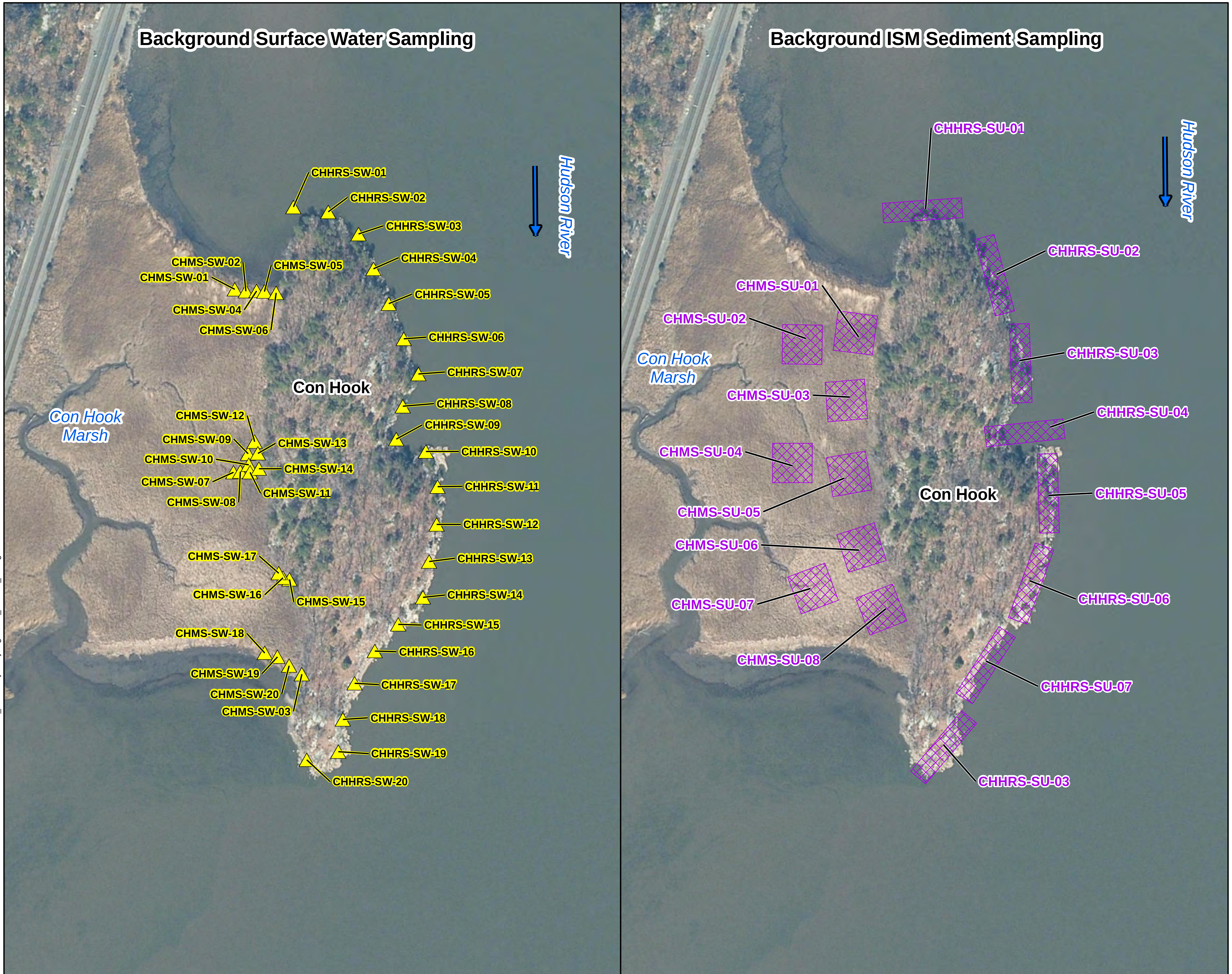
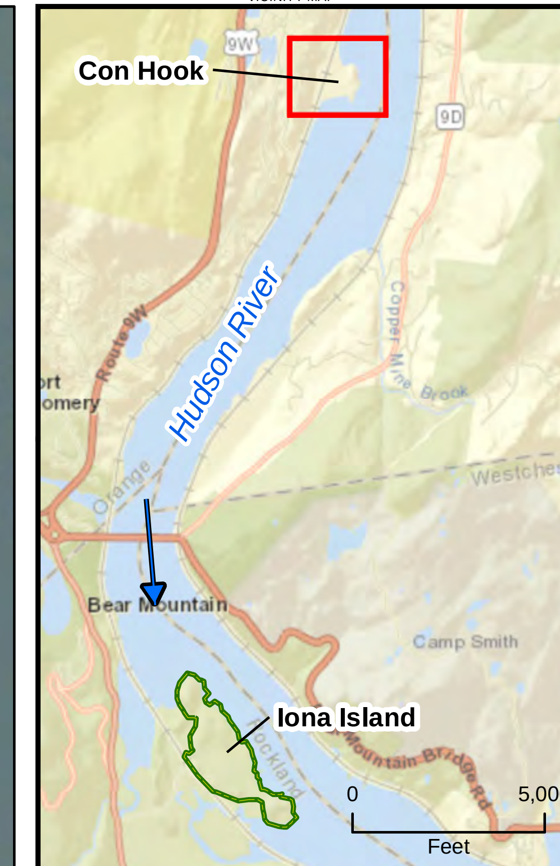


VICINITY MAP



Legend

- Background Sediment Sampling Unit
- Discrete Surface Water Sampling Location
- Surface Water Flow Direction

0 200 400
Feet
1 in = 200 ft

N

FIGURE 2-10
Con Hook Background Surface Water and Sediment Sampling Locations

HAZARDOUS TOXIC AND RADIOACTIVE WASTE FEASIBILITY STUDY

Source
Aerial: ESRI ArcGIS Online Map Service (ESRI 2009b).
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Map Date: 7/19/2024

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3. REMEDIAL ACTION OBJECTIVES AND PRELIMINARY REMEDIATION GOALS

The purpose of this section is to assemble pertinent information that will be used in the screening, development, and evaluation of remedial alternatives for the Former Dump Area and Hudson River shoreline in its vicinity under this FS. This section discusses the following:

- Identify the COCs and the media of concern to be addressed based on previous investigation results
- Allowable exposure based on risk
- Identify potential federal and state ARARs and TBC guidance
- Develop PRGs based on ARARs and TBC guidance
- Define the RAO(s)
- Specify areas and volumes to be addressed

This information will be used by the decision-makers during development of the Record of Decision for the Iona Island Naval Ammunition Depot FUDS.

3.1 EXTENT AND IMPACTS OF CONTAMINANTS OF CONCERN

Defining PRGs and remedial goals is determined by the findings of the RI. The physical characteristics that defined and constrained both nature and extent and risk in the RI, also afford an opportunity to streamline the development of PRGs in the FS. This FS proposes the use of lead as an indicator COC to define and direct the development of a single project PRG. The justification for this approach is found in the unique site characteristics for receptors, COCs, and media nature/extent. Each of these elements is discussed below.

3.1.1 Receptors of Concern

At the conclusion of the HHRA, the Former Dump Area (**Figure 1-2**) and Hudson River Shoreline sediments represent unacceptable risk to the recreator (adult/youth/child) (**Table 2-1**).

At the conclusion of the RSLERA in the ERA, the Former Dump Area and Iona Island Hudson Rivers Shoreline sediments represent unacceptable risk to two species of insectivorous birds (golden-wing warbler and cerulean warbler), which are New York State–listed species of special concern, and two federally endangered fish species (juvenile Atlantic sturgeon and juvenile short-nosed sturgeon) (**Table 2-2**). This area currently functions as a wetland, though it is populated predominantly with invasive species (e.g., phragmites). As discussed in Section 1.4.5, priority would be given to alternatives that allow restoration of this ecological resource to a functioning wetland with native species.

3.1.2 Contaminants of Concern

Risk at the site for human receptors is driven solely by lead. Lead is also the primary risk driver for ecological receptors, with lesser contributions from copper for state-listed birds, and from antimony, cadmium, copper, nickel and zinc for federally listed threatened juvenile sturgeon. **Table 2-1** and **Table 2-2** summarize these findings.

The presence of ash from the former on-site incinerator (Former Building 121), as encountered during test pitting in the Former Dump Area, represents an ongoing source area and a release from this area to the Hudson River Shoreline was identified.

The metals contributing to unacceptable risk originate from this ash and are collocated and comingled. By remediating the primary risk driver lead, the risk associated with other collocated metals is also mitigated.

3.1.3 Media/Nature and Extent

The areal extent of contaminated soil associated with the Former Dump Area is based on the extent of the low-lying marsh area between Iona and Round Island (**Table 3-1**), while the vertical extent of contamination in this area is sharply defined due to bedrock at approximately 3 feet bgs. Contaminated sediment associated with the Former Dump Area also includes a small sand and gravel beach that is exposed at low tide and is inundated twice daily during high tide and storm events, as well as the submerged shoreline to approximately 25 feet offshore.

For the Hudson River Shoreline, a shallow bedrock shelf extends from Iona Island to approximately 250 to 350 feet offshore before sloping steeply downward to a depth of approximately -95 feet below the river surface. While sediment may be present along the shelf beyond the area immediately adjacent to the Former Dump Area, shoreline reconnaissance at low tide has shown that any contaminated sediment would be limited to the nearshore area due to dispersion within this site's high-energy riverine environment.

3.1.4 Summary

The development of a single project PRG for lead is justified based on the physical characteristics of the Former Dump Area. Specifically:

- The receptors potentially exposed to unacceptable risk are focused.
- The risk driver for all receptors is lead.
- All COCs contributing to unacceptable risk are associated with ash in the Former Dump Area and are collocated and comingled with lead.
- Removal of contaminated soil and sediment based upon a PRG for lead will simultaneously remove the risk contributions from other collocated metals.

- Former Dump Area is limited to the area between Round and Iona Islands and the Hudson River.
- Contamination is restricted to 3 feet bgs of hydric soils in the Former Dump Area and the sediments in the shoreline immediately adjacent.

Thus, development of a remedial plan based upon the remediation of lead that is protective of receptors for which unacceptable risk is present (i.e., human recreators and species of conservational concern) will also accomplish the removal of all collocated metal COCs contributing to the overall site risk.

3.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The development and evaluation of remedial alternatives under CERCLA includes an assessment of alternative Property remedies on the basis of their ability to comply with ARARs. The development and evaluation of remedial alternatives under CERCLA include a comparison of alternative Property remedies to ARARs. Pursuant to CERCLA/NCP, compliance with ARARs is a threshold requirement that a remedial alternative must meet in order to be eligible for selection (unless the ARAR is waived).

The ARAR analysis is directed at substantive, promulgated regulations with regard to on-site activities (CERCLA § 121[d], 42 U.S.C. § 9621[d]; NCP, 40 C.F.R. § 300.5). Furthermore, CERCLA response actions, per CERCLA/NCP, are exempt from permits and similar procedural requirements with regard to on-site activities (42 USC § 9621[e][1]; 40 C.F.R. § 300.400[e][1]).

For off-site activities (e.g., transportation), compliance is required for applicable, substantive, and procedural requirements [NCP, 40 CFR § 300.400[e][2]). Such off-site activities are not part of the ARAR analysis, but may be discussed under the implementability factor, to the extent that they pose challenges for certain alternatives.

The goals of remedy selection are to protect human health and the environment, to maintain protection over time, and to minimize untreated waste (40 CFR 300.430 of the NCP [55 Federal Register 8846]). The remedial action must comply with all ARARs, including environmental laws, regulations, and standards promulgated by the federal government. In addition, compliance with promulgated state laws is necessary if the state ARAR is more stringent than the federal ARAR. Section 121(e) of CERCLA, codified at 40 CFR Part 300.400(e), exempts any on-site response action from complying with the administrative requirements of federal, state, or local permits. However, response actions may need to comply with substantive requirements of applicable or relevant and appropriate permitting laws and regulations.

3.2.1 Definition of ARARs

Pursuant to the NCP, 40 CFR § 300.5, a regulation may qualify as an ARAR if it meets the definition of being either "applicable" or "relevant and appropriate." Each of these components is discussed below.

"Applicable" requirements—As defined by 40 CFR 300.5 are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site and establish the degree of cleanup for a remedial action. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable.

"Relevant and appropriate" requirements—Cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site and establish the degree of cleanup for a remedial action. Only those state standards that are identified by a state in a timely manner and are more stringent than federal requirements may be relevant and appropriate (40 CFR 300.5).

Whether or not a requirement is appropriate (in addition to being relevant) will vary depending on factors such as (1) the existence of wetlands or endangered species on or near the Property, (2) the duration of the response action, (3) the form or concentration of the chemicals present, (4) the nature of the release, and (5) the availability of other standards that more directly match the circumstances at the Property. In some cases, only a portion of the requirement may be relevant and appropriate. The identification of relevant and appropriate requirements is a two-step process; only those requirements that are considered both relevant and appropriate must be addressed at CERCLA sites.

3.2.2 Classification of ARARs

Due to their property-specific nature, identification of ARARs calls for evaluation of federal and state environmental and facility siting laws regarding COCs, Property characteristics, and proposed remedial alternatives. Requirements that pertain to the remedial response at a CERCLA property can be categorized as follows:

- **Chemical-specific ARARs** set health or risk-based concentration limits in various environmental media for specific hazardous substances, pollutants, or contaminants. These ARARs establish protective cleanup levels for the chemicals in the designated media.
- **Location-specific ARARs** protect against damage to unique or sensitive areas. They also restrict activities that may be harmful as a result of the characteristics of the Property or the immediate environment.
- **Action-specific ARARs** are usually technology- or activity-based requirements to or limitations on action taken with respect to hazardous wastes or requirements to conduct certain actions to address certain circumstances at a site.

3.2.3 To Be Considered Guidance

Without ARARs, advisories, criteria, or guidance may be identified as TBC information for a particular scenario. TBC materials (e.g., federal/state criteria, advisories, and guidance values) are non-promulgated advisories or guidance issued by a federal or state government that are not legally binding and do not have the status of ARARs. TBC guidance documents or advisories, considered in support of determining the necessary level of cleanup for protection of human health or the environment, may be used where no specific ARARs exist for a chemical or situation.

3.2.4 Identification of ARARs and TBC Guidance

ARARs identified for the Iona Island Naval Ammunition Depot FUDS include the following:

- Federal action-specific ARARs for the remedial alternatives under evaluation.
- Federal location-specific ARARs that are listed based on the presence of any threatened or endangered species (e.g. juvenile short-nose sturgeon and juvenile Atlantic sturgeon).

Note that in conjunction with the FS ARAR development process, USACE has requested that NYSDEC identify state ARARs that may be applicable to actions at the Iona Island Naval Ammunition Depot FUDS. A response from NYSDEC is pending and state ARARs may be considered.

3.2.4.1 Chemical-Specific ARARs

- No chemical-specific ARARs were identified.

3.2.4.2 Action-Specific ARARs

One action-specific federal ARAR was identified.

- ***Endangered Species Act 16 USC 1538(a)(1)(B)* —** Prohibits the take of any endangered species.

3.2.4.3 Location-Specific ARARs

The location-specific federal ARAR includes:

- ***Clean Water Act– 40 CFR 230.10(a)* —** This statute, known as "Section 404," prohibits the discharge of dredged or fill material into waters of the United States if there is a practicable alternative to the proposed discharge that would have less adverse impact on the aquatic ecosystem. Practical alternatives include, but are not limited to, activities which do not involved a discharge of dredged or fill material into waters of the United States, and an alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes.

3.2.5 Waivers from ARARs

Compliance with an ARAR may be waived under certain conditions provided that human health and the environment are protected. 40 CFR 300.430(f)(1)(ii)(C) lists six statutory waivers. Under 40 CFR 300.430(f)(1)(ii)(C)(2), an ARAR waiver is available for situations where compliance with an ARAR will cause greater risk to human health and the environment than noncompliance. An ARAR waiver is required under Alternative 4 for 40 CFR 230.10(a), and a detailed discussion of the ARAR waiver is found in section 6.3.4.2.

3.3 PRELIMINARY REMEDIATION GOAL

PRGs are contaminant concentration levels that are based on readily available information such as risk-based doses, legal standards (ARARs), and guidance and advisories (TBC criteria). PRGs are in turn used to determine the feasibility of proposed remedial actions.

Risk-based PRGs are proposed cleanup levels, which are based on human health and ecological risks and are intended to be protective of human health and the environment. Multiple media were evaluated during the RI, including upland surface and subsurface soil, hydric surface and subsurface soil within the Former Dump Area, surface water within the Former Dump Area, and surface water and sediment along the Hudson River and Iona Marsh shorelines at the end points of preferential flow pathways from the Former Dump Area. Based on the results of the RI, soil within the Former Dump Area and Hudson River shoreline sediment in its immediate vicinity poses an unacceptable risk to human health and/or the environment, with risk being driven by exposure to lead. Since risk in soil and sediment is driven by exposure to lead, risk concerns are based on exceedances of the PRG for lead.

Factors taken into consideration when identifying PRGs for a specific contaminant for a specific medium included the following:

- Establishing whether remediation goals for lead in soil and sediment provide protection of both human and ecological receptors

- Property-specific background values for lead, because CERCLA does not require clean up to concentrations below natural or anthropogenic property-specific background levels (EPA 2002)

Ecological risk-based PRGs are proposed cleanup levels which are intended to be protective of ecological receptors identified in the RI. The PRG for lead in soil was based on review of the following TBC guidance and property-specific background levels, as no ARARs were identified:

- EPA Region 4 ecological screening value for lead in soil of 11 mg/kg, as presented in EPA Region 4 ERA Supplemental Guidance, Scientific Support Section Superfund Division EPA Region 4, March 2018 (EPA 2018)

- NYSDEC unrestricted use soil cleanup objective (SCO) for lead of 63 mg/kg (representative of pre-disposal conditions) (NYSDEC 2006)

- NYSDEC protection of ecological resources SCO for lead of 63 mg/kg (NYSDEC 2006)

- Property-specific background values for lead in soil. As presented in the RI, background ISM soil results for lead ranged from 33 to 94 mg/kg, with a 95UCL of 82.1 mg/kg (USACE 2024b).

Table 3-2 summarizes lead concentrations in soil, current (August 2024) federal and state screening criteria, and background concentrations. The Property-specific background value for lead in soil was identified as 82.1 mg/kg. Consistent with Property-specific background concentrations, a PRG of 82 mg/kg has been selected for lead in soil.

The PRG for lead in sediment was based on review of the following TBC guidance and Property-specific background levels, as no ARARs were identified:

- EPA Region 4 (March 2018) ecological screening value for sediment of 35.8 mg/kg (EPA 2018).

- NYSDEC Freshwater Sediment Guidance Values (NYSDEC 2014), which classify sediment as Class A (low risk to aquatic life; <36 mg/kg), Class B (potential risk to aquatic life 36-130 mg/kg), or Class C (likely risk to aquatic life >130 mg/kg)

- Site-specific background values for lead in sediment. As presented in the RI, Property-specific background ISM sediment results for lead ranged from 39 to 71 mg/kg, with a 95UCL of 67.4 mg/kg (USACE 2024b).

Table 3-3 summarizes lead concentrations in sediment, current (August 2024) project-specific screening criteria, and site specific background concentrations. The site-specific background value for lead was identified as the site-specific 95UCL of 67.4 mg/kg. Consistent with Property-specific background concentrations, a PRG of 67 mg/kg has been selected for lead in sediment since the targeted removal of sediment lead concentrations greater than 67 mg/kg will result in protectiveness of human health and ecological receptors.

3.4 REMEDIAL ACTION OBJECTIVES

RAOs are Property-specific goals for protecting the human health and the environment. RAOs include cleanup objectives that have been established based on the nature and extent of contamination, potential for human and environmental exposure, and ARARs. RAOs support the determination of protectiveness and effectiveness of remedial action alternatives.

The RAOs for the Iona Island Naval Ammunition Depot FUDS are as follows:

- Reduce the risk of ingestion/direct contact by current and anticipated future human receptors (recreational users) to COC (lead) above the PRG in contaminated soil in the Former Dump Area

- Reduce the risk of ingestion/direct contact by current and anticipated future human receptors (recreational users) to COC (lead) above the PRG in contaminated sediment along the Hudson River shoreline adjacent to the Former Dump Area

- Prevent impacts to biota from ingestion/direct contact with COC (lead) above the PRG in contaminated soil of the Former Dump Area causing toxicity or impacts from bioaccumulation through the terrestrial food chain

- Prevent impacts to biota from ingestion/direct contact with Hudson River shoreline COC (lead) above the PRG in contaminated sediment in the vicinity of the Former Dump Area causing toxicity or impacts from bioaccumulation through the aquatic food chain

- Prevent migration of COC in soil (lead) above the PRG from the Former Dump Area to the adjacent Hudson River Shoreline

State regulators have expressed interest in maintaining the Former Dump Area between Iona and Round Island as a wetland with native wetland plant species. While not an RAO, maintaining the low-lying marsh area between Iona and Round Island as a wetland with native wetland plant species is considered a post-remediation objective for the Property.

3.5 EXTENT OF IMPACT TO ENVIRONMENTAL MEDIA

The Former Dump Area represents an ongoing source area due to the presence of ash from the former on-site incinerator, as encountered during test pitting and shoreline bathymetric data. Potential risks within the Former Dump Area are confined to a small area of the overall Property, with sharply defined lateral extent of contamination due to island topography and the Hudson River, and sharply defined vertical extent of contamination due to bedrock at approximately 3 feet bgs.

The estimated volume of material in the Former Dump Area and along the Hudson River Shoreline is presented in **Table 3-4**. Note that these estimated volumes are in situ, and they do not account for potential expansion of soil and sediment upon excavation. Volumes were calculated based on areal extent, depth, and type of material anticipated to be encountered in each area as based on ISM soil and sediment sample grain size results from the RI (USACE 2024b).

3.5.1 Former Dump Area Hydric Soils

The areal extent of contaminated soil associated with the Former Dump Area was based on the extent of the low-lying marsh area between Iona and Round Island (location of the Former Dump Area) determined during the RI shoreline reconnaissance (USACE 2024b). This area is approximately 1.10 acres or 48,096 square feet (**Figure 3-1**). Vertical depth of contaminated soil is based on the assumed depth to bedrock (3 feet bgs) as based on test pitting and shoreline bathymetric data. The volume of associated contaminated soil is therefore estimated to be 5,344 cubic yards.

Soil samples were collected and submitted for grain size analysis during the RI. Based on grain size, soil of the Former Dump Area primarily consists of silt, medium sand, and fine sand with lesser amounts of coarse sand, gravel, and clay. Soil was classified using the Unified Soil Classification System (ASTM International [ASTM] 2006) as follows:

- DU-17: SM/GM (silty sand and silty sand with gravel)
- DU-18: SM and SP-SM (silty sand and poorly graded sand with silt)
- DU-19: SM (silty sand).

Based on the density of dry sand (100 pounds per square foot) and wet sand (120 pounds per square foot), contaminated soil is estimated to range from 7,214 and 8,657 U.S. tons (**Table 3-4**).

3.5.2 Hudson River Shoreline Sediment

The areal extent of contaminated sediment associated with the Former Dump Area was based on the extent of the sediment DU sampled during Phase II of the RI (IHRS-DU-01) (USACE 2024b). This area is approximately 0.56 acres or 24,596 square feet (**Figure 3-1**) and includes a small sand and gravel beach that is exposed at low tide and inundated twice daily during high tide and during storm events, as well as the submerged shoreline beyond the beach. The northwestern edge of the beach area terminates at a river wall that extends northwestward along the Iona Island shoreline. The southeastern edge of the beach terminates along Round Island approximately 240 feet beyond downstream from the Former Dump Area. Historical installation layout maps from 1934 and 1947 (USAGC 2018) indicate that the shoreline east of the Former Dump Area contains fill material associated with a 10-inch diameter discharge pipe. No discharge pipe was observed in this area during the shoreline reconnaissance or HTRW Project RI field activities (USACE 2024b).

As detailed in the Iona Island HTRW Project RI Report, a shallow bedrock shelf extends from Iona Island to approximately 250 to 350 feet offshore before sloping steeply downward to a depth of approximately -95 feet below the river surface. While sediment may be present along the shelf beyond the extent of IHRS-DU-01, it is anticipated contaminated sediment would be limited to the nearshore area. This area includes the beach that is exposed at low tide and the submerged shoreline approximately 25 feet offshore. Metals concentrations in sediment are anticipated to decrease further offshore due to dispersion within this site’s high energy riverine environment.

According to test pitting that was done during the Iona Island MMRP RI Report in 2020, vertical depth of contaminated sediment is based on the assumed depth to bedrock, which is based on shoreline bathymetric data (3 feet). The volume of associated contaminated sediment is therefore estimated to be 2,733 cubic yards.

Sediment of the Hudson River shoreline primarily consists of medium sand with lesser amounts of coarse sand, fine sand, and gravel, and was classified using the Unified Soil Classification System (ASTM 2000) as SP (poorly graded sand). Based on the density of dry sand (100 pounds per square foot) and wet sand (120 pounds per square foot), contaminated sediment is estimated to range from 3,690 to 4,428 U.S. tons (**Table 3-4**).

Table 3-1. Summary of Contaminants of Concern for Receptor Category by Media

Area of Concern and Media	Receptor Category	Contaminants of Concern
Former Dump Area Hydric Soil	Ecological Receptors (plants, soil invertebrates, insectivorous mammals, insectivorous birds, and herptiles)	Chromium, copper, lead, mercury, zinc
Iona Island Hudson River Shoreline Sediment	Human Receptors (Recreational users)	Lead
	Ecological Receptors (plants, benthic invertebrates, demersal fish, herptiles and insectivorous birds)	Antimony, cadmium, copper, lead, nickel and zinc

Table 3-2. Lead Concentrations in Soil Compared to Federal and State Screening Criteria and Property-Specific Background Concentrations

Location[a]	Range of Lead Detections (mg/kg)	PRG for Lead (mg/kg)			
		EPA Region 4 Ecological Screening Value[b]	ISM Sampling Background 95UCL[c]	NYSDEC Unrestricted Use and Protection of Ecological Resources SCO [d]	NYSDEC Residential Use SCO [d]
DU-17 Surface Soil	1,200 to 2,900	11	82.1	63	400
DU-17 Subsurface Soil	820 to 2,700				
DU-18 Surface Soil	1,400 to 1,500				
DU-18 Subsurface Soil	2,000 to 2,900				
DU-19 Surface Soil	38 to 67				
DU-19 Subsurface Soil	1 to 14				

Notes:
[a] Surface soil collected from 0-6 inches bgs. Subsurface soil collected at 6 to 36 inches bgs.
[b] As presented in EPA Region 4 ERA Supplemental Guidance, Scientific Support Section Superfund Division EPA Region 4, March 2018 (EPA 2018).
[c] As presented in the RI Report (USACE 2024b).
(d) As defined in 6 NYCRR Part 375 Environmental Remediation Programs SCOs (NYSDEC 2006).
DU = decision unit
EPA = U.S. Environmental Protection Agency
ISM = incremental sampling methodology
mg/kg = milligram(s) per kilogram
NYSDEC = New York State Department of Environmental Conservation
PRG = preliminary remediation goal
SCO = soil cleanup objective
UCL = upper confidence limit

Table 3-3. Lead Concentrations in Sediment Compared to Federal Screening Criteria and Property-Specific Background Concentrations

Location	Range of Lead Detections (mg/kg)	PRG for Lead (mg/kg)	
		EPA Region 4 Ecological Screening Value for Sediment (EPA 2018)	ISM Sampling Background 95UCL (USACE 2024b)
Hudson River Shoreline Sediment	7,700 to 14,000	35.8	67.4

Notes:
EPA = U.S. Environmental Protection Agency
ISM = incremental sampling methodology
mg/kg = milligram(s) per kilogram
PRG = preliminary remediation goal
UCL = upper confidence limit
USACE = U.S. Army Corps of Engineers

Table 3-4. Estimated Volume and Weight of Contaminated Soil and Sediment

Location	Media	Area (Acres)	Area (Square Feet)	Depth (Feet)	Estimated Volume (Cubic Yards)	Estimated Weight Dry (US Tons)[(a)]	Estimated Weight Saturated (US Tons)[(b)]
Former Dump Area	Soil	1.10	48,096	3	5,344	7,214	8,657
Hudson River Shoreline	Sediment	0.56	24,596	3	2,733	3,690	4,428
	Total	1.66	72,692	3	8,077	10,904	13,085

Notes:
[(a)] Assumes dry sand based on grain size analysis from the RI (density of 100 pounds per cubic foot)
[(b)] Assumes saturated sand based on grain size analysis from the RI (density of 120 pounds per cubic foot)

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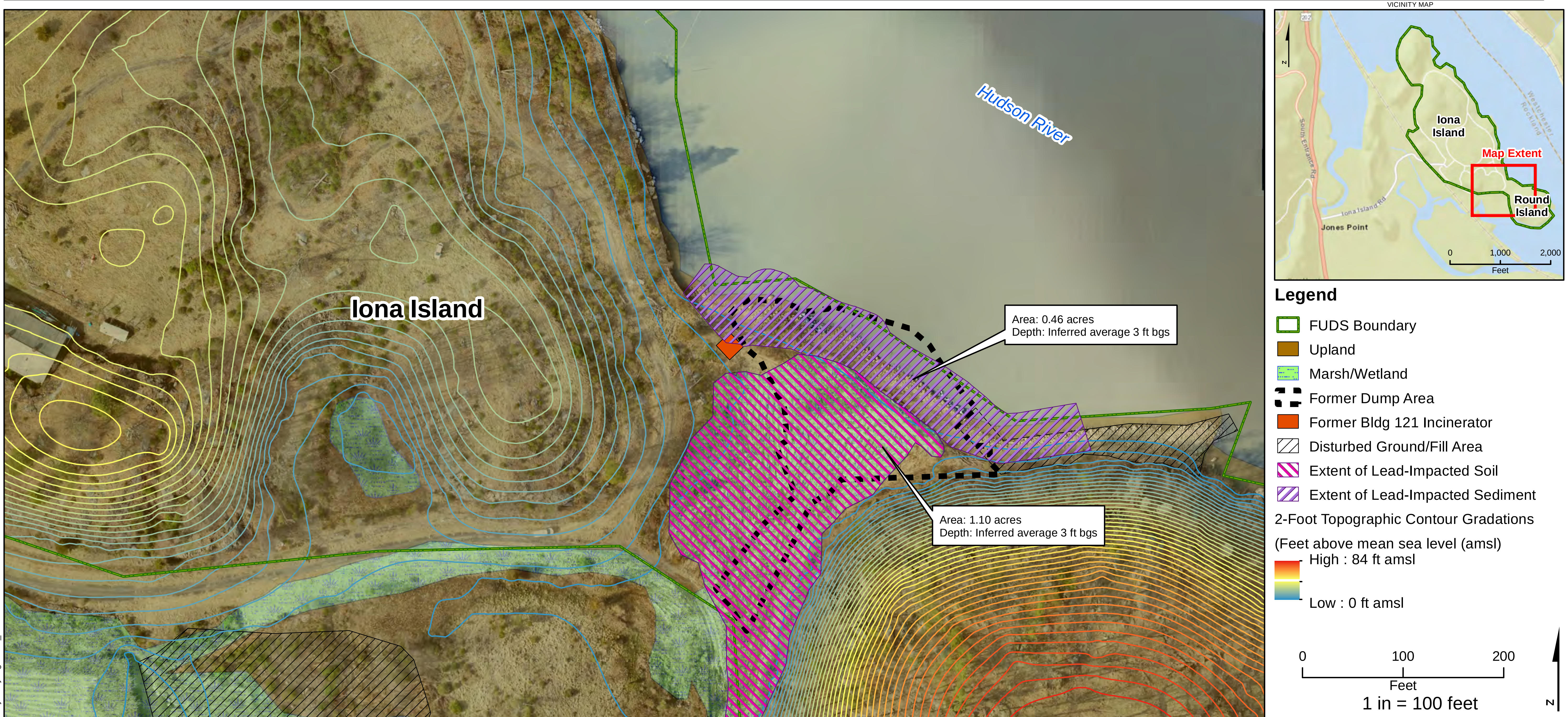

FIGURE 3-1
Extent of Lead-Impacted Soil and Sediment

HAZARDOUS TOXIC AND RADIOACTIVE WASTE FEASIBILITY STUDY

Source
Aerial: EA Engineering, Science, and Technology. April, 7 2020
Disturbed Ground/Fill Area and AOC Boundary: USAGC 2018
Upland and Marsh/Wetland: 2020 EA Shoreline Reconnaissance
Map Date: 8/2/2024

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4. IDENTIFICATION AND SCREENING OF TECHNOLOGIES

The purpose of this section is to identify GRAs, alone or in combination with each other, that will achieve the RAOs for the Property. This section also identifies specific technologies and process options, and screens these for each GRA against the criteria of effectiveness, implementability, and cost. This section does not discuss the alternatives evaluation that is included in Section 5 (i.e., no action). Those technologies and process options that are retained through the screening process are assembled into specific, comprehensive RAOs (Section 5).

4.1 GENERAL RESPONSE ACTIONS

GRAs are those actions that may be taken to satisfy the RAOs for the Property. GRAs are developed for each medium of interest and can include, but are not limited to, treatments, extraction, institutional controls, or a combination of these. These actions will address the RAOs by either reducing the COC concentrations or by preventing exposure to COCs in environmental media. Volumes or areas of media (i.e., Former Dump Area, Hudson River shoreline, etc.) are identified in this FS for which the GRAs are applicable. GRAs consider the requirements for protectiveness as identified in the RAOs and the chemical and physical characterization of the Property. Based on the results of the HHRA and ERA, lead in soil at the Former Dump Area and in Hudson River shoreline sediment in the vicinity of the Former Dump Area is the risk-driving COC for this site.

Appropriate GRAs were selected based on the media of concern and COCs identified in Section 3.1. The HHRA and ERA determined that risk to human health and ecological receptors was driven by exposure to lead in soil within the Former Dump Area and Hudson River shoreline sediment in its vicinity. The Former Dump Area represents an ongoing source area due to the presence of ash from the former on-site incinerator. Therefore, GRAs were determined primarily by the existence of presumptive remedies for lead in soil and sediment (i.e., treatment and/or removal) (EPA 1996). Five GRAs were identified for implementation to address contaminated soil and sediment as follows:

- Land use controls
- Excavation and off-site disposal
- Excavation and ex situ treatment
- In situ treatment
- Containment

By matching appropriate GRAs with the RAOs, a list of preliminary remedial technologies were developed. One or more technologies may be considered within each GRA category.

Table 4-1 presents methods of action, technology types, and process options that may be applicable to the Iona Island Naval Ammunition FUDS from which potential remedial alternatives can be identified and screened.

4.1.1 Land Use Controls

Land use controls (LUCs) are any type of physical, legal, or administrative mechanism that restrict the use of or limit access to real property to prevent or reduce risks to human health and the environment. Physical mechanisms encompass a variety of engineered remedies to contain or reduce contamination (soil caps, vertical barriers) and physical barriers to limit access to property, such as fences. The legal mechanisms can include restrictive covenants and deed notices. Administrative mechanisms include notices, educational materials, or other land use management systems to ensure compliance with use restrictions. USACE does not have authority to implement, maintain, or enforce LUCs related to real property ownership or to the imposition of governmental controls because FUDS are not under DoD jurisdiction for purposes of control of the property usage; however, because this property is owned by New York State, the State could implement and enforce an Environmental Easement on a portion of the property if needed. LUCs involve a combination of engineering controls and institutional controls, with educational controls as a subset to institutional controls.

Engineering Controls**—**Physical controls are measures that prevent or discourage access to areas with contaminated media, thereby mitigating the potential for exposure. Examples of engineering controls for human receptors include fencing, soil caps, and vertical barriers. Exposure of select ecological receptors to contaminated media may be minimized or prevented through use of engineering controls depending on the receptors and the type of engineering controls implemented (i.e., fine mesh fencing).

Institutional Controls**—**Institutional controls involve government controls, proprietary controls, and educational controls. Governmental controls are those controls within the power of a governmental unit (local, state, federal) that restrict the interaction of receptors with the contamination. Examples of government controls include zoning, well restrictions, permitting, and dig permits. Proprietary controls are those administrative controls within the power of a landowner under state law that restrict the interaction of receptors with the contamination, and examples include deed restrictions, environmental covenants, and easements. Educational controls are those administrative controls that inform or educate possible visitors of the danger of the contamination so that they may voluntarily self-restrict their interaction with the contamination. Examples include the distribution of education pamphlets and flyers, signs, webpages, emails, letters, and training to provide human receptors with knowledge of contaminated media and potential exposure risks.

4.1.2 Excavation and Off-site Disposal

This GRA involves the physical removal of soil and sediment, with off-site disposal as either hazardous or non-hazardous waste. Excavation can involve removal of all impacted soil and sediment or the selective removal of a “hot spot.” Based on the metal concentrations of soil/sediment, it is assumed that excavated waste will be hazardous. Disposal involves transporting the soil to a Toxic Substances Control Act permitted disposal facility or Municipal Solid Waste Landfill or Resource Conservation and Recovery Act Subtitle D Non-Hazardous Landfill.

4.1.3 Excavation and Ex-Situ Treatment

Ex situ treatment of soil involves the removal of soil and sediment followed by the application of treatment technologies to transform, destroy, or immobilize the targeted constituents. Chemical stabilization and soil washing were identified as technologies corresponding to the ex situ treatment GRA.

***Chemical Stabilization*—**This technology involves use of amendments that are mixed with soil and sediment to prevent the leaching of COCs through the formation of insoluble compounds.

***Soil Washing*—**This technology involves removal of COCs by chemical treatment methods in aqueous suspension. Chemical treatment involves the addition of extraction agents to excavated soil and sediment in a mixing vessel. Extraction agents react with COCs and leach them from the soil into a solution that is then disposed of off-site. Treated soil is then returned to the excavation area. The type of extractant used depends on the COCs and the characteristics of the soil and sediment matrix. Extractants for metals may include chelating agents, oxidizing and reducing agents, acids, and surfactants.

4.1.4 In Situ Treatment

This GRA involves treatment of soil in situ (in place) without needing to physically move contaminated material. Common treatment methods include physical, chemical, or biological mechanisms for reducing the concentrations, mobility, or bioavailability (i.e., availability for uptake by plants or animals) of contaminants. Bioremediation (phytoremediation), stabilization/solidification, vitrification, and soil flushing were identified as technologies corresponding to the in situ treatment GRA.

***Phytoremediation*—**This technology uses bio uptake into plants to remove and remediate COCs from soil and sediment. Phytoremediation can be achieved by phytoextraction (uptake of contaminants by plant roots with accumulation in plant tissues) and phytosequesteration (immobilization of contaminants within the root zone, limiting migration).

***Encapsulation by Solidification*—**This technology uses a binding agent (i.e., cement, asphalt, etc.) mixed with soil and sediment to encapsulate contaminated material in place and thus reduce the potential for leaching and contaminant mobility.

***Vitrification*—**This technology uses electrodes installed in the ground to introduce an electrical current and transform the contaminated soil and sediment to an inert, solid form (e.g., glass). Contaminated media are heated to temperatures exceeding 2,000 degrees Fahrenheit, the media solidify, and the contamination within the treated area is transformed and is no longer mobile or available.

In Situ Soil Flushing**—**This technology uses water or other suitable aqueous extracting solutions to flush contaminants from soil and sediment. Extracting agents may include chelating agents, oxidizing/reducing agents, acids/bases, and surfactants. The extracting agent solution is applied to the surface to mobilize COCs, usually by solubilization. The resulting fluid is then extracted in situ using pump-and-treat methods for off-site disposal or treatment.

4.2 DEVELOPMENT AND SCREENING OF TECHNOLOGIES

The first step in developing remedial alternatives is to examine a variety of available remedial technologies and to identify those technologies that warrant further consideration based on the applicability of the technology for the Property-specific conditions and COCs. Following the screening of technologies, remedial alternatives are assembled. The primary focus of this screening evaluation is on the effectiveness. A qualitative assessment of the implementability (both technical and administrative feasibility) and general cost of the technologies is also performed.

Effectiveness**—**This evaluation focuses on the effectiveness of the technology to treat or contain contaminated media and thus meet RAOs, the potential impacts to human health and the environment resulting from implementation of the technology, and the reliability of the technology considering the COCs and Property-specific conditions. Technologies that do not provide adequate protection of human health and the environment may be eliminated from further consideration. In addition, technologies that offer significantly less effectiveness than other technologies/process options may be eliminated from the alternative development process.

Implementability**—**The implementability evaluation includes both the technical and institutional (administrative) feasibility of implementing each technology. This evaluation places emphasis on the availability of equipment, materials, and personnel to perform the technologies and eliminates technology types that are clearly ineffective or unworkable at the Property. Technologies that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period may be eliminated from further consideration.

Cost**—**The cost criterion is used in a more limited role to screen the technologies. Relative costs are used in lieu of detailed estimates. This evaluation is used to compare costs for process options within the same technology. At this stage in the evaluation, costs are generalized as low, moderate, or high. Detailed costing is included in the detailed analysis of alternatives in Section 6.0.

4.2.1 Land Use Controls (Retained)

LUCs involve a combination of engineering controls (capping/barriers), and/or institutional controls (environmental easements and educational controls) to limit potential exposure routes to human health and ecological receptors.

4.2.1.1 Capping

Capping would consist of installation of a minimum 3-foot soil cover or cap over contaminated soil or sediment, vegetated with native plant species.

Effectiveness

A cap would not include treatment or removal of contaminated soil within the Former Dump Area, or sediment along the Hudson River shoreline in its vicinity. Contaminated media would be left in place, and a soil cover or cap would be installed to prevent potential surficial migration of contaminants in soil from the Former Dump Area to the Hudson River shoreline. The cap would need to be designed, inspected, and maintained due to twice-daily tidal inundation of the low-lying marsh area between Iona and Round Island. A cap could be a component of a solution to fully contain contaminated soil or sediment. When properly implemented in conjunction with other controls, capping would achieve the RAOs for human health exposure and the environment. Potential short-term impacts to human health may exist when installing vertical barriers, but these impacts can be minimized through the use of best management practices and appropriate personal protective equipment (PPE).

Implementability

Caps are commonly used and can be implemented with owner support. Construction equipment for the installation of soil caps is readily available; however, installation of a soil cover/cap would be challenging due to the twice-daily tidal inundation of the marsh area and Hudson River shoreline. The use of a cofferdam or other barrier during construction would support successful installation. Design of a soil cover or cap would need to account for potential erosion of soil due to tidal inundation and storm events, and erosion of sediment due to tidal fluctuations, currents, and wave action. Prior to soil cover/cap installation, an evaluation would be needed to determine appropriate capping material for soil and sediment. Capping material would need to be transported to and staged at the Property. The majority of the upland area of Iona Island is open space, and there is available room for on-site staging.

Cost

A cap is expected to have high capital costs and operation and maintenance (O&M) costs due to the location in a tidal marsh area on the Hudson River. O&M costs include periodic inspections, regular cap maintenance, and reporting. The duration of implementation has a significant impact on the total costs.

Summary

A cap would not treat contaminated soil within the Former Dump Area or sediment along the Hudson River shoreline in its vicinity but would be a component of a control to contain contaminants, which would be left in place, thereby reducing human health and ecological risks.

4.2.1.2 Vertical Barrier

Vertical barriers would be installed along the Hudson River shoreline adjacent to the low-lying marsh area between Iona and Round Island to prevent migration of contaminants to the Hudson River.

Effectiveness

A vertical barrier would not treat or remove contaminated soil within the Former Dump Area, or sediment along the Hudson River shoreline in its vicinity. Contaminated media would be left in place, and vertical barriers would be a component of a solution to prevent potential migration of contaminants in soil from the Former Dump Area to the Hudson River shoreline. Vertical barriers would need to be designed, inspected, and maintained to withstand twice-daily tidal fluctuations and prevent inundation of the contaminated media. When properly implemented in conjunction with other controls, vertical barriers would achieve the RAOs for human health exposure and the environment. Potential short-term impacts to human health may exist when installing vertical barriers, but these impacts can be minimized through the use of best management practices and appropriate PPE.

Implementability

Vertical barriers are commonly used and can be implemented with owner support. Construction equipment for the installation of vertical barriers is readily available; however, installation of a vertical barrier would be challenging due to the twice-daily tidal inundation of the marsh area and Hudson River shoreline. The use of a cofferdam or other temporary barrier during construction would support successful installation. Design of a vertical barrier would need to account for wear due to tidal inundation and storm events, as well as freeze-thaw cycles, heat stress, and substrate erosion, which would compromise the integrity of the barrier over time.

Cost

A vertical barrier is expected to have high capital costs and O&M costs due to the location in a tidal marsh area on the Hudson River. O&M costs would consist of periodic inspections, regular cap maintenance, and reporting. The duration of implementation has a significant impact on the total costs.

Summary

A vertical barrier would not treat contaminated soil within the Former Dump Area or sediment along the Hudson River shoreline in its vicinity but would be a component of a control to contain contaminants, which would be left in place, thereby reducing human health and ecological risks.

4.2.1.3 Fencing

Fine mesh fencing would be installed and maintained along the perimeter of the low-lying area between Iona and Round Island (location of the Former Dump Area) and along the Hudson River shoreline in the vicinity of the Former Dump Area.

Effectiveness

Fencing would prevent human and some ecological receptors from coming into contact with the Former Dump Area to the Hudson River shoreline. Fine mesh fencing can reduce or prevent exposure to contaminated soil and sediment for some species. However, these process options alone will not address exposure to all ecological receptors. (For example, fine mesh fencing would not apply to plants, soil invertebrates, and benthic invertebrates.)

Implementability

Fencing would require the placement of structures and framing to support fencing. Periodic inspections and maintenance of LUCs would be required to ensure continued protection of human health and ecological receptors.

Costs

Fencing would have low capital costs. Long-term O&M costs would consist of annual inspections and occasional repair of fencing, as needed.

Summary

Fencing would be a component of a control to prevent human and some species from coming into contact with contaminated media, thereby reducing human health and ecological risks.

4.2.1.4 Institutional Controls

Institutional controls would consist of governmental, proprietary, and educational controls intended to limit the use of the site to activities that will not disturb contaminated media. Governmental and proprietary controls are those administrative controls within the power of the government and Property owner, respectively. Educational controls would include development of informational signs and pamphlets, which would be distributed to the landowner and to the public through the use of outdoor literature boxes. One literature box would be placed at each entrance or access point to the site, including by land and by water. Pamphlets and signs would identify contaminated media and detail exposure risk. Signs would be placed every 100 feet along the perimeter fence and with each literature box.

Effectiveness

Institutional controls would be intended to restrict human interaction with contamination that would remain in place. When properly implemented, institutional controls would achieve the RAOs for human health exposure but would not address ecological risks.

Implementability

Institutional controls are standard legal mechanisms that are implemented regularly; however, FUDS are not under DoD jurisdiction. Therefore, implementation of institutional controls would depend on landowner cooperation.

Costs

Costs would be low and would include up-front legal fees and development of documents associated with institutional controls (e.g., a Land Use Control Implementation Plan).

Summary

Institutional controls would not reduce site contaminants but would address human health exposure risks to contamination remaining on site.

4.2.2 Excavation (Retained)

Soil in the low-lying marsh between Iona and Round Island (location of the Former Dump Area) and Hudson River shoreline sediment in its vicinity would be excavated and removed. Physical removal of impacted soil could be accomplished through excavation, while affected sediment could be removed by excavation, dredging, or a combination of both. As soil and sediment are saturated to ground surface, dewatering of excavation areas may be required.

Effectiveness

Excavation is an effective technology to remove the impacted media for treatment or disposal. This process option is effective in the long term because it removes impacted soil and sediment, thus meeting the RAOs.

Potential impacts to human health and the environment exist during excavation due to exposure to contaminated soil and sediment, dust generation, and erosion created by excavation activities in the short term. Controls for dust and erosion would be implemented to address these impacts. Transportation of excavated material would increase traffic on-site.

Implementability

Excavation would be implementable to the extent that the required access is granted by the Property owner. Soil removal is generally performed by excavation using standard conventional earth-moving equipment (i.e., excavators). An amphibious excavator may be necessary for soil excavation due to the twice-daily tidal inundation of the marsh area and Hudson River shoreline. Sediment removal can be performed by excavation using an amphibious excavator, mechanical dredging, and/or hydraulic dredging. Excavation (inclusive of dredging) is a common remedy and is relatively straightforward and implementable, equipment is readily available, and the process is a well-established technology. Additionally, the required personnel to perform excavation can be readily obtained.

As soil and sediment are saturated to ground surface, dewatering of excavation areas may be required. Dewatering involves pumping water to temporarily lower water levels to allow excavation in dry and stable conditions. Dewatering may be difficult due to the twice-daily tidal inundation of the marsh area and Hudson River shoreline. This action may require the installation of temporary cofferdams and the establishment of a dewatering facility and treatment of removed water. It is anticipated that all activities that will entail disturbance or excavation will require the installation of a cofferdam to protect the construction area from tidal inundation and the river from sedimentation, and sediment erosion control measures such as silt socks and/or straw waddles to help retain sediment. These measures will be written into the sediment and erosion control plan along with other “best management practices” that will also be reviewed by stakeholders.

It is noted that without ex situ treatment prior to off-site disposal, waste characterization sampling would need to be conducted to determine whether excavated material can be disposed of off-site as either hazardous or non-hazardous waste.

Costs

Excavation would be associated with high capital costs. Excavation can be relatively inexpensive for shallow soil and sediment; however, dewatering can be expensive.

Summary

Excavation is a technically implementable and reliable technology, and it was retained for further evaluation. It is assumed that alternatives with excavation would include backfilling and re-planting with native species.

4.2.3 Ex situ Treatment On-site (Retained)

Ex situ treatment refers to remedial techniques for contaminated soil and sediment that involve excavating the material and treating it above ground. Soil in the low-lying marsh between Iona and Round Island (location of the Former Dump Area) and sediment in the Hudson River shoreline in its vicinity would be excavated and treated on-site using the treatment options described in the subsections below.

4.2.3.1 Chemical Stabilization (Retained for Treatment Prior to Off-site Disposal).

Chemical stabilization would require the excavation, on-site staging, and treatment of excavated soil and sediment with the addition of chemical amendments (e.g., soluble phosphate). Excavated material would be transferred to an on-site staging area, and stockpiled soil would be covered prior to treatment. Treated material would either be placed back in the excavation area after treatment or transported to an off-site disposal facility for disposal as non-hazardous waste.

Effectiveness

Chemical stabilization is generally reliable in preventing migration of contaminants and is effective for long-term source control. Effectiveness depends on the degree to which the amendment is delivered to the excavated material and whether uniform mixing is achieved. However, chemical stabilization does not reduce the contaminant volume, nor does it prevent exposure through direct contact with soil and sediment unless used in conjunction with containment. Therefore, if treated material is returned to the excavation area without containment, RAOs for human health and the environment would not be achieved.

Potential impacts to human health and the environment exist during excavation due to exposure to contaminated soil and sediment, dust generation, and erosion created by excavation activities in the short term. Controls for dust and erosion would be implemented to address these impacts. Chemical stabilization would not adversely impact human health or the environment, other than the potential short-term exposures for workers during treatment. Transport of excavated and treated material to and from the on-site staging area would increase traffic on-site.

Implementability

Excavation and on-site treatment would be implementable to the extent that the required access is granted by the Property owner. Bench-scale testing would be required to evaluate the applicable immobilization technology relative to site conditions. Chemical treatment requires import and availability of suitable stabilization amendments, staging of amendments on-site, and mixing of amendments into excavated material. As the majority of the upland area of Iona Island is open space, there is available room (approximately one acre would be needed) for on-site staging and treatment of excavated soil and sediment. Therefore, ex situ chemical stabilization is considered feasible. Excavated material may require dewatering prior to addition of amendments.

Costs

Chemical stabilization would be associated with high capital costs. Excavation can be relatively inexpensive for shallow soil and sediment. Chemical treatment has moderate to high costs associated with bench scale testing and the need to procure suitable stabilization amendments. However, treatment allows for material to be either returned to the excavation area or disposed of off-site as non-hazardous waste, thus eliminating or reducing disposal costs.

Summary

Chemical stabilization is implementable at the Property. However, if treated soil is returned to the excavation area without containment, RAOs would not be achieved. Therefore, returning treated soil to the excavation area is not considered feasible and for this circumstance, it was not retained for further consideration. Ex situ chemical stabilization was only retained for further consideration when used prior to off-site disposal (i.e., to reduce off-site disposal costs).

4.2.3.2 Soil Washing (Not Retained)

Soil washing would require excavation of soil and sediment and treatment of excavated material by addition of extracting agents in a mixing vessel. Once treated, leachate would be disposed of off-site, and treated soil would be staged on-site prior to returning to the excavation area.

Effectiveness

Soil washing would remove COCs from excavated soil and sediment and thus prevent direct contact with impacted media and future migration of contaminated soil from the Former Dump Area to the Hudson River shoreline.

Potential impacts to human health and the environment exist during excavation due to exposure to contaminated soil and sediment, dust generation, and erosion created by excavation activities in the short term. Controls for dust and erosion would be implemented to address these impacts. Treatment involves the use of potentially hazardous chemicals to remove COCs; therefore, on-site staging and use of these chemicals could adversely impact human health and/or the environment. Transport of excavated and treated material to and from the on-site staging/treatment area would increase traffic on-site.

Soil washing can remove vital nutrients from soil and sediment and thus change soil and sediment properties. Returning treated soil and sediment to the excavation area between Iona and Round Island (location of the Former Dump Area) may not allow this area to continue to function as a wetland even if the area is replanted with native wetland species.

Implementability

Excavation would be implementable to the extent that the required access is granted by the Property owner. The majority of the upland area of Iona Island is open space, and there is available room for on-site staging and treatment of excavated soil and sediment. However, soil washing is difficult to implement as it requires bench-scale studies to determine appropriate extraction agents, import and availability of extraction agents, maintenance of specialized equipment, establishment of a designated treatment facility using potentially hazardous chemicals to remove COCs, and disposal of leached fluids. Treatment requires a long timeframe for implementation, and the rate of treatment may limit the rate of excavation. Flushing fluids may need treatment to meet appropriate disposal standards.

Costs

Soil washing would be associated with high capital costs and low O&M costs. Excavation can be relatively inexpensive for shallow soil and sediment. Soil washing has high costs associated with bench scale testing, procurement of suitable extraction agents, use of specialized equipment and a designated treatment facility, and off-site disposal of leached fluids. Separation of solvents from recovered flushing fluid for reuse in the process is a major factor in the cost of soil flushing.

Summary

Soil washing is not considered feasible as it is difficult and costly to implement. This process option was not retained for further consideration.

4.2.4 In Situ Treatment

Soil in the low-lying marsh between Iona and Round Island (location of the Former Dump Area) and Hudson River shoreline sediment in its vicinity would be treated in place on-site using the treatment options described in the subsections below.

4.2.4.1 Phytoremediation (Not Retained)

Phytoremediation would use bio uptake into plants to remove and remediate COCs from soil within the Former Dump Area. The low-lying marsh area between Iona and Round Island would be cleared of current vegetation and replanted with appropriate wetland plant species capable of accumulating lead. The marsh area would be maintained and undisturbed to allow plants to grow. Plants would be harvested at the end of the growing season for disposal and replanted for the subsequent growing season.

Effectiveness

Phytoremediation is generally used for lower levels of contamination than what exists in soil of the Former Dump Area. Effectiveness is limited to growing season length, and multiple growing seasons would be needed for RAOs to be achieved. Treatment would require a long time-frame and would need to be used in conjunction with another process option to reduce exposure to human and ecological receptors during implementation.

Phytoremediation may not be effective for sediment. The sandy sediment lacks organic matter, and there may be a lack of sufficient habitat to allow for growth of aquatic plants.

During the implementation period there would be risks associated with contact to COCs to workers implementing the remedy and others who could potentially come in contact with soil and sediment unless used with another process option such as engineering controls.

Implementability

Phytoremediation is easy to implement. Following the clearing of existing vegetation, phytoremediation would require planting of appropriate species, maintaining plants during the growing season, subsequent harvest for disposal, demonstration of natural processes causing attenuation, and subsequent monitoring. Implementability would be dependent on the overall potential toxicity to plants, growing season length, and the number of successful growing seasons. Phytoremediation of Hudson River shoreline sediment may not be implementable as the sandy sediment lacks organic matter, and there may be a lack of sufficient habitat for aquatic plants.

Costs

Phytoremediation would be associated with low capital costs and moderate O&M costs associated with procuring, planting, harvesting, and disposing of wetland plants each growing season; demonstration of natural processes causing degradation; and subsequent monitoring of contaminants in soil.

Summary

Due to the high concentrations of lead and other metals in soil, the lack of aquatic plant habitat along the Hudson River shoreline, and the long timeframe to reach RAOs, phytoremediation is not considered feasible. Therefore, phytoremediation was not retained for further consideration.

4.2.4.2 In Situ Solidification/Stabilization (Not Retained)

Use of in situ solidification/stabilization (ISS) would require mixing of a binding agent (i.e., cement, asphalt, etc.) with soil within the low-lying marsh area between Iona and Round Island (location of the Former Dump Area) and Hudson River shoreline sediment in its vicinity.

Effectiveness

ISS does not lessen the volume and toxicity of hazardous wastes, but it does lessen their mobility, prevent direct contact by receptors, and reduce migration of contaminants encased in the solid matrix. ISS is effective in meeting the RAOs because it encases/binds contaminants in a solid matrix, which prevents human and ecological receptors from directly contacting contaminated media. It is reliable if the binding agent successfully binds contaminants and the solid matrix retains its structure.

ISS is most effective where the contaminated media are isolated above the water table, which limits the mobility of COCs. The low-lying marsh area between Iona and Round Island and the Hudson River shoreline in its vicinity is inundated with water twice daily during high tide and during storm events. Soil and sediment are saturated to ground surface. The high water content of soil and sediment can interfere with the solidification process by inhibiting bonding of the waste to the binding material, slowing the setting of the mixtures, decreasing the stability of the matrix, or reducing the strength of the solidified area. In addition, tidal inundation, weathering, and freeze/thaw cycles can compromise integrity of the solidified mass over time and increase the potential for leaching of contaminants.

Potential impacts to human health exist during treatment due to exposure to contaminated soil and sediment in the short term. ISS causes significant changes to soil and sediment properties and an increase in the volume of material. As such, ISS would not allow this area to continue to function as a wetland.

Implementability

ISS is commonly used to treat contaminants in situ and is a well-established technology. ISS would be implementable to the extent that the required access is granted by the Property owner.

With regards to feasibility, ISS would be challenging at the Property. Bench scale testing would be required to select the appropriate binding material for the Property and to assess the medium volume increase that will occur due to the addition of the binding agent and soil mixing. ISS requires import and availability of suitable binding agent, staging of material on-site, and mixing of the binding agent into soil and sediment in place using standard construction equipment (i.e., excavators, auger). The majority of the upland area of Iona Island is open space, and there is available room for on-site staging. However, implementation of in situ mixing would require working around the twice-daily tide cycles and monitoring to evaluate effectiveness.

Costs

ISS is associated with moderate to high capital costs and low O&M costs associated with the need to procure suitable binding agents and deliver the binding agents to soil and sediment.

Summary

ISS would be difficult to implement at the Property due to twice-daily tidal inundation. High water content of soil and sediment can interfere with solidification and compromise stability and strength of the solidified area, and weathering and freeze/thaw cycles can compromise long-term integrity. In addition, following treatment, the low-lying marsh area between Iona and Round Island (location of the Former Dump Area) would not continue functioning as a wetland. Therefore, ISS was not retained for further consideration.

4.2.4.3 Vitrification (Not Retained)

Vitrification would require installation of an electricity supply system, high voltage electrodes into soil and sediment, a vapor extraction pipeline system, and a gas treatment system and air emissions control system prior to implementation. The residual material resulting from vitrification is a mass of vitrified soil and sediment that remains in place following the treatment. This mass can take up to 1 or 2 years to cool completely

Effectiveness

Vitrification is effective for near-surface and surface soil and sediment and applies to all COCs at the Property. The vitrification process produces a glass product that is chemically stable and leach-resistant. Vitrification would achieve RAOs for human health and ecological receptors by preventing direct contact with COCs and preventing the migration of contaminants to the Hudson River shoreline. In addition, vitrification would prevent migration of contaminants from soil of the Former Dump Area to Hudson River shoreline sediment in its vicinity.

Production of a mass of vitrified soil would significantly alter the habitat of the low-lying marsh area between Iona and Round Island and would not allow this area to continue functioning as a wetland. In addition, erosion and weathering can affect the stability of the vitrified material over time.

Vitrification requires the installation and use of high-voltage lines, which presents a potential danger to human health during implementation. Treatment of wet soil and sediment will result in production of steam and spatter of molten material, which can present hazards to workers. Heat used in the vitrification process can destroy toxic compounds by producing secondary compounds, resulting in a release of toxic gases on the soil surface. Toxic gases would need to be captured on the soil surface and treated.

Implementability

A Property-specific treatability study would be needed to establish applicability and project the likely performance of in situ vitrification. Vitrification requires a large amount of energy and long timeframe for implementation. There is electric power to some of the remaining buildings on Iona Island, but there is no electric conveyance in the Former Dump Area. Implementability may be difficult at the Property due to twice-daily tidal inundation and the presence of saturated soil and sediment. Vitrification is applicable to any type of soil and sediment; however, it is not typically used on soil and sediment with high water content, as additional energy is required. In addition, treatment of saturated soil and sediment can result in health and safety hazards due to production of steam and spatter of molten material.

Implementation of in situ vitrification requires installation of electrical infrastructure and specialized equipment, addition of stabilizing agents (alkaline compounds such as sodium, potassium oxides, etc.), high energy consumption, and capture and treatment of gaseous emissions resulting from the vitrification process. Additional evaluation/pilot testing would need to be conducted prior to mobilization to determine soil and sediment properties that could impact the vitrification process (i.e., water content, thermal conductivity, mineralogical content) and methodology to prevent tidal inundation. In addition, monitoring and analysis of the soil and sediment matrix would need to be conducted to determine the type of vitreous material being formed, and the need for additional stabilizing agents to ensure success of the vitrification process.

Costs

Vitrification is associated with high capital costs and low O&M costs due to the need for specialized equipment and the high energy costs. Costs for vitrification increase with moisture content.

Summary

Vitrification has short-term risks to workers, requires a large amount of energy, would be difficult to implement, would have high capital costs, and would significantly alter the habitat of the low-lying marsh area between Iona and Round Island, which would not allow the area to continue functioning as a wetland. Therefore, vitrification was not considered feasible, and this process option was not retained for further consideration.

4.2.4.4 In Situ Soil Flushing (Not Retained)

In situ soil flushing would require application of extracting agents to soil within the low-lying area between Iona and Round Island and Hudson River shoreline sediment in its vicinity, extraction of resulting fluid using pump-and-treat methods, and off-site disposal of resulting fluids.

Effectiveness

In situ soil flushing is dependent on Property-specific properties, such as hydraulic conductivity and permeability, that will influence the effectiveness of extractants in mobilizing contaminants and the recovery of the resulting fluid. A Property-specific treatability study would be needed to establish applicability and project the likely performance of in situ soil flushing.

Treatment involves the use of potentially hazardous chemicals to remove COCs; therefore, on-site staging and use of these chemicals could adversely impact human health or the environment. In addition, soil flushing can remove vital nutrients from soil and sediment and alter the physical and chemical properties of soil and sediment. This would significantly alter the habitat of the low-lying marsh area between Iona and Round Island.

Implementability

In situ soil flushing is difficult to implement, and a bench-scale study would need to be completed prior to implementation to determine appropriate extraction agents. In addition, in situ flushing would be difficult to implement due to the approximate bedrock depth of only 3 feet. A Property-specific treatability study would need to be conducted to determine applicability and effectiveness. Soil flushing requires installation of injection wells to apply extraction agents, installation of extraction wells to remove leached fluids, use of potentially hazardous chemicals to remove COCs, monitoring to evaluate effectiveness, and disposal of leached fluids. Implementation at the Property may be difficult due to twice-daily tidal inundation. Flushing fluids may need treatment to meet appropriate discharge or disposal standards.

Costs

In situ soil flushing would be associated with high capital costs and low O&M costs. Soil flushing has high costs associated with bench scale testing, procurement of suitable extraction agents, installation of injection and extraction wells, monitoring, and off-site disposal of leached fluids. Separation of solvents from recovered flushing fluid for reuse in the process is a major factor in the cost of soil flushing.

Summary

In situ soil flushing is not considered feasible, as it would be difficult to implement, could result in adverse effects to human health and the environment during implementation, would significantly alter the habitat of the low-lying marsh area between Iona and Round Island, and has high costs. Therefore, soil flushing was not retained for further consideration.

4.2.5 Off-site Disposal (Retained)

Soil in the low-lying marsh between Iona and Round Island (location of the Former Dump Area) and Hudson River shoreline sediment in its vicinity would be excavated and removed as described in Section 4.2.2. Excavated material would be placed directly onto trucks, transported to an off-site facility authorized to accept the waste stream, and disposed of as hazardous waste and/or non-hazardous waste.

Effectiveness

Off-site disposal would effectively remove contaminated soil and sediment from the property and would thus prevent direct contact with impacted media and future migration of contaminated soil from the Former Dump Area to the Hudson River shoreline. This process option is effective in the long term because it removes impacted soil and sediment, thus meeting the RAOs.

Implementability

Disposal would be implementable and would require identification of an off-site facility capable of accepting material. Excavated material may require dewatering prior to off-site disposal.

It is noted that without ex situ treatment prior to off-site disposal, waste characterization sampling would need to be conducted to determine whether excavated material can be disposed of off-site as either hazardous or non-hazardous waste.

Costs

Off-site disposal would be associated with high capital costs. Disposal costs depend on the volume of material to be disposed of as hazardous versus non-hazardous waste and the location of the Property relative to the disposal facility.

Summary

Disposal is a technically implementable and reliable technology, and it was retained for further evaluation. It is assumed that alternatives with excavations would include backfilling and re-planting with native species.

4.3 SUMMARY

Based on the screening of technologies presented above and summarized in **Table 4-1** below, the following technologies were not retained:

- Soil washing
- Phytoremediation
- In situ encapsulation by solidification
- Vitrification
- In situ soil flushing

The following technologies were retained to be incorporated into remedial alternatives that will address the contamination at this site:

- Land use controls

- Excavation
- Off-site disposal
- Ex situ treatment on-site

These alternatives are developed and detailed in the following sections.

Table 4-1. Description of Technologies

Technology	Process Options	Effectiveness in Addressing RAOs	Implementability	Key Factors	Cost	Status
Land Use Controls						
Engineering controls.	Installation of fine mesh fencing, soil cap, and/or vertical barrier to prevent or discourage access to areas with contaminated media.	Effective for human health risk RAOs associated with contact of soil and sediment. Partially effective for ecological risk RAOs. Would not prevent potential migration of contaminants in soil from the Former Dump Area to the Hudson River shoreline.	Fine mesh fencing is easily implemented with owner approval and support; however, a soil cap and vertical barrier are more difficult to construct due to the twice-daily tidal inundation of the marsh area and Hudson River shoreline. Cap installation requires import of soil/cap cover material and on-site staging. May require consolidation and grading of soil and sediment prior to installation of a cover/cap. Engineering controls would require periodic inspections and regular maintenance to ensure continued protection of receptors.	Requires state and public acceptance. Cap design would need to account for potential erosion due to tidal inundation/fluctuation, storm events, currents, and wave action. It would require consolidation of soil and sediment prior to installation of the soil cover/cap. Will alter environment due to increase in topography following installation of cover/cap. Vertical barrier and cap construction would require the use of a cofferdam with dewatering or other water management methods to allow for work in the dry.	High.	Retained for potential combination with other technologies.
Institutional controls.	Deed restrictions, easements, dig permits, and educational controls including distribution of educational materials (i.e., pamphlets, flyers), installation of warning signs used to modify behavior by providing awareness and education concerning contaminated media.	Partially effective for human health risk RAOs associated with contact of soil and sediment. Not effective for ecological risk RAOs. Would not prevent potential migration of contaminants in soil from the Former Dump Area to the Hudson River shoreline.	Would need to be implemented by the landowner or with owner approval, because FUDS are not currently under DoD jurisdiction for purposes of control of the property usage. USACE does not have authority to implement, maintain, or enforce LUCs related to real property ownership or to the imposition of governmental controls. Educational controls would require periodic inspections and maintenance to ensure continued protection of human receptors. Educational pamphlets are easy to produce and distribute with owner approval.	Requires state and public acceptance.	Low.	Retained for potential combination with other technologies.
Removal						
Excavation.	Mechanical excavation used to remove soil/sediment.	Will achieve the RAOs. This is a proven technology for removing contaminated soil/sediment.	Implementable but may be challenging due to the twice-daily tidal inundation of the marsh area and Hudson River shoreline. May require excavation areas to be dewatered.	Requires state and public acceptance. May require establishment of dewatering facilities and treatment of removed water.	High.	Retained for consideration.
Off-site Disposal.	Off-site facility authorized to accept the waste stream, disposal as either hazardous or non-hazardous waste depending on waste characterization results.		Low degree of difficulty to implement. Requires identification of a facility capable of accepting material. Landfill capacity and permitting may limit excavation and disposal rates. Requires waste characterization sampling prior to off-site transport.	Material may require dewatering to meet criteria for acceptance. Long range transport may be required dependent on disposal facility capacity/location.	High.	Retained for consideration.
Ex situ Treatment						
Chemical Stabilization.	Amendments are added to excavated material to prevent the leaching of COCs through the formation of insoluble compounds. Treated material is then either returned to the excavation area or disposed of off-site.	Effective at preventing migration of contaminants and is effective for long-term source control.	Low degree of difficulty to implement. Requires bench-scale testing to identify applicable amendment and import and on-site staging of amendment. Excavation may be challenging due to the twice-daily tidal inundation of the marsh area and Hudson River shoreline. Requires identification of on-site area for staging and treatment of excavated material. Off-site disposal requires identification of a disposal facility capable of accepting material and waste characterization sampling. This technology would require restoration and backfilling of the existing wetlands to make it a similar state post-treatment.	Material may require dewatering prior to treatment. Would not achieve human health and ecological risk RAOs if treated material is returned to the excavation area.	Moderate to high.	Retained for treatment prior to off-site disposal of excavated material.

Technology	Process Options	Effectiveness in Addressing RAOs	Implementability	Key Factors	Cost	Status
Soil Washing.	Removal of COCs by chemical treatment methods in aqueous solution. Once treated, leachate would be disposed of at an off-site disposal facility. Treated material would either be returned to the excavation area or disposed off-site.	It is effective at removing COCs from soil and sediment but requires a long time-frame. It would need to be used in conjunction with another process option to reduce exposure to human and ecological receptors during implementation.	Difficult to implement. Requires bench-scale studies to determine appropriate extraction agents and import and on-site staging of extracting agent. Excavation may be challenging due to the twice-daily tidal inundation of the marsh area and Hudson River shoreline. Requires identification of on-site area for staging and treatment of excavated material. Treatment requires establishment of a designated treatment facility using potentially hazardous chemicals to remove inorganics from fill. Requires a long timeframe for implementation and the rate of treatment may limit the rate of excavation. Off-site disposal requires identification of a disposal facility capable of accepting material and waste characterization sampling. This technology would require restoration and backfilling of the existing wetlands to make it a similar state post-treatment.	Treatment involves the use of potentially hazardous chemicals. Requires long term use of facilities for soil/fill treatment and disposal or recycling of leached fluids. Requires a long timeframe for implementation and the rate of treatment may limit the rate of excavation. Requires use and maintenance of specialized equipment and chemicals. Returning treated material to the excavation area will alter the environment and prevent retainment of the low-lying marsh area between Iona and Round Island as a wetlands.	High.	Not retained.
In Situ Treatment						
Phytoremediation.	Reliance on bio-uptake into plants to remove and remediate COCs from soil.	Likely not effective due to high concentrations of metals.	Easily implemented. Requires demonstration of natural processes causing degradation and subsequent monitoring. Depends on overall potential toxicity to plants, growing season length, and number of successful growing seasons. This technology would require restoration and backfilling of the existing wetlands to make it a similar state post-treatment.	Generally used for lower levels of contamination than what exists at the Property. Plant mass is contaminated and would increase exposure to herbivorous eco receptors.	Low.	Not retained.
In Situ Solidification	Addition of binding agent to soil/sediment to produce monolith with low leachability that binds the COCs into the solidified matrix; requires in situ mixing.	Effective in meeting the RAOs because it encases/binds contaminants in a solid matrix which prevents human and ecological receptors from directly contacting contaminated media.	Requires bench scale testing would be required to select the appropriate binding material and import and on-site staging of suitable binding agent. In situ mixing may be difficult to implement at the Property due to twice-daily tidal inundation and soil saturation to ground surface. This technology would require restoration and backfilling of the existing wetlands to make it a similar state post-treatment.	May involve volume increase due to bulking. Causes significant changes to soil and sediment properties and will alter the environment, thus preventing retainment of the low-lying marsh area between Iona and Round Island as a wetland.	Moderate to high.	Not retained.
Vitrification.	Uses electrical to transform contaminated soil and sediment to an inert, solid form (e.g., glass).	Effective for meeting RAOs. Produces a glass product that is chemically stable and leach-resistant.	Difficult to implement. Requires a large amount of infrastructure and energy usage and it is not usually used on soil with high water content as additional energy consumption is required. Requires use and maintenance of specialized equipment and capture and treatment of gaseous emissions. This technology would require restoration and backfilling of the existing wetlands to make it a similar state post-treatment.	Residual material resulting from vitrification is a mass of vitrified soil and sediment that will prevent retainment of the low-lying marsh area between Iona and Round Island as a wetlands.	High.	Not retained.

Technology	Process Options	Effectiveness in Addressing RAOs	Implementability	Key Factors	Cost	Status
Soil Flushing.	Uses water or other suitable aqueous extracting solution to flush contaminants from soil and sediment. Resulting fluid is then extracted in situ using pump-and-treat methods for off-site disposal or treatment.	Soil flushing would have an unknown level of long-term effectiveness at the Property. Effectiveness would need to be evaluated through bench scale and field pilot tests.	Difficult to implement. Requires bench-scale studies and pilot tests, installation of injection and extraction wells, injection of potentially hazardous chemicals, monitoring to evaluate effectiveness, and off-site disposal of extracted leached fluids. This technology would require restoration and backfilling of the existing wetlands to make it a similar state post-treatment.	Treatment involves the use of potentially hazardous chemicals that will alter the physical/chemical properties of the soil system and significantly alter the habitat and environment of the low-lying marsh area between Iona and Round Island. Flushing fluids may need treatment to meet appropriate discharge or disposal standards.	High.	Not retained

Notes:
COC = contaminant of concern
DoD = Department of Defense
FUDS = Formerly Used Defense Sites
ISS = in situ solidification and stabilization
LUC = land use control
RAO = remedial action objective

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5. DEVELOPMENT AND SCREENING OF ALTERNATIVES

This section describes the development and screening of remedial alternatives to address affected media at the Former Dump Area and Hudson River and associated shoreline sediment in its vicinity.

5.1 RATIONALE FOR ALTERNATIVE DEVELOPMENT

The remedial alternatives are assembled using technologies and process options that were retained from Section 4 and are inclusive of all elements of a specific alternative (i.e., additional data gap “pre-design” sampling, remedial design, construction and startup, and O&M). Development of the alternatives also considers factors including land use scenarios, exposure scenarios, and accommodation of ARARs and PRGs.

The remedial alternatives must consider the requirements in the DERP Manual and the FUDS Handbook, which include:

- A no-action alternative
- An action that would remediate the site to a condition that allows unlimited use and unrestricted exposure; unlimited use and unrestricted exposure means the remedy does not include a restriction on land or groundwater use to be protective for current and reasonably anticipated future land uses)
- An action to remediate the site to a protective condition that requires land use restrictions (i.e., LUCs or exposure controls)

5.1.1 Technologies and Process Options

The retained GRA technologies and process options (Section 4) for soil are the following:

- Land use controls
- Excavation
- Off-site disposal
- Ex situ treatment on-site

5.2 DEVELOPMENT OF ALTERNATIVES

Technologies and process options retained from the preliminary screening based on technical implementability (Section 4) include no action, LUCs (including capping and vertical barriers), excavation and disposal, and excavation and ex situ treatment on-site. The primary focus of this screening evaluation is on the effectiveness and implementability of each option, with less emphasis on cost.

The following potential remedial alternatives were developed for the Iona Island Naval Ammunition Depot FUDS from the technologies that were retained from the preliminary screening in Section 4.0. The four possible alternatives for further evaluation in Section 6 are:

- Alternative 1—No Action
- Alternative 2—Excavation and off-site disposal of contaminated soil and sediment as hazardous waste
- Alternative 3—Excavation, ex situ treatment, and off-site disposal of contaminated soil and sediment as non-hazardous waste
- Alternative 4— Capping of Contaminated Soil and Sediment Accompanied by Installation of a Permanent Vertical Barrier and Additional LUCs

Each of these alternatives is discussed in detail in Section 6.

6. DETAILED ANALYSIS OF ALTERNATIVES

6.1 INTRODUCTION

The four retained alternatives from Section 5 are:

- Alternative 1—No action
- Alternative 2—Excavation and off-site disposal of contaminated soil and sediment as hazardous waste
- Alternative 3—Excavation, on-site treatment, and off-site disposal of contaminated soil and sediment as non-hazardous waste
- Alternative 4—Capping of Contaminated Soil and Sediment Accompanied by Installation of a Permanent Vertical Barrier and Additional LUCs

The evaluation criteria applied to each of these alternatives are presented in Section 6.2 and are applied to each alternative in Section 6.3. Section 6.4 provides a comparative analysis and summarizes the rationale for each alternative.

6.2 EVALUATION CRITERIA

The NCP, 40 CFR 300, outlines several objectives a remedy must meet (**Table 6-1**):

- Each remedial action selected shall be protective of human health and the environment (40 CFR 300.430 [f][1][ii][A]).
- On-site remedial actions that are selected must attain those ARARs that are identified at the time of the ROD signature (40 CFR 300.430 [f][1][ii][B]).
- Each remedial action selected shall be cost-effective, provided that it first satisfies the threshold criteria set forth in 40 CFR 300.430 (f)(1)(ii)(A) and (B). A remedy shall be cost-effective if its costs are proportional to its overall effectiveness (40 CFR 300.430 [f][1][ii][D]).
- Each remedial action shall use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable (40 CFR 300.430 [f][1][ii][E]).

The NCP established nine evaluation criteria to address these statutory requirements. The criteria fall into three categories: threshold criteria, primary balancing criteria, and modifying criteria as follows:

- Threshold Criteria
    - Overall protection of human health and the environment

  - Compliance with ARARs
- Balancing Criteria
  - Long-term effectiveness and permanence
  - Reduction of toxicity, mobility, or volume through treatment
  - Short-term effectiveness
  - Implementability
  - Cost
- Modifying Criteria
  - State acceptance
  - Community acceptance

This section presents an evaluation of the retained Remedial Alternatives based on threshold and balancing criteria. The first threshold criterion must be attained, and the second criterion must also be met unless an ARAR waiver is granted. Alternatives are then evaluated with respect to the primary balancing criteria, where the relative advantages and disadvantages of the criteria are evaluated. Each alternative is evaluated individually, as well as collectively, with respect to these criteria.

The final two criteria are modifying criteria (state acceptance and community acceptance), where the state regulatory agencies and the community provide input on whether they support or oppose the alternative. The last two criteria are evaluated through the public comment and response period for the PP and are not part of the FS.

6.2.1 Threshold Criteria

Overall Protection of Human Health and the Environment**—**This is a threshold criterion that must be met. It assesses whether each alternative provides adequate protection of human health and the environment within the scope of the proposed alternative. This criterion is a measure of how well the alternative reduces exposure to Property contaminants, reduces risk to human health, and protects the environment. As such, this criterion considers the following:

- Net reduction in contaminated soil and sediment,
- Estimated quantity of residual contaminated soil and sediment,
- Expected depth of residual contaminated soil and sediment,
- Potential human exposure pathways (considering future land use),

- Potential ecological exposure pathways

Compliance with ARARs**—**This is a threshold criterion that must be met unless an ARAR is waived. It is used to evaluate whether each proposed alternative meets the ARARs identified in Section 3.

6.2.2 Primary Balancing Criteria

Long-Term Effectiveness and Permanence**—**This criterion is a measure of how well the response action protects public safety and limits exposure. It also evaluates the magnitude of the risk remaining at the Property after RAOs have been met.

Reduction of Toxicity, Mobility, or Volume through Treatment**—**This criterion is a measure of how well the Remedial Alternative reduces toxicity, mobility, or volume of contaminants through treatment. This criterion considers the following factors:

- Treatment processes employed and the materials treated
- Amount of hazardous material to be destroyed or treated
- Degree of reduction expected in toxicity, mobility, or volume of contaminants through treatment
- Degree to which the treatment is irreversible
- Type and quantity of residuals that remain after treatment activities
- Whether the alternative meets EPA's preference for treatment

Short-Term Effectiveness**—**This criterion addresses the effects of an alternative during the implementation phase until the RAOs are met. More specifically, each alternative will be evaluated for:

- Protection of the community and workers
- Adverse environmental impacts resulting from construction and implementation
- Time required to implement the alternative

Implementability**—**Each alternative is evaluated with respect to the technical and administrative feasibility of implementing the alternative. The evaluation is conducted based on three main criteria, as listed below:

- ***Technical Feasibility*****—**This criterion addresses the difficulties associated with construction of the remedy and the ability to monitor its effectiveness. It evaluates:
  - Reliability of the alternative and any technical operational difficulties

  - Reliability to complete the remedial action without significant schedule delays
  - Environmental conditions with respect to setup, construction, and operation of the alternative

- ***Administrative Feasibility*****—**This criterion focuses on the planning stages for each alternative and assesses:
  - Coordinating services needed to carry out an alternative
  - Arranging the delivery of services in a timely manner
  - Addressing the concerns of regulatory agencies

- ***Availability of Materials and Services*****—**This criterion evaluates the following:
  - Availability of the personnel needed to perform the operations
  - Availability of adequate disposal facilities
  - Availability of supporting services (e.g., laboratory services)

Cost**—**This criterion evaluates the total cost of each alternative, including capital and O&M costs. Costs were estimated using a combination of RS Means Online software© and a budgetary proposal obtained from a remediation contractor. Estimated remediation costs, including excavation, treatment/stabilization of soils, and off-site disposal of soil as non-hazardous waste, and professional judgment were evaluated. The cost estimates included in this FS assume a margin of error of +50 percent and -30 percent. They are intended for comparison purposes only and may not be the actual cost that is expended at the time of implementation.

6.2.3 Modifying Criteria

State Acceptance**—**This criterion will be evaluated based on comments received from NYSDEC and NYSDOH (state regulators) on this FS and the PP received during the public comment period and will be addressed during the finalization of the ROD.

Community Acceptance**—**The concerns of the community, including the Property owner (PIPC), should be considered in presenting alternatives that would be acceptable to the community. This criterion will be evaluated based on comments received on this FS and the PP received during the public comment period and will be addressed in the finalization of the ROD.

6.3 INDIVIDUAL ANALYSIS

6.3.1 Alternative 1—No Action

The no action alternative is evaluated to satisfy the NCP requirement of 40 CFR 300.430(e)(6), which requires consideration of this alternative as a baseline against which other alternatives may be compared. The no action alternative would involve leaving the Property in its current condition. Under this alternative, no remedial action would be taken, and contaminated media are left “as is,” without the implementation of any containment, removal, treatment, or other protective actions.

6.3.1.1 Overall Protection of Human Health and the Environment

This alternative does not achieve the RAOs for human health and ecological receptors. Therefore, Alternative 1 does not meet the threshold criteria of protection of human health and environment.

6.3.1.2 Compliance with ARARs

No compliance with ARARs is necessary because no action will be initiated.

6.3.1.3 Long-Term Effectiveness and Permanence

Alternative 1 is ineffective in the long term because potential risk to human and ecological receptors exposed to contaminated media would not be mitigated.

6.3.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The no action alternative does not include any treatment; therefore, it would not reduce the toxicity, mobility, or volume of contaminated soil and sediment.

6.3.1.5 Short-Term Effectiveness

Under Alternative 1, no remediation would be conducted. Therefore, no change in environmental impacts or potential exposures for on-site workers or the community would occur. However, contaminated media will remain, and potential risk to human and ecological receptors exposed to contaminated media will not be mitigated. Although no time is needed to implement this alternative, the RAOs will not be met.

6.3.1.6 Implementability

This is readily implementable, as no action would be taken.

6.3.1.7 Costs

No costs are associated with Alternative 1.

6.3.1.8 State Acceptance

This criterion is not evaluated formally until comments on the FS and the upcoming PP are received.

6.3.1.9 Community Acceptance

This criterion is not evaluated formally until comments on the FS and the upcoming PP are received.

6.3.2 Alternative 2—Excavation and Off-site Disposal of Contaminated Soil and Sediment as Hazardous Waste

Alternative 2 involves excavation and off-site disposal of contaminated media as hazardous waste based on the assumption that waste characterization results would determine the media is hazardous, and Property restoration (grading/backfilling and re-planting with native wetland plant species such as narrow-leaf cattail). Any debris discovered during excavation activities would be segregated and disposed of at an appropriate facility.

6.3.2.1 Overall Protection of Human Health and the Environment

This alternative achieves the RAOs for all receptors. This alternative would ensure removal of the source area and contaminated media, thereby rendering all exposure pathways incomplete and eliminating risk to human health and ecological receptors.

6.3.2.2 Compliance with ARARs

This alternative is compliant with ARARs. To comply with the ESA, USACE will ensure no endangered species are impacted during excavation, backfill, and construction work. After the excavation of contaminated media, Alternative 2 proposes the placement of a comparable volume of clean fill material into the project location. The Clean Water Act (CWA), 40 CFR § 230.10(a), prohibits the discharge of dredged or fill material into waters of the United States if there is a practicable alternative that would have less adverse impact on the aquatic ecosystem. For this alternative, the placement of clean fill material into the project location is a “discharge of fill material,” and the project location, a wetland adjacent to the Hudson River, qualifies as waters of the United States.

Even though this alternative involves the discharge of fill material into waters of the United States, it is compliant with the CWA. There is no practicable alternative to this discharge that would have less adverse impacts on the aquatic ecosystem. After excavation of the contaminated media, the project area would be backfilled with material and replanted with native vegetation. There would be a temporal loss of wetland functions while the work is underway; however, Alternative 2 would result in a net benefit to the aquatic ecosystem by eliminating an ongoing source of contamination. This alternative would restore the wetlands by re-establishing the system’s hydrology and native vegetative cover. Other alternatives, such as not placing any material into the excavated location or placing material that would not re-establish the location’s wetland hydrology and native vegetation, would have more adverse impacts on the aquatic ecosystem. Therefore, this alternative is compliant with 40 CFR § 230.10(a). However, *assuming arguendo*, that this alternative does not comply with 40 CFR § 230.10(a), this alternative meets the requirements of an ARAR waiver as discussed in further detail in section 6.3.4.2.

6.3.2.3 Long-Term Effectiveness and Permanence

Excavation and off-site disposal of contaminated soil and sediment would permanently reduce risks to human and ecological receptors. Therefore, Alternative 2 is effective in the long-term and permanent.

6.3.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 2 does not involve treatment; therefore, no reduction of toxicity, mobility or volume through treatment will occur.

6.3.2.5 Short-Term Effectiveness

Alternative 2 is favorable in meeting the short-term effectiveness criterion. Construction is estimated to take 6 months. Excavation and staging of contaminated soil would have short-term impacts to construction workers, park personnel, and ecological receptors. Additionally, erosion has the potential to release soil and sediment into the Hudson River. Potential risks would be minimized through the use of a temporary cofferdam (or equivalent construction water control) during construction as well as the use of best management practices and the use of appropriate PPE. Specific risk minimization measures would be identified in the development of the work plan.

In the short term, construction would disrupt ecological receptors that may be present and prevent access to the wetland resource for fauna.

6.3.2.6 Implementability

Alternative 2 is implementable, but the twice-daily tidal inundation would make excavation more challenging than an upland excavation would be. Cofferdams and dewatering would be needed to allow for the excavation to be conducted in the dry. In general, excavation and off-site disposal is straightforward, and excavation equipment is readily available. Off-site transportation and disposal options for hazardous and non-hazardous soils are also readily available. Soil staging would require access from the landowner for identification and set up of a temporary staging area for excavated soils prior to loading for off-site disposal. This area would need to be deconstructed and restored following completion of treatment and off-site disposal.

6.3.2.7 Costs

Total costs associated with Alternative 2 would be a net present value of $11,845,000, which includes direct and indirect capital costs of $11,798,000 and 5 years of annual O&M costs of $10,000. The detailed cost estimate is presented in **Appendix B**.

6.3.2.8 State Acceptance

This criterion is not evaluated formally until comments on the FS and the upcoming PP are received.

6.3.2.9 Community Acceptance

This criterion is not evaluated formally until comments on the FS and the upcoming PP are received.

6.3.3 Alternative 3—Excavation, Ex-Situ Treatment, and Off-site Disposal of Contaminated Soil and Sediment as Non-Hazardous Waste

Alternative 3 involves excavation of contaminated media, ex situ on-site chemical treatment to bind contaminants into the media, off-site disposal of excavated and treated material as non-hazardous waste, and wetland restoration (grading/backfilling and replanting with native wetland plant species such as narrow-leaf cattail). Any debris discovered during excavation activities would be segregated and disposed of at an appropriate facility.

6.3.3.1 Overall Protection of Human Health and the Environment

This alternative achieves the RAOs for all receptors. This alternative would ensure removal of the source area and contaminated media and eliminate unacceptable risk to human and ecological receptors.

6.3.3.2 Compliance with ARARs

This alternative is compliant with ARARs. This analysis is the same as Alternative 2 discussed in Section 6.3.2.2.

6.3.3.3 Long-Term Effectiveness and Permanence

The excavation, on-site treatment, and off-site disposal of contaminated soil and sediment would permanently reduce risks to human and ecological receptors. Therefore, Alternative 3 is effective in the long term and permanent.

6.3.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Under Alternative 3, the toxicity, mobility, or volume of contaminants in soil and sediment would be permanently reduced through excavation, on-site treatment, and off-site disposal.

6.3.3.5 Short-Term Effectiveness

Alternative 3 is favorable in meeting the short-term effectiveness criterion. This alternative is estimated to take 6 months. Excavation, staging, and treatment of contaminated soil would have short-term impacts to construction workers, park personnel, and ecological receptors. Erosion has the potential to release soil and sediment into the Hudson River. Potential risks would be minimized through the use of a temporary cofferdam (or equivalent construction water control) during construction as well as the use of best management practices and the use of appropriate PPE. Specific risk minimization measures would be identified in the development of the work plan.

In addition, construction would temporarily disrupt ecological receptors that may be present and prevent access to the wetland resource for fauna.

6.3.3.6 Implementability

This alternative is implementable but is more challenging to implement than Alternative 2 due to staging and on-site treatment of excavated soil and sediment. As with Alternative 2, cofferdams and dewatering would be needed to allow for the excavation to be conducted in the dry. In general, excavation and off-site disposal are straightforward. Off-site transportation and disposal options for non-hazardous soil and sediment are also readily available. This alternative would require the use of additional area outside of the dump site for soil staging and on-site treatment which would require landowner access. This required area for staging and treatment would be larger than the space required for Alternative 2. This area would need to be deconstructed and restored following completion of treatment and off-site disposal.

6.3.3.7 Costs

Total costs associated with Alternative 3 would be a net present value of $9,867,000, which includes direct and indirect capital costs of $9,820,000 and 5 years of annual O&M costs of $10,000. The detailed cost estimate is presented in **Appendix B**.

6.3.3.8 State Acceptance

This criterion is not evaluated formally until comments on the FS and the upcoming PP are received.

6.3.3.9 Community Acceptance

This criterion is not evaluated formally until comments on the FS and the upcoming PP are received.

6.3.4 Alternative 4—Capping of Contaminated Soil and Sediment Accompanied by Installation of a Permanent Vertical Barrier and Additional LUCs

This alternative remediates the project to a protective condition that requires land use restrictions (i.e., LUCs or exposure controls). A minimum 3-foot soil cover or cap would be installed over contaminated soil including relocated sediment from the Hudson River shoreline. A temporary cofferdam would be needed to allow for excavation and construction. The shoreline would be restored with sand and replanted with native wetland vegetation.

A permanent concrete vertical barrier would be installed inland from the Hudson River shoreline and adjacent to the low-lying marsh area between Iona and Round Islands. The barrier would be constructed at a height that would not be overtopped during high tides and would be keyed into bedrock and the hill slopes of Iona and Round Islands. The vertical barriers would limit natural drainage of storm surges and precipitation and would require a drainage system. The drainage system would require maintenance and monitoring, and water discharge from the drainage system would require monitoring. A pre-design investigation would be required to examine leaching potential of contaminants from the soil into the groundwater. Following installation of the vertical barrier, the soil cover/cap would be planted with native species consistent with the surrounding terrestrial vegetative communities.

Additional LUCs would involve a combination of educational controls/signage, environmental easement with a restriction on digging into the cap, and engineering controls (e.g., fence) to limit potential exposure routes to human and ecological receptors. A fine mesh fence would be installed and maintained along the perimeter of the low-lying area between Iona and Round Island and along the Hudson River shoreline in the vicinity of the Former Dump Area. In addition, signs would be installed along the fence, every 100 feet, as well as with each literature box located at both the land and water entrances. Signs and pamphlets would identify contaminated media and detail exposure risk. Pamphlets would be replenished in literature boxes and mailed out annually in the spring (prior to high use times), and updated as site conditions change, as appropriate. Signs and literature boxes would be inspected annually and replaced as needed.

6.3.4.1 Overall Protection of Human Health and the Environment

This alternative is overall protective of human health and the environment and eliminates unacceptable risk to human health and the environment.

6.3.4.2 Compliance with ARARs

This alternative does not comply with 40 CFR 230.10(a). 40 CFR § 230.10(a), prohibits the discharge of fill material into waters of the United States if there is a practicable alternative that would have less adverse impact on the aquatic ecosystem. Alternative 4 involves the discharge of fill material creating a cap over the contaminated material and a loss of wetlands. Alternatives 2 and 3, which are both practicable, have less adverse impact on the aquatic ecosystem and result in no permanent loss of wetlands.

However, pursuant to 40 CFR 300.430(f)(1)(ii)(C)(2), an ARAR waiver is available for situations where compliance with an ARAR will cause greater risk to human health and the environment than noncompliance. For Alternative 4, compliance with 40 CFR 230.10(a) would result in no fill material being placed at the project location and a cap would not be constructed. Complying with the ARAR and not constructing the cap would result in greater risk to human health and the environment because the project location would remain exposed and the property would continue to pose unacceptable risk. Even though construction of a cap with clean fill material would result in a discharge of fill material into waters of the United States, there would still be an environmental benefit by removing exposure to the contaminated soils and sediment. Therefore, compliance with 40 CFR § 230.10(a) would result in greater risk to human health and the environment than capping the contaminated soils and the USACE is waiving this ARAR pursuant to 40 CFR 300.430(f)(1)(ii)(C)(2).

This alternative complies with the ESA, and USACE will ensure no endangered species are impacted during construction work.

6.3.4.3 Long-Term Effectiveness and Permanence

The removal of contaminated shoreline sediment, capping of contaminated soil and relocated sediment, installation of a vertical barrier, and LUCs would effectively reduce unacceptable risk to human and ecological receptors. Ensuring the long-term effectiveness of this remedy would require extensive monitoring and maintenance, including cap repair and replacement due to erosion. Alternative 4 would be effective in the long-term but requires extensive monitoring and maintenance to address the risk remaining on-site.

6.3.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4 does not involve treatment, and, thus, no reduction to toxicity, mobility or volume through treatment will occur.

6.3.4.5 Short-Term Effectiveness

Alternative 4 is favorable in meeting the short-term effectiveness criterion. Construction is expected to take 9 months. Limited excavation of shoreline sediment would have short-term impacts to construction workers, park personnel, and ecological receptors. In addition, erosion has the potential to release soil and sediment into the Hudson River and there is the potential for inflow of river water into the construction zone. These risks would be minimized through the use of a temporary cofferdam (or equivalent construction water control) during construction as well as the use of best management practices and the use of appropriate PPE. Specific risk minimization measures would be identified in the development of the work plan.

In the short-term, construction would disrupt ecological receptors that are present and prevent access to the wetland resource as foraging habitat to neighboring fauna.

6.3.4.6 Implementability

This alternative is more challenging to implement at the Former Dump Area due to the difficulty of installing and maintaining a vertical barrier and soil cap in a tidal area. The dynamic water-saturated nature of wetlands makes construction difficult and increases the risk of barrier failure from unstable soil, hydrostatic pressure, and changes in water flow. The added complexity of maintaining a drainage system creates more opportunities for failure and increased risk. The wet environment also makes the vertical barrier and soil cap vulnerable to freeze/thaw cycles, which could increase the barrier and cap's permeability and decrease their strength.

6.3.4.7 Costs

Total costs associated with Alternative 4 would be a net present value of $10,660,000, which includes direct and indirect capital costs of $7,757,000 and thirty years of annual O&M costs of $130,000. The detailed cost estimate is presented in **Appendix B**.

6.3.4.8 State Acceptance

This criterion is not evaluated formally until comments on the FS and the upcoming PP are received.

6.3.4.9 Community Acceptance

This criterion is not evaluated formally until comments on the FS and the upcoming PP are received.

6.4 COMPARATIVE ANALYSIS

Regulatory and community acceptance is unknown at this time and will not be evaluated formally until comments on the FS and the upcoming PP are received. The evaluation of the four alternatives in accordance with the remaining seven criteria is summarized in this section and in **Table 6-1**. The preferred alternative will be discussed with the stakeholders as part of the review of this document and in preparation for selection of an alternative for presentation in the PP.

6.4.1 Overall Protection of Human Health and the Environment

Alternative 1 will not achieve these criteria because it does not meet RAOs for human health and ecological receptors. Alternatives 2, 3, and 4 achieve overall protection of human health and the environment.

6.4.2 Compliance with ARARs

No compliance with ARARs is necessary for Alternative 1 because no action is being taken. Alternatives 2 and 3 comply with ARARs. Alternative 4 meets the requirements for an ARAR waiver pursuant to 40 CFR 300.430(f)(1)(ii)(C)(2). Compliance with 40 CFR § 230.10(a) would cause greater risk to human health and the environment than noncompliance.

6.4.3 Long-Term Effectiveness and Permanence

Alternative 1 is ineffective in the long term because risk would not be mitigated. Alternatives 2 and 3 are permanently effective at reducing risks to human and ecological receptors because contaminants would be removed from the site. Alternative 4 is less effective in the long-term. Alternative 4 requires extensive monitoring and maintenance of the cap and vertical barriers due to twice-daily tidal inundations. Alternative 4 is not a permanent action because controls may need to be replaced in the long term to maintain effectiveness.

6.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives 1, 2, and 4 do not reduce toxicity, mobility, or volume because there is no treatment of contaminants; however, contaminants are removed from the site under Alternative 2 and mobility is reduced under Alternative 4. Alternative 3 permanently reduces the toxicity, mobility, and volume of contaminants through treatment.

6.4.5 Short-Term Effectiveness

Alternative 1 is not effective in the short term because risks would not be mitigated. Alternatives 2, 3, and 4 are favorable in meeting the short-term effectiveness criterion, though there will be some short-term impacts to park personnel and ecological receptors during construction. Risks will need to be minimized using best practices as detailed in the individual analysis.

6.4.6 Implementability

Alternative 1 is readily implementable, as no action would be taken. Alternatives 2 and 3 are implementable, though twice-daily tidal inundation will increase the level of difficulty. Alternative 3 is more challenging than Alternative 2 due to the added step of staging and on-site treatment of excavated soil. Alternative 4 has the lowest implementability among the alternatives. Alternative 4 poses technical feasibility challenges due to the difficulty of installing and maintaining a vertical barrier and soil cap in a tidal area. For Alternatives 2, 3, and 4, the necessary services and materials for implementation are readily available.

6.4.7 Costs

Alternative 1 is the least expensive alternative because there are no costs associated with no action. Alternative 4 is the most expensive alternative due to the amount of fill material that would need to be transported to the site and the long term costs associated with maintaining the barrier and soil cover in a tidal area. Alternatives 2 and 3 are similar in cost, though Alternative 3 is less expensive because the soil would be disposed of as non-hazardous. Detailed cost estimates are presented in **Appendix B**.

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Table 6-1. Comparative Analysis Summary of Remedial Alternatives

Criteria	Alternative 1: No action	Alternative 2: Excavation and off-site disposal of contaminated soil and sediment as hazardous waste	Alternative 3: Excavation, ex situ treatment, and off-site disposal of contaminated soil and sediment as non-hazardous waste	Alternative 4: Capping of Contaminated Soil and Sediment Accompanied by Installation of a Permanent Vertical Barrier and Additional LUCs
Overall Protection of Human Health and the Environment	Fail	Pass	Pass	Pass
Compliance With ARARs	N/A	Pass	Pass	Waiver*
Long-Term Effectiveness and Permanence	∇	Δ	Δ	∇
Reduction of Toxicity, Mobility, and Volume through Treatment	∇	∇	Δ	∇
Short-Term Effectiveness	∇	Δ	Δ	Δ
Implementability	Δ	Δ	Δ	Δ
Total Cost	$0	$11,845,000	$9,867,000	$10,660,000

Notes:
Δ = In comparison with other alternatives, it complies well with criteria.
♦ = In comparison with other alternatives, it partially complies with criteria.
∇ = In comparison with other alternatives, it does not comply as well with criteria.
Cost estimates are based upon 2024 dollars. Total Net Cost rounded to nearest $1,000.
* Waiver would depend on Alternatives 2 and 3 not being practicable.
ARAR = applicable or relevant and appropriate requirement
LUC = land use control
N/A = not applicable

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Appendix A

Analytical Results Tables

Table A-1 Data Collection Activities Soil Analytical Results, April 1997

					Location	**Former Building 103 - Paint & Oil Storage**	**Former Building 121 – Incinerator**	**Former Sewage Disposal Plant**	**Former Building 407 – Paint Shop and Pipe Shop**	**Former Building 410 – Power House**	**Former Fuel Oil AST Near Dock 131**	**Former Fuel Oil ASTs Near Former Building 417**		**Former Dump Area**	
					Sample ID	**IX103-B1**	**IX121-B1**	**IX124/8-B1**	**IX407-B1**	**IX410-B1**	**IX131-B1**	**IX417-B1**	**IX417-B2**	**IXDMP-B1**	**IXDMP-B2**
					Depth (feet)	**0.0-2.0**	**0.0-2.0**	**0.0-2.0**	**0.0-2.0**	**0.0-2.0**	**0.0-2.0**	**0.0-2.0**	**0.0-2.0**	**0.0-2.0**	**0.0-2.0**
					Matrix	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**
					Sample Date										
Analyte	**CAS Number**	**EPA Residential Soil RSL Value[1]**	**EPA Industrial Soil RSL Value[1]**	**EPA Ecological Soil Screening Level[2]**	**Units**	**10/2/1996**	**10/2/1996**	**10/2/1996**	**10/3/1996**	**10/3/1996**	**10/3/1996**	**10/2/1996**	**10/2/1996**	**10/2/1996**	**10/2/1996**
RCRA Metals															
Arsenic	7440-38-2	0.68	3.0	19 (p)	mg/kg	**82.9**	2.5 B	5.1	**28.8**	Not tested	Not tested	Not tested	Not tested	(<0.13 U)	**24.5**
Barium	7440-39-3	1,500	22,000	333 (i)	mg/kg	42.3	**1,240**	36.8 B	69.2	Not tested	Not tested	Not tested	Not tested	289	**509**
Cadmium	7440-43-9	7.1	98	0.36 (m)	mg/kg	**0.97**	**220**	**0.44 B**	**0.56 B**	Not tested	Not tested	Not tested	Not tested	**5.8**	**9.9**
Total Chromium	16065-83-1	12,000	180,000	26 (a)	mg/kg	8.6	19.3	20.0	16.9	Not tested	Not tested	Not tested	Not tested	**26.2**	**244**
Lead	7439-92-1	400	800	11(a)	mg/kg	**118**	**8,990**	**84.7**	**542**	Not tested	Not tested	Not tested	Not tested	**1,270**	**9,160**
Mercury	7439-97-6	1.1	4.6	No standard	mg/kg	0.13	0.61	0.22	0.35	Not tested	Not tested	Not tested	Not tested	0.58	0.25
Selenium	7782-49-2	39	580	0.52 (p)	mg/kg	0.48 B	**0.95 B**	**1.2 B**	**0.68 B**	Not tested	Not tested	Not tested	Not tested	(<0.30 U)	**1.2 B**
Silver	7440-22-4	39	580	4.20 (a)	mg/kg	(<0.54 U)	(<3.6 U)	(<0.71 U)	(<0.64 U)	Not tested	Not tested	Not tested	Not tested	1.5 B	**16.3**
SVOCs															
2,4-dinitrotoluene	121-14-2	1.7	7.4	No standard	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	(<0.36 U)	(<0.36 U)	(<0.37 U)	(<0.36 U)	(<0.37 U)	(<0.41 U)	68
2,6-dinitrotoluene	606-20-2	0.36	1.5	No standard	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	(<0.36 U)	(<0.36 U)	(<0.37 U)	(<0.36 U)	(<0.37 U)	(<0.41 U)	2.8
2-methylnaphthalene	91-57-6	24	300	29.0 (i)	mg/kg	(<0.37 U)	0.037 J	(<0.44 U)	(<0.36 U)	(<0.36 U)	(<0.37 U)	(<0.36 U)	0.041	(<0.41 U)	(<0.047 U)
acenaphthalene	208-96-8	No standard	No standard	29.0 (i)	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	0.024 J	0.040 J	(<0.37 U)	(<0.36 U)	0.044 J	(<0.41 U)	(<0.047 U)
acenaphthene	82-32-9	360	4,500	29.0 (i)	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	(<0.36 U)	0.087 J	(<0.37 U)	(<0.36 U)	0.032 J	(<0.41 U)	(<0.047 U)
anthracene	120-12-7	1,800	23,000	29.0 (i)	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	0.038 J	0.16 J	(<0.37 U)	(<0.89 U)	0.087 J	(<0.41 U)	(<0.047 U)
benzo(a)anthracene	56-55-3	1.1	21	1.1 (m)	mg/kg	0.065 J	0.20 J	(<0.44 U)	0.39	**1.1**	(<0.37 U)	0.25 J	0.61	(<0.41 U)	0.072 J
benzo(a)pyrene	50-32-8	0.11	2.1	1.1 (m)	mg/kg	0.072 J	0.21 J	(<0.44 U)	0.45	0.96	(<0.37 U)	0.28 J	0.65	0.066 J	0.062 J
benzo(b)fluoranthene	205-99-2	1.1	21	1.1 (m)	mg/kg	0.11 J	0.28 J	0.062 J	0.66	**1.1**	(<0.37 U)	0.40 J	0.87	(<0.41 U)	0.11 J
benzo(g,h,i)perylene	191-24-2	NS	NS	1.1 (m)	mg/kg	0.048 J	0.18 J	(<0.44 U)	0.31 J	0.7	(<0.37 U)	0.24 J	0.48	(<0.41 U)	0.052 J
benzo(k)fluoranthene	207-08-9	11	210	1.1 (m)	mg/kg	0.040 J	0.11 J	(<0.44 U)	0.25 J	0.42	(<0.37 U)	0.17 J	0.35 J	(<0.41 U)	0.054 J
bis(2-ethylhexyl)phthalate	117-81-7	39	160	No standard	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	0.036 JB	0.019 JB	(<0.37 U)	(<0.36 U)	0.037 JB	(<0.41 U)	0.032 JB
Butyl Benzyl Phthalate	85-68-7	290	1,200	No standard	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	0.038 J	0.024 J	(<0.37 U)	(<0.36 U)	0.026 J	(<0.41 U)	(<0.047 U)
carbazole	86-74-8	No standard	No standard	29.0 (i)	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	(<0.36 U)	0.055 J	(<0.37 U)	(<0.36 U)	0.050 J	(<0.41 U)	(<0.047 U)
chrysene	218-01-9	110	2,100	1.1 (m)	mg/kg	0.087 J	0.24 J	(<0.44 U)	0.45	**1.1**	(<0.37 U)	0.28 J	0.75	(<0.41 U)	0.11 J
di-n-butylphthalate	84-74-2	630	8,200	No standard	mg/kg	0.14 J	0.15 J	0.037 J	0.4	0.29 J	0.12 J	(<0.36 U)	0.16 J	0.18 J	26
dibenz(a,h)anthracene	53-70-3	0.11	2.1	1.1 (m)	mg/kg	(<0.37 U)	0.055 J	(<0.44 U)	0.084 J	**0.15 J**	(<0.37 U)	0.076 J	0.099 J	(<0.41 U)	(<0.047 U)
dibenzofuran	132-64-9	7.3	100	No standard	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	(<0.36 U)	0.040 J	(<0.37 U)	(<0.36 U)	(<0.37 U)	(<0.41 U)	(<0.047 U)
diethyl phthalate	84-66-2	5,100	66,000	No standard	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	0.097 J	0.039 J	(<0.37 U)	0.34 J	(<0.37 U)	(<0.41 U)	(<0.047 U)
fluoranthene	206-44-0	240	3,000	1.1 (m)	mg/kg	0.10 J	0.33 J	0.076 J	0.41	**1.8**	(<0.37 U)	0.32 J	0.9	0.16 J	0.17 J
fluorene	86-73-7	240	3,000	29.0 (i)	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	(<0.36 U)	0.088 J	(<0.37 U)	(<0.36 U)	0.024 J	(<0.41 U)	(<0.047 U)
indeno(l,2,3-c,d)pyrene	193-39-5	1.1	21	1.1 (m)	mg/kg	0.053 J	0.20 J	(<0.44 U)	0.38	0.73	(<0.37 U)	0.26 J	0.53	(<0.41 U)	0.058 J
n-nitrosodiphenylamine (2)	86-30-6	No standard	No standard	No standard	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	(<0.36 U)	(<0.36 U)	(<0.37 U)	(<0.36 U)	(<0.37 U)	(<0.41 U)	1.1
naphthalene	91-20-3	3.8	17	29.0 (i)	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	(<0.36 U)	0.027 J	(<0.37 U)	(<0.36 U)	(<0.37 U)	(<0.41 U)	(<0.047 U)
phenanthrene	85-01-8	No standard	No standard	29.0 (i)	mg/kg	(<0.37 U)	0.15 J	(<0.44 U)	0.12 J	0.75	(<0.37 U)	0.088 J	0.38	(<0.41 U)	0.10 J
phenol	108-95-2	1,900	25,000	No standard	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	0.026 J	0.020 J	(<0.37 U)	(<0.36 U)	0.03 J	0.067 J	(<0.047 U)
pyrene	129-00-0	180	2,300	1.1 (m)	mg/kg	0.11 J	0.32 J	0.067 J	0.43	**2.0**	(<0.37 U)	0.30 J	1.0	0.13 J	0.12 J

Table A-1 Data Collection Activities Soil Analytical Results, April 1997

					Location	Former Building 103 - Paint & Oil Storage	Former Building 121 – Incinerator	Former Sewage Disposal Plant	Former Building 407 – Paint Shop and Pipe Shop	Former Building 410 – Power House	Former Fuel Oil AST Near Dock 131	Former Fuel Oil ASTs Near Former Building 417		Former Dump Area	
					Sample ID	IX103-B1	IX121-B1	IX124/8-B1	IX407-B1	IX410-B1	IX131-B1	IX417-B1	IX417-B2	IXDMP-B1	IXDMP-B2
					Depth (feet)	0.0-2.0	0.0-2.0	0.0-2.0	0.0-2.0	0.0-2.0	0.0-2.0	0.0-2.0	0.0-2.0	0.0-2.0	0.0-2.0
					Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
					Sample Date										
Analyte	CAS Number	EPA Residential Soil RSL Value[1]	EPA Industrial Soil RSL Value[1]	EPA Ecological Soil Screening Level[2]	Units	10/2/1996	10/2/1996	10/2/1996	10/3/1996	10/3/1996	10/3/1996	10/2/1996	10/2/1996	10/2/1996	10/2/1996
VOCs															
1,1-Dichloroethene	75-35-4	23	100	No standard	mg/kg	0.002 JB	Not tested	0.002 JB	0.002 JB	0.002 JB	Not tested	Not tested	Not tested	0.002 JB	0.002 JB
Acetone	67-64-1	6,100	67,000	No standard	mg/kg	0.013 B	Not tested	0.005 JB	0.018 B	0.004 JB	Not tested	Not tested	Not tested	0.016 B	0.005 JB
Methylene Chloride	75-09-2	35	320	No standard	mg/kg	0.001 JB	Not tested	(<0.013 U)	0.002 SB	0.002 JB	Not tested	Not tested	Not tested	(<0.013 U)	0.002 JB
PCBs															
Aroclor 1260	11096-82-5	0.24	0.99	No standard	mg/kg	(<0.038 U)	Not tested	(<0.05 U)	0.14	Not tested	Not tested	Not tested	Not tested	**1.2**	**0.28**

1. United States Environmental Protection Agency (EPA) Regional Screening Levels (RSLs) Table, EPA, May 2019. Value shown is equal to HI=0.1. Carcinogenic values equal to 1x10-6.
2. EPA Ecological Soil Screening Levels (ECO-SSLs), February 2005 - April 2008. (a) = Avian; (i) = Soil Invertebrates; (m) = Mammalian; (p) = Plants

NOTES:
CAS = Chemical Abstracts Service
mg/kg = Milligram(s) per kilogram
B = Compound detected in one or more quality assurance / quality control blank sample(s)
J =Estimated concentration
U =The analyte was not detected. Reporting limits for the non-detects were not defined.
Bold values exceed NYSDEC background concentrations and EPA Ecological Soil Screening Levels.
Red concentrations meet or exceed EPA Residential Soil RSLs.
Concentrations highlighted in yellow are at or exceed EPA Industrial Soil RSLs.
Shaded values indicate detection limits are higher than screening values.

Table A-2. Site Investigation Soil Analytical Results, 2007

Analyte	CAS Number	EPA Residential Soil RSL Value[2]	EPA Industrial Soil RSL Value[2]	Ecological Soil Screening Level [3]	Units	Bldg 601 Magazine No. 1	Bldg 601 Magazine No. 1	Bldg 502 Magazine No. 4	Bldg 308 Quarters No. 3	Bldg 601 Magazine No. 1	Bldg 407 Paint Shop and Pipe Shop	Bldg 112 Quarters No. 2	Bldg 419 Mine Storage
					Location[1]	Bldg 601 Magazine No. 1	Bldg 601 Magazine No. 1	Bldg 502 Magazine No. 4	Bldg 308 Quarters No. 3	Bldg 601 Magazine No. 1	Bldg 407 Paint Shop and Pipe Shop	Bldg 112 Quarters No. 2	Bldg 419 Mine Storage
					Sample ID:	**II-EA-SS-02-01**	**FD#1**	**II-EA-SS-02-02**	**II-EA-SS-02-03**	**II-EA-SS-02-04**	**II-EA-SS-02-05**	**II-EA-SS-02-06**	**II-EA-SS-02-07**
					Parent Name:	**NA**	**II-EA-SS-02-01**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
					Depth (in.)	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**
					Matrix	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**
					Sample Date:	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**
Metals													
Antimony	7440-36-0	3.1	47	0.27 (m)	mg/kg	**2.4 J**	**2 J**	**0.71 J**	(<0.29 UJ)	**0.52 J**	**0.86 J**	**0.67 J**	(<0.3 UJ)
Copper	7440-50-8	310	4,700	28 (m)	mg/kg	36.1	34.2	20.3	**52.9**	31.9	**76.1**	**44**	24.3
Lead	7439-92-1	400	800	11 (a)	mg/kg	**98.1 J**	**96.7 J**	**209 J**	**178 J**	**121 J**	**319 J**	**202 J**	**33.1 J**
Mercury	7439-97-6	1.1	4.6	No standard	mg/kg	0.54 J	0.56 J	0.21 J	0.087 J	0.2 J	0.37 J	0.3 J	0.089 J
Nickel	7440-02-0	150	2,200	130 (m)	mg/kg	20	19.5	8.8	18.8	20.9 J	21.6 J	19.1 J	19.6 J
Zinc	7440-66-6	2,300	35,000	46 (a)	mg/kg	**82.4**	**74.2**	**54.5**	**80.3**	**96.4 J**	**134 J**	**129 J**	**69 J**
Explosives													
2,4-dinitrotoluene	121-14-2	1.7	7.4	No standard	mg/kg	(<0.081 U)	(<0.08 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)
2,6-dinitrotoluene	606-20-2	0.36	1.5	No standard	mg/kg	(<0.081 U)	(<0.08 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)
2-amino-4,6-dinitrotoluene	35572-78-2	15	230	No standard	mg/kg	(<0.081 U)	(<0.08 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)
2-nitrotoluene	88-72-2	3.2	15	No standard	mg/kg	(<0.16 U)	(<0.16 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)
3-nitrotoluene	99-08-1	0.63	8.2	No standard	mg/kg	(<0.16 U)	(<0.16 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)
4-amino-2,6-dinitrotoluene	19406-51-0	15	230	No standard	mg/kg	(<0.081 U)	(<0.08 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)
4-nitrotoluene	99-99-0	25	140	No standard	mg/kg	(<0.16 U)	(<0.16 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)
Nitroglycerin	55-63-0	0.63	8.2	No standard	mg/kg	(<8.1 U)	(<8 U)	(<4 U)	(<4 U)	(<4 U)	(<4 U)	(<4 U)	(<4 U)
Tetryl (Trinitrophenylmethylnitramine)	479-45-8	16	230	No standard	mg/kg	(<0.16 U)	(<0.16 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)
TNT	118-96-7	3.6	51	No standard	mg/kg	(<0.081 U)	(<0.08 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)

Analyte	Bldg 310 Hose House	Bldg 316 Semi Sub-Surface Magazine	Bldg 217 Fire Station and Labor Office	Bldg 222 Miscellaneous Storage Building	Bldg 215 Garage	Bldg 108 Storehouse No. 2	Bldg 203 Stone Crusher	Bldg 104 Pump House No. 2
Sample ID:	**II-EA-SS-02-08**	**II-EA-SS-02-09**	**II-EA-SS-02-10**	**II-EA-SS-02-11**	**II-EA-SS-02-12**	**II-EA-SS-02-13**	**II-EA-SS-02-14**	**II-EA-SS-02-15**
Parent Name:	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Depth (in.)	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**
Matrix	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**
Sample Date:	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**
Metals								
Antimony	1.2 J	**0.33 J**	(<0.32 UJ)	**0.68 J**	(<0.3 UJ)	**0.58 J**	**1.6 J**	**1.6 J**
Copper	**64.1**	**106**	17.5	27.9	21.1	30.6	**112**	31.9
Lead	772 J	**11.8 J**	**47.2 J**	**66.5 J**	**50.1 J**	**161 J**	**195 J**	**220 J**
Mercury	0.053 J	0.028 J	0.09 J	0.12 J	0.094 J	0.35 J	0.44 J	0.57 J
Nickel	16.8 J	16.4	14	13.3	15	18 J	21.9	16.3 J
Zinc	**234 J**	**66.3**	**69.8**	**75.5**	**76.3**	**104 J**	**134**	**93.4 J**
Explosives								
2,4-dinitrotoluene	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.079 U)	(<0.04 U)
2,6-dinitrotoluene	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.079 U)	(<0.04 U)
2-amino-4,6-dinitrotoluene	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.079 U)	(<0.04 U)
2-nitrotoluene	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.16 U)	(<0.08 U)
3-nitrotoluene	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.16 U)	(<0.08 U)
4-amino-2,6-dinitrotoluene	0.044	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.079 U)	(<0.04 U)
4-nitrotoluene	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.16 U)	(<0.08 U)
Nitroglycerin	(<4 U)	(<4 U)	(<4 U)	(<4 U)	(<4 U)	(<4 U)	(<7.9 U)	(<4 U)
Tetryl (Trinitrophenylmethylnitramine)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.16 U)	(<0.08 U)
TNT	0.013 J	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.079 U)	(<0.04 U)

1. Location refers to the nearest former building.
2. United States Environmental Protection Agency (EPA) Regional Screening Levels (RSLs) Table, EPA, May 2019. Value shown is equal to HI=0.1. Carcinogenic values equal to 1x10-6.
3. EPA Ecological Soil Screening Levels (ECO-SSLs), February 2005 - April 2008. Lowest values presented: (a) = Avian; (i) = Soil Invertebrates; (m) = Mammalian; (p) = Plants

NOTES:
BG=background sample
CAS = Chemical Abstracts Service
J=Analyte is present. Reported value may not be accurate or precise.
U=Not detected (i.e. less than method detection limits for metals and less than reporting limits for explosives). The associated number indicates the approximate sample concentration necessary to be detected.
UJ=Not detected, quantitation limit may be inaccurate or imprecise.
Bold values exceed EPA Ecological Soil Screening Levels.
Red concentrations exceed EPA Residential Soil RSLs.
Shaded values indicate detection limits are higher than any screening values.

Table A-2 Site Investigation Soil Analytical Results, 2007

					Location[1]	Bldg 104 Pump House No. 2	Bldgs 124-127 Sewage Disposal Plant	Bldg 210 Shell House	Bldg 210 Shell House	Bldg 115 Shell House	Background	Background	Background	Background	Background
					Sample ID:	**FD#2**	**II-EA-SS-02-16**	**II-EA-SS-02-17**	**FD#4**	**II-EA-SS-02-18**	**II-BG-SS-02-01**	**II-BG-SS-02-02**	**II-BG-SS-02-03**	**II-BG-SS-02-04**	**II-BG-SS-02-05**
					Parent Name:	**II-EA-SS-02-15**	**NA**	**NA**	**II-EA-SS-02-17**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
					Depth (in.)	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**
					Matrix	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**
					Sample Date:										
Analyte	**CAS**	**EPA Residential Soil RSL Value2**	**EPA Industrial Soil RSL Value2**	**Ecological Soil Screening Level [3]**	**Units**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**
Metals															
Antimony	7440-36-0	3.1	47	0.27 (m)	mg/kg	**2.1 J**	**0.6 J**	**0.46 J**	(<0.31 UJ)	(<0.29 UJ)	**1.5 J**	**1.8 J**	**1.8 J**	**1.1 J**	**1.9 J**
Copper	7440-50-8	310	4,700	28 (m)	mg/kg	35.1	**73.8**	26.3	26.5	41.4	**45.7**	**54.9**	**55.1**	12.3	**45.7**
Lead	7439-92-1	400	800	11 (a)	mg/kg	**239 J**	**101 J**	**132 J**	**131 J**	**33.5 J**	**178 J**	**201 J**	**88.2 J**	**24.4 J**	**164 J**
Mercury	7439-97-6	1.1	4.6	No standard	mg/kg	0.66 J	0.46 J	0.087 J	0.073 J	0.068 J	0.82 J	0.58 J	0.56 J	0.14 J	0.52 J
Nickel	7440-02-0	150	2,200	130 (m)	mg/kg	18.2	12.3 J	13 J	13.5	9.8 J	26.8	23.4	13.5	12.1	22.5
Zinc	7440-66-6	2,300	35,000	46 (a)	mg/kg	**105**	**136 J**	**102 J**	**96.6**	**67.2 J**	**268**	**212**	**53.4**	**57**	**124**
Explosives															
2,4-dinitrotoluene	121-14-2	1.7	7.4	No standard	mg/kg	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	Not tested	Not tested	Not tested	Not tested	Not tested
2,6-dinitrotoluene	606-20-2	0.36	1.5	No standard	mg/kg	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	Not tested	Not tested	Not tested	Not tested	Not tested
2-amino-4,6-dinitrotoluene	35572-78-2	15	230	No standard	mg/kg	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	Not tested	Not tested	Not tested	Not tested	Not tested
2-nitrotoluene	88-72-2	3.2	15	No standard	mg/kg	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	Not tested	Not tested	Not tested	Not tested	Not tested
3-nitrotoluene	99-08-1	0.63	8.2	No standard	mg/kg	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	Not tested	Not tested	Not tested	Not tested	Not tested
4-amino-2,6-dinitrotoluene	19406-51-0	15	230	No standard	mg/kg	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	Not tested	Not tested	Not tested	Not tested	Not tested
4-nitrotoluene	99-99-0	25	140	No standard	mg/kg	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	Not tested	Not tested	Not tested	Not tested	Not tested
Nitroglycerin	55-63-0	0.63	8.2	No standard	mg/kg	(<4 U)	(<4 U)	(<4 U)	(<4 U)	(<4 U)	Not tested	Not tested	Not tested	Not tested	Not tested
Tetryl (Trinitrophenylmethylnitramine)	479-45-8	16	230	No standard	mg/kg	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	Not tested	Not tested	Not tested	Not tested	Not tested
TNT	118-96-7	3.6	51	No standard	mg/kg	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	Not tested	Not tested	Not tested	Not tested	Not tested

Table A-3 Site Investigation Sediment Analytical Results, 2007

					Sample ID:	II-EA-SD-02-01	II-EA-SD-02-02	FD#3 Duplicate of II-EA-SD-02-02	II-BG-SD-02-01	II-BG-SD-02-02	II-BG-SD-02-03
					Depth (in.)	0-6	0-6	0-6	0-6	0-6	0-6
					Matrix	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
					Sample Date:						
Analyte	**CAS Number**	**EPA Residential Soil RSL Value[1]**	**EPA Industrial Soil RSL Value[1]**	**EPA Ecological Sediment Screening Value [2]**	**Units**	12/4/2007	12/4/2007	12/4/2007	12/4/2007	12/4/2007	12/4/2007
Metals											
Antimony	7440-36-0	3.1	47	2	mg/kg	0.55 J	**22.3 J**	**43.3 J**	1.1 UJ	1.4 UJ	1.9 J
Copper	7440-50-8	310	4,700	18.7	mg/kg	**48.8**	**1,110**	**2,740**	**45.8**	**46.1**	**104**
Lead	7439-92-1	400	800	30.2	mg/kg	**79 J**	**2,340 J**	**5,030 J**	**64.5 J**	**117 J**	**100 J**
Mercury	7439-97-6	1.1	4.6	0.13	mg/kg	0.082 J	0.026 J	0.05 J	**0.47 J**	**0.68 J**	**0.45 J**
Nickel	7440-02-0	150	220	15.9	mg/kg	20.6 J	**53.1 J**	**85.4**	**31.6**	**29.8**	**35.7**
Zinc	7440-66-6	2,300	35,000	124	mg/kg	**184 J**	**2,470 J**	**2,980**	**178**	**217**	**224**
Explosives											
2,4-dinitrotoluene	121-14-2	1.7	7.4	0.029	mg/kg	0.04 U	0.04 U	0.04 U	Not tested	Not tested	Not tested
2,6-dinitrotoluene	606-20-2	0.36	1.5	0.296	mg/kg	0.04 U	0.04 U	0.04 U	Not tested	Not tested	Not tested
2-amino-4,6-dinitrotoluene	35572-78-2	15	230	0.052	mg/kg	0.04 U	0.04 U	0.04 U	Not tested	Not tested	Not tested
2-nitrotoluene	88-72-2	3.2	15	3.448	mg/kg	0.08 U	0.08 U	0.08 U	Not tested	Not tested	Not tested
3-nitrotoluene	99-08-1	0.63	8.2	4.787	mg/kg	0.08 U	0.08 U	0.08 U	Not tested	Not tested	Not tested
4-amino-2,6-dinitrotoluene	19406-51-0	15	230	0.07	mg/kg	0.04 U	0.04 U	0.04 U	Not tested	Not tested	Not tested
4-nitrotoluene	99-99-0	25	140	4.534	mg/kg	0.08 U	0.08 U	0.08 U	Not tested	Not tested	Not tested
Nitroglycerin	55-63-0	0.63	82	0.133	mg/kg	4 U	4 U	4 U	Not tested	Not tested	Not tested
Tetryl (Trinitrophenylmethylnitramine)	479-45-8	16	230	NS	mg/kg	0.08 U	0.08 U	0.08 U	Not tested	Not tested	Not tested
Trinitrotoluene	118-96-7	3.6	51	0.112	mg/kg	0.04 U	0.04 U	0.04 U	Not tested	Not tested	Not tested

1. Location refers to the nearest former building.
2. United States Environmental Protection Agency (EPA) Regional Screening Levels (RSLs) Table for Soil, USEPA, May 2019. Value shown is equal to HI=0.1. Carcinogenic values equal to 1x10-6.
3. EPA Region 4 Sediment Screening Values for Hazardous Waste Sites, Marine/Estuarine Sediment Screening Value (March 2018)

NOTES:
CAS = Chemical Abstracts Service
J = Analyte is present between the method detection limit and the reporting limit.
U=Not detected (i.e. less than method detection limits for metals and less than reporting limits for explosives). The associated number indicates the approximate sample concentration necessary to be detected.
UJ = Not detected, quantitation limit may be inaccurate or imprecise.
Bold values exceed EPA Ecological Sediment Screening Values.
Red concentrations exceed EPA Residential Soil RSLs.
Concentrations highlighted in yellow meet or exceed USEPA Industrial Soil RSLs.
Shaded values indicate detection limits are higher than screening values.

Table A-4 Site Contaminants in Upland Surface Soil

Analyte	CAS #	Contaminant Concentration Range (mg/kg)	Minimum Contaminant Concentration Location	Maximum Contaminant Concentration Location	DU-01	DU-02	DU-03	DU-04	DU-05	DU-06	DU-07	DU-09	DU-10	DU-11	DU-12	DU-13	DU-14	DU-15	DU-16	DU-20	DU-21	DU-22	DU-23	DU-25	EXDU-1	EXDU-2	EXDU-3	EXDU-4	EXDU-5	EXDU-6	EXDU-7
					DU Concentration Range (mg/kg)																										
TAL Metals																															
Antimony	7440-36-0	1.2 to 2.5	DU-13	DU-13	< Background	< Background	< Background	**1.5 to 2.1**	< Background	< Background	< Background	< Background	< Background	< Background	< Background	**1.2 to 2.5**	< Background	< Background	< Background	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Arsenic	7440-38-2	8 to 43	DU-6	DU-11	**8.9 to 12**	**13 to 14**	**12 to 15**	**23 to 41**	**11 to 12**	**8 to 11**	**17 to 18**	< Background	< Background	**37 to 43**	**13 to 14**	**9.7 to 11**	**16 to 18**	< Background	< Background	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Barium	7440-39-3	55 to 110	DU-6	DU-7	**65 to 71**	**68 to 79**	**75 to 85**	**74 to 100**	**65 to 78**	**55 to 72**	**93 to 110**	**59 to 65**	**56 to 58**	**76 to 79**	**79 to 84**	**86 to 96**	**76 to 81**	**58 to 62**	**56 to 61**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Cadmium	7440-43-9	0.19 to 1.1	DU-6	DU-4	**0.24 to 0.35**	< Background	< Background	**0.86 to 1.1**	0.2 to 0.23	**0.19 to 0.31**	**0.48 to 0.62**	0.22 to 0.26	< Background	**0.36 to 0.37**	**0.33 to 0.38**	**0.74 to 0.77**	**0.27 to 0.28**	**0.38 to 0.58**	**0.25 to 0.33**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Calcium	7440-70-2	2,900 to 28,000	DU-5	DU-11	**3,700 to 5,100**	**7,800 to 13,000**	**3,100 to 8,200**	**7,200 to 12,000**	**2,900 to 3,800**	**14,000 to 15,000**	**15,000 to 17,000**	**5,800 to 8,700**	**14,000 to 17,000**	**25,000 to 28,000**	**10,000 to 13,000**	**8,500 to 9,200**	**6,800 to 9,500**	**7,100 to 9,900**	**7,200 to 8,000**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Cobalt	7440-48-4	6.3 to 8.6	DU-6	DU-13	**6.8 to 7.5**	**7.4 to 7.7**	**7.3 to 8**	**6.8 to 7.8**	**7.7 to 7.9**	**6.3 to 7.9**	< Background	**7.3 to 7.6**	**7.5 to 8**	**6.7 to 7**	**7.5 to 7.9**	**8.2 to 8.6**	**6.8 to 7.3**	**6.7 to 6.8**	**8 to 8.5**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Copper	7440-50-8	25 to 600	DU-3	DU-13	< Background	**26 to 28**	**25 to 28**	**49 to 61**	< Background	**30 to 42**	**43 to 60**	**27 to 30**	< Background	**30 to 37**	**47 to 51**	**220 to 600**	< Background	**30 to 33**	**33 to 39**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Iron	7439-89-6	18,000 to 22,000	Multiple	DU-16	< Background	**18,000 to 19,000**	**18,000 to 19,000**	**19,000 to 20,000**	**19,000 to 20,000**	< Background	**18,000 to 19,000**	< Background	< Background	< Background	< Background	**18,000 to 19,000**	< Background	**18,000 to 19,000**	**20,000 to 22,000**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Lead	7439-92-1	72 to 2,000	DU-6	DU-7	< Background	**78 to 110**	**120 to 150**	**250 to 360**	**76 to 100**	**72 to 130**	**570 to 2,000**	< Background	< Background	**110 to 130**	**82 to 89**	**150 to 190**	**96 to 120**	**120 to 130**	< Background	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Magnesium	7439-95-4	3,800 to 19,000	DU-13	DU-11	**3,800 to 4,700**	**7,300 to 10,000**	**4,400 to 7,200**	**5,100 to 8,100**	**4,600 to 5,500**	**10,000 to 11,000**	**10,000 to 12,000**	**5,100 to 6,800**	**9,900 to 11,000**	**17,000 to 19,000**	**7,100 to 8,600**	**5,400 to 5,700**	**5,500 to 7,100**	**5,900 to 7,700**	**6,100 to 6,500**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Manganese	7439-96-5	410 to 1,100	DU-15	DU-13	**470 to 480**	**620 to 660**	**580 to 670**	**430 to 510**	**690 to 800**	**520 to 870**	**460 to 630**	**470 to 510**	**520 to 570**	**600 to 600**	**790 to 940**	**830 to 1,100**	**670 to 720**	**410 to 480**	**430 to 450**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Potassium	2023695	910 to 1,700	DU-11	DU-16	**1,200 to 1,200**	**1,200 to 1,400**	**1,200 to 1,400**	**1,200 to 1,300**	**1,200 to 1,300**	**1,200 to 1,200**	**1,000 to 1,100**	**1,200 to 1,300**	**1,200 to 1,400**	**910 to 1,000**	**1,100 to 1,100**	**1,400 to 1,400**	**980 to 1,000**	**1,200 to 1,200**	**1,400 to 1,700**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Sodium	7440-23-5	56 to 440	DU-11	DU-16	**95 to 110**	**71 to 75**	**68 to 110**	**170 to 230**	**57 to 64**	**79 to 89**	**85 to 95**	**160 to 170**	**83 to 88**	**56 to 64**	**67 to 73**	**120 to 130**	**70 to 73**	**75 to 81**	**330 to 440**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Thallium	7440-28-0	0.19 to 0.22	DU-7, DU-11	DU-11	< Background	< Background	< Background	< Background	< Background	< Background	**0.19 to 0.21**	< Background	< Background	**0.19 to 0.22**	< Background	< Background	< Background	< Background	< Background	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Zinc	7440-66-6	56 to 280	DU-6	DU-4	**67 to 92**	**72 to 80**	**98 to 130**	**150 to 280**	**74 to 79**	**56 to 79**	**200 to 210**	**67 to 70**	< Background	**87 to 110**	**93 to 100**	**140 to 170**	**74 to 78**	**120 to 250**	**66 to 71**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
PAHs																															
1-Methylnaphthalene	90-12-0	0.021 to 0.45	DU-2	DU-13	< Background	**0.036 to 0.075**	< Background	**0.021 to 0.061**	< Background	Not sampled	Not sampled	< Background	Not sampled	**0.023 to 0.028**	**0.044 to 0.073**	**0.26 to 0.45**	Not sampled	Not sampled	< Background	< Background	< Background	**0.04 to 0.041**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
2-Methylnaphthalene	91-57-6	0.0082 to 0.5	DU-16	DU-13	< Background	**0.031 to 0.055**	< Background	**0.039 to 0.069**	< Background	Not sampled	Not sampled	< Background	Not sampled	**0.036 to 0.044**	**0.053 to 0.098**	**0.31 to 0.5**	Not sampled	Not sampled	**0.0082 to 0.041**	< Background	< Background	**0.057 to 0.064**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Acenaphthene	83-32-9	0.036 to 4.7	DU-16	DU-13	< Background	**0.12 to 0.26**	< Background	< Background	< Background	Not sampled	Not sampled	< Background	Not sampled	< Background	**0.36 to 0.54**	**2.6 to 4.7**	Not sampled	Not sampled	**0.036 to 0.15**	< Background	< Background	**0.077 to 0.11**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Acenaphthylene	208-96-8	0.09 to 1.3	DU-2	DU-13	< Background	**0.09 to 0.14**	< Background	**0.15 to 0.25**	< Background	Not sampled	Not sampled	< Background	Not sampled	**0.16 to 0.23**	< Background	**0.21 to 1.3**	Not sampled	Not sampled	< Background	< Background	< Background	**0.15 to 0.26**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Anthracene	120-12-7	0.063 to 8	DU-16	DU-13	< Background	**0.34 to 0.73**	< Background	**0.18 to 0.39**	< Background	Not sampled	Not sampled	< Background	Not sampled	**0.097 to 0.15**	**0.59 to 0.86**	**3.9 to 8**	Not sampled	Not sampled	**0.063 to 0.18**	< Background	< Background	**0.27 to 0.44**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Benzo(a)anthracene	56-55-3	0.89 to 17	DU-4	DU-13	< Background	**1.4 to 3.3**	< Background	**0.89 to 1.3**	< Background	Not sampled	Not sampled	< Background	Not sampled	**0.52 to 0.97**	**1.5 to 2.2**	**9.4 to 17**	Not sampled	Not sampled	< Background	< Background	< Background	**1.2 to 2**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Benzo(a)pyrene	50-32-8	0.75 to 13	DU-11	DU-13	< Background	**1.2 to 2.7**	< Background	**1.1 to 1.1**	< Background	Not sampled	Not sampled	< Background	Not sampled	**0.75 to 1.2**	**1.2 to 1.8**	**7.1 to 13**	Not sampled	Not sampled	< Background	< Background	< Background	**1.1 to 1.9**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Benzo(b)fluoranthene	205-99-2	1.1 to 17	DU-11	DU-13	< Background	**1.7 to 3.9**	< Background	**2.1 to 2.9**	< Background	Not sampled	Not sampled	< Background	Not sampled	**1.1 to 1.6**	**1.6 to 2.8**	**9.7 to 17**	Not sampled	Not sampled	< Background	< Background	< Background	**1.8 to 3.1**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Benzo(g,h,i)perylene	191-24-2	0.64 to 7.9	DU-22	DU-13	< Background	**0.68 to 1.5**	< Background	**0.86 to 0.91**	< Background	Not sampled	Not sampled	< Background	Not sampled	**0.78 to 1.2**	**0.69 to 1.4**	**4.2 to 7.9**	Not sampled	Not sampled	< Background	< Background	< Background	**0.64 to 1**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Benzo(k)fluoranthene	207-08-9	0.36 to 7.4	DU-11	DU-13	< Background	**0.48 to 1.2**	< Background	**0.66 to 0.92**	< Background	Not sampled	Not sampled	< Background	Not sampled	**0.36 to 0.57**	**0.62 to 1.1**	**3.8 to 7.4**	Not sampled	Not sampled	< Background	< Background	< Background	**0.56 to 1.1**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Chrysene	218-01-9	0.75 to 16	DU-11	DU-13	< Background	**1.3 to 3.1**	< Background	**1 to 2.6**	< Background	Not sampled	Not sampled	< Background	Not sampled	**0.75 to 1.3**	**1.5 to 2.4**	**9.3 to 16**	Not sampled	Not sampled	< Background	< Background	< Background	**1.2 to 2.2**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Dibenz(a,h)anthracene	53-70-3	0.16 to 2.4	DU-11	DU-13	< Background	**0.24 to 0.45**	< Background	**0.26 to 0.3**	< Background	Not sampled	Not sampled	< Background	Not sampled	**0.16 to 0.23**	**0.2 to 0.38**	**1.2 to 2.4**	Not sampled	Not sampled	< Background	< Background	< Background	**0.2 to 0.38**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Fluoranthene	206-44-0	1.3 to 38	DU-4	DU-13	< Background	**2.6 to 5.6**	< Background	**1.3 to 7.9**	< Background	Not sampled	Not sampled	< Background	Not sampled	< Background	**3.1 to 4.3**	**21 to 38**	Not sampled	Not sampled	< Background	< Background	< Background	**1.9 to 3.5**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Fluorene	86-73-7	0.069 to 3.9	DU-22	DU-13	< Background	**0.1 to 0.22**	< Background	< Background	< Background	Not sampled	Not sampled	< Background	Not sampled	< Background	**0.28 to 0.44**	**2 to 3.9**	Not sampled	Not sampled	< Background	< Background	< Background	**0.069 to 0.13**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Indeno(1,2,3-c,d)pyrene	193-39-5	0.73 to 9.2	DU-22	DU-13	< Background	**0.81 to 1.8**	< Background	**1 to 1.1**	< Background	Not sampled	Not sampled	< Background	Not sampled	**0.74 to 1.1**	**0.76 to 1.5**	**4.9 to 9.2**	Not sampled	Not sampled	< Background	< Background	< Background	**0.73 to 1.2**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Naphthalene	91-20-3	0.012 to 1.1	DU-16	DU-13	< Background	**0.044 to 0.067**	< Background	**0 to 0.051**	< Background	Not sampled	Not sampled	< Background	Not sampled	**0.068 to 0.098**	**0.086 to 0.25**	**0.75 to 1.1**	Not sampled	Not sampled	**0.012 to 0.089**	< Background	< Background	**0.053 to 0.066**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Phenanthrene	85-01-8	0.46 to 27	DU-4	DU-13	< Background	**1.4 to 2.8**	< Background	**0.46 to 3.8**	< Background	Not sampled	Not sampled	< Background	Not sampled	< Background	**2.3 to 3.2**	**15 to 27**	Not sampled	Not sampled	< Background	< Background	< Background	**0.71 to 1.4**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Pyrene	129-00-0	1.3 to 30	DU-4	DU-13	< Background	**2.5 to 5.5**	< Background	**1.3 to 5.7**	< Background	Not sampled	Not sampled	< Background	Not sampled	< Background	**2.5 to 3.6**	**17 to 30**	Not sampled	Not sampled	< Background	< Background	< Background	**2 to 3.5**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
PCBs																															
Aroclor 1260	11096-82-5	0.011 to 0.034	DU-25	DU-23	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	**0.019 to 0.034**	**0.011 to 0.016**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Total PCBs	1336-36-3	0.011 to 0.034	DU-25	DU-23	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	**0.019 to 0.034**	**0.011 to 0.016**	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled
Explosives Residues																															
1,3,5-trinitrobenzene	99-35-4	0.029	EXDU-1		Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	0.029	---	---	---	---	---	---
1,3-dinitrobenzene	99-65-0	0.038 to 0.051	EXDU-1		Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	0.038 to 0.051	---	---	---	---	---	---
2,4,6-trinitrotoluene	118-96-7	0.21 to 0.37	EXDU-1		Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	0.21 to 0.37	---	---	---	---	---	---
2,4-dinitrotoluene	121-14-2	0.06 to 0.22	EXDU-1		Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled	0.06 to 0.22	---	---	---	---	---	---

Note: Metals analytes in Red denote CERCLA hazardous metals.

Table A-5 Site Contaminants in Former Dump Area Surface Soil

Metals Analyte	CAS #	Former Dump Area Contaminant Concentration Range (Concentrations Exceeding Background) (mg/kg)	Minimum Contaminant Concentration Location	Maximum Contaminant Concentration Location	Surface Soil Contaminant Concentration Range by Decision Unit (mg/kg)		
					DU-17	DU-18	DU-19
TAL Metals							
Aluminum	7429-90-5	16,000 to 25,000	DU-19	DU-19	< Background	< Background	**16,000 to 25,000**
Antimony	7440-36-0	6.2 to 9.9	DU-18	DU-17	**6.5 to 9.9**	**6.2 to 6.9**	< Background
Arsenic	7440-38-2	6.8 to 15	DU-19	DU-18	< Background	**7.8 to 15**	**6.8 to 12**
Barium	7440-39-3	63 to 360	DU-19	DU-18	**120 to 150**	**230 to 360**	**63 to 83**
Cadmium	7440-43-9	0.25 to 20	DU-19	DU-17	**5 to 20**	**4.2 to 5.2**	**0.25 to 0.33**
Calcium	7440-70-2	10,000 to 74,000	DU-19	DU-17	**43,000 to 74,000**	**12,000 to 13,000**	**10,000 to 15,000**
Chromium, Total	7440-47-3	14 to 240	DU-18	DU-18	< Background	**14 to 240**	< Background
Cobalt	7440-48-4	7 to 19	DU-18	DU-19	< Background	**7 to 7.6**	**14 to 19**
Copper	7440-50-8	83 to 1,700	DU-17	DU-18	**83 to 280**	**40 to 1,700**	**130 to 180**
Iron	7439-89-6	23,000 to 36,000	DU-19	DU-19	< Background	**27,000 to 35,000**	**23,000 to 36,000**
Lead	7439-92-1	1,200 to 2,900	DU-18	DU-18	**1,200 to 2,900**	**1,400 to 1,500**	< Background
Magnesium	7439-95-4	5,700 to 45,000	DU-19	DU-17	**26,000 to 45,000**	**7,800 to 7,900**	**5,700 to 8,300**
Manganese	7439-96-5	380 to 550	DU-17	DU-18	**380 to 440**	**450 to 550**	**410 to 470**
Mercury	7439-97-6	0.61 to 4.3	DU-17	DU-18	**0.61 to 0.98**	**1.5 to 4.3**	< Background
Potassium	2023695	920 to 2,300	DU-18	DU-18	**1,100 to 1,400**	**920 to 2,300**	**1,200 to 1,600**
Silver	7440-22-4	0.56 to 0.92	DU-17	DU-18	**0.56 to 0.72**	**0.63 to 0.92**	< Background
Sodium	7440-23-5	370 to 810	DU-17	DU-18	**370 to 490**	**590 to 810**	**1700 to 3100**
Zinc	7440-66-6	83 to 8,200	DU-18	DU-17	**5,700 to 8,200**	**83 to 1,800**	**90 to 120**
PAHs							
1-Methylnaphthalene	90-12-0	0.026 to 0.041	DU-17	DU-18	**0.026 to 0.037**	**0.04 to 0.041**	< Background
2-Methylnaphthalene	91-57-6	0.018 to 0.072	DU-19	DU-18	**0.039 to 0.056**	**0.06 to 0.072**	**0.018 to 0.035**
Acenaphthylene	208-96-8	0.059 to 0.27	DU-18	DU-19	**0.11 to 0.18**	**0.059 to 0.12**	**0.13 to 0.27**
Anthracene	120-12-7	0.13 to 0.43	DU-18	DU-19	**0.15 to 0.24**	**0.13 to 0.21**	**0.19 to 0.43**
Benzo(a)anthracene	56-55-3	1.1 to 2.5	DU-19	DU-19	< Background	< Background	**1.1 to 2.5**
Benzo(a)pyrene	50-32-8	0.44 to 1.9	DU-18	DU-19	< Background	**0.44 to 0.92**	**0.9 to 1.9**
Benzo(b)fluoranthene	205-99-2	0.86 to 3.4	DU-18	DU-19	< Background	**0.86 to 1.6**	**1.6 to 3.4**
Benzo(g,h,i)perylene	191-24-2	0.55 to 1.1	DU-19	DU-19	< Background	< Background	**0.55 to 1.1**
Benzo(k)fluoranthene	207-08-9	0.59 to 1.2	DU-19	DU-19	< Background	< Background	**0.59 to 1.2**
Chrysene	218-01-9	0.86 to 2.3	DU-18	DU-19	< Background	**0.86 to 1.5**	**0.98 to 2.3**
Dibenz(a,h)anthracene	53-70-3	0.11 to 0.41	DU-18	DU-19	< Background	**0.11 to 0.19**	**0.26 to 0.41**
Fluoranthene	206-44-0	1.6 to 4	DU-19	DU-19	< Background	< Background	**1.6 to 4**
Indeno(1,2,3-c,d)pyrene	193-39-5	0.77 to 1.5	DU-19	DU-19	< Background	< Background	**0.77 to 1.5**
Naphthalene	91-20-3	0.046 to 0.24	DU-19	DU-18	**0.069 to 0.094**	**0.2 to 0.24**	**0.046 to 0.083**
PCBs							
Aroclor 1248	12672-29-6	0.84 to 0.14	DU-17	DU-18	**0.084 to 0.095**	**0.099 to 0.14**	Not detected
Aroclor 1260	11096-82-5	0.0022 to 0.25	DU-19	DU-18	**0.041 to 0.048**	**0.074 to 0.25**	**0.0022 to 0.011**
PCB, Total	1336-36-3	0.0071 to 0.4	DU-19	DU-18	**0.13 to 0.14**	**0.17 to 0.4**	**0.0071 to 0.011**

Note: Metals analytes in Red denote CERCLA hazardous metals.

Table A-6 Site Contaminants in Former Dump Area Subsurface Soil

Metals Analyte	CAS #	Contaminant Concentration Range (mg/kg)	Minimum Contaminant Concentration Location	Maximum Contaminant Concentration Location	DU Concentration Range in Subsurface Soil (mg/kg)		
					DU-17	DU-18	DU-19
TAL Metals							
Aluminum	7429-90-5	20,000 to 25,000	DU-19	DU-19	< Background	< Background	**20,000 to 25,000**
Antimony	7440-36-0	4.4 to 13	DU-17	DU-18	**4.4 to 4.8**	**5.5 to 13**	< Background
Arsenic	7440-38-2	16 to 25	DU-18	DU-17	**22 to 25**	**16 to 19**	< Background
Barium	7440-39-3	270 to 460	DU-18	DU-17	**280 to 460**	**270 to 330**	< Background
Beryllium	7440-41-7	1.2 to 1.5	DU-17	DU-17	**1.2 to 1.5**	< Background	< Background
Cadmium	7440-43-9	3.2 to 24	DU-17	DU-18	**3.2 to 3.9**	**4.7 to 24**	< Background
Calcium	7440-70-2	14,000 to 44,000	DU-17	DU-18	**14,000 to 22,000**	**20,000 to 44,000**	**17,000 to 20,000**
Chromium, Total	7440-47-3	29 to 33	DU-18	DU-18	< Background	**29 to 33**	< Background
Cobalt	7440-48-4	16 to 18	DU-19	DU-19	< Background	< Background	**16 to 18**
Copper	7440-50-8	130 to 5,600	DU-17	DU-18	**130 to 180**	**5,100 to 5,600**	**210 to 210**
Iron	7439-89-6	25,000 to 43,000	DU-17	DU-18	**25,000 to 26,000**	**33,000 to 43,000**	**33,000 to 36,000**
Lead	7439-92-1	820 to 2,900	DU-17	DU-18	**820 to 2,700**	**2,000 to 2,900**	< Background
Magnesium	7439-95-4	6,400 to 24,000	DU-17	DU-18	**6,400 to 9,800**	**11,000 to 24,000**	**7,000 to 7,600**
Manganese	7439-96-5	450 to 510	DU-18	DU-18	< Background	**450 to 510**	< Background
Mercury	7439-97-6	0.71 to 0.21	DU-18	DU-18	**0.77 to 0.9**	**0.71 to 2.1**	< Background
Nickel	7440-02-0	52 to 79	DU-18	DU-18	< Background	**52 to 79**	< Background
Potassium	2023695	1,100 to 1,200	DU-19	DU-19	< Background	< Background	**1,100 to 1,200**
Selenium	7782-49-2	1.1 to 1.5	DU-17	DU-17	**1.1 to 1.5**	< Background	< Background
Silver	7440-22-4	0.83 to 2.1	DU-18	DU-18	< Background	**0.83 to 2.1**	< Background
Sodium	7440-23-5	420 to 3,400	DU-18	DU-19	**480 to 510**	**420 to 430**	**2,400 to 3,400**
Thallium	7440-28-0	0.27 to 0.8	DU-18	DU-17	**0.6 to 0.8**	**0.27 to 0.35**	< Background
Vanadium	7440-62-2	52 to 59	DU-19	DU-19	< Background	< Background	**52 to 59**
Zinc	7440-66-6	60 to 5,600	DU-19	DU-18	**1,600 to 2,900**	**3,100 to 5,600**	**60 to 62**
PAHs							
1-Methylnaphthalene	90-12-0	0.08 to 0.11	DU-18	DU-17	**0.087 to 0.11**	**0.08 to 0.1**	< Background
2-Methylnaphthalene	91-57-6	0.095 to 0.16	DU-18	DU-17	**0.12 to 0.16**	**0.095 to 0.12**	< Background
Acenaphthene	83-32-9	0.18 to 0.23	DU-18	DU-18	< Background	**0.18 to 0.23**	< Background
Anthracene	120-12-7	0.081 to 0.23	DU-17	DU-18	**0.081 to 0.21**	**0.12 to 0.23**	< Background
Chrysene	218-01-9	0.65 to 1.7	DU-18	DU-18	< Background	**0.65 to 1.7**	< Background
Fluorene	86-73-7	0.14 to 0.16	DU-18	DU-18	< Background	**0.14 to 0.16**	< Background
Naphthalene	91-20-3	0.2 to 0.71	DU-17	DU-18	**0.2 to 0.28**	**0.46 to 0.71**	< Background
Phenanthrene	85-01-8	0.66 to 1.4	DU-18	DU-18	< Background	**0.66 to 1.4**	< Background
PCBs							
Aroclor 1260	11096-82-5	0.049 to 0.054	DU-19	DU-19	Not detected	Not detected	**0.049 to 0.054**
Aroclor 1262	37324-23-5	0.057 to 0.15	DU-18	DU-18		**0.057 to 0.15**	Not detected
PCB, Total	1336-36-3	0.049 to 0.15	DU-19	DU-18		**0.057 to 0.15**	**0.049 to 0.054**

Note: Metals analytes in Red denote CERCLA hazardous metals.

Table A-7 Site Contaminants in Surface Water

Metals Analyte	CAS #	Con Hook Hudson River Shoreline Concentration Range (µg/L)	Con Hook Marsh Concentration Range (µg/L)	Iona Island Concentration Range in Surface Water (µg/L)			
				Former Dump Area (DUMP-SW-01 to DUMP-SW-20)	Hudson River Shoreline Aadjacent to Former Dump Area (IHRS-SW-01 to IHRS-SW-20)	Iona Marsh At Outlet of Riprap Filled Drainage Swale (RRDS-SW-01 to RRDS-SW-20)	Iona Marsh At Outlet of Tidal Wetland Swale (TWS-SW-01 to TWS-SW-20)
TAL Metals							
Arsenic	7440-38-2	0 to 0.46	0 to 2.7	< Background	**0.4 to 0.64**	< Background	< Background
Barium	7440-39-3	12 to 13	4.8 to 18	< Background	**12 to 26**	< Background	< Background
Chromium, Total	7440-47-3	0 to 0.55	0 to 0.64	< Background	< Background	Not detected	**0.58 to 0.69**
Copper	7440-50-8	0.95 to 3.4	0.61 to 1.3	**1.3 to 7.1**	**2.3 to 11**	**1.2 to 1.6**	**1 to 1.5**
Magnesium	7439-95-4	3,400 to 4,000	2,900 to 13,000	< Background	**3,600 to 5,900**	< Background	< Background
Potassium	2023695	1,100 to 1,400	1,200 to 3,300	< Background	**1,500 to 2,500**	< Background	< Background
Sodium	7440-23-5	15,000 to 18,000	17,000 to 110,000	< Background	**14,000 to 34,000**	< Background	< Background
Zinc	7440-66-6	0 to 90	0 to 4.2	**2 to 44**	< Background	Not detected	< Background

Note: Metals analytes in Red denote CERCLA hazardous metals.

Table A-8 Site Contaminants in Sediment

Metals Analyte	CAS #	Iona Island Concentration Range in Sediment (mg/kg)		
		Iona Island Hudson River Shoreline Adjacent to AOC #16 – Area D (former Dumping Area) (IHRS-DU-01)	Iona Marsh at Outlet of Riprap Filled Drainage Swale (RRDS-DU-01)	Iona Marsh at Outlet of Tidal Wetland Swale (TWS-DU-01)
TAL Metals				
Antimony	7440-36-0	**89 to 110**	0.73 to 0.77	0.73 to 1
Arsenic	7440-38-2	**32 to 35**	**9.4 to 9.7**	**8 to 9.3**
Barium	7440-39-3	**370 to 510**	**100 to 110**	**92 to 95**
Cadmium	7440-43-9	**8.9 to 9.6**	**0.91 to 0.96**	**0.84 to 2.2**
Chromium, Total	7440-47-3	**130 to 150**	**40 to 43**	**41 to 43**
Cobalt	7440-48-4	12 to 14	**14 to 15**	**13 to 14**
Copper	7440-50-8	**4,600 to 7,600**	**51 to 58**	**55 to 72**
Iron	7439-89-6	**140,000 to 180,000**	**35,00 to 37,000**	**29,000 to 36,000**
Lead	7439-92-1	**7,700 to 14,000**	**56 to 67**	**65 to 97**
Manganese	7439-96-5	1200	**2,700 to 2,800**	**1,000 to 1,200**
Nickel	7440-02-0	**69 to 110**	**34**	**31 to 35**
Silver	7440-22-4	**1 to 2**	0.31 to 0.33	0.28 to 0.36
Vanadium	7440-62-2	**30 to 37**	29 to 31	**33 to 35**
Zinc	7440-66-6	**3,600 to 3,800**	**190 to 200**	**230 to 990**

Note: Metals analytes in Red denote CERCLA hazardous metals.

Appendix B

Cost Estimates

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ALTERNATIVE COST SUMMARY				
Alternative	**Capital Cost**	**Lifetime Long Term Monitoring Cost**	**Total Cost**	**Construction Time (years)**
Alternative 1				
No Action	$0	$0	$0	0
Alternative 2				
Excavation and Offsite Disposal of Lead-Contaminated Soil and Sediment as Hazardous Waste and Backfilling of Area	$11,798,000	$47,135	$11,845,000	1 years
Alternative 3				
Excavation, Ex-Situ Treatment, Offsite Disposal of Lead Contaminated Soil and Sediment as Non-Hazardous Waste, and Backfilling of Area	$9,820,000	$47,135	$9,867,000	1 years
Alternative 4				
Capping of Contaminated Soil and Sediment Accompanied by Installation of a Permanent Vertical Barrier and Additional LUCs	$7,757,000	2,902,758.00	$10,660,000	1 years

Iona Island HTRW Feasibility Study Cost Estimate

Alternative 1: NO ACTION			
Pre-Construction Activities			
	NA	**Subtotal**	$ -
Site Activities			
	NA	**Subtotal**	$ -
Long-Term Monitoring			
	NA	**Subtotal**	$ -
	Total Pre-Construction Activities Cost		$ -
	Total Site Activities Cost		$ -
	Total Long-Term Monitoring Cost		$ -
	Total Cost		$ -

Iona Island HTRW Feasibility Study Cost Estimate
Iona Island Naval Ammunition Depot
Formerly Used Defense Site
Stony Point, Rockland County, New York

Alternative 2: Excavation and Offsite Disposal of Lead-Contaminated Soil and Sediment as Hazardous Waste and Backfilling of Area		**Estimated Cost to Implement**			**$ 11,845,000**
		Construction Time			**1 years**
		Post Remediation Monitoring			**5 years**
		Quantity	**Unit**	**Unit Cost**	**Total Cost**
REMEDIAL ACTION TOTAL CAPITAL COST					**$ 11,798,000**
Total of Pre-Construction and Construction Activities					**$ 7,971,378**
Pre-Construction Activities					
1.0	Permitting	1	LS	$ 80,000.00	$ 80,000
2.0	Remedial Action Work Plan, federal, state, and municipal deliverables	1	LS	$ 110,000.00	$ 110,000
Construction Activities					
3.0	Mobilization, Demobilization and Site Prep (3% of Subtotal, as rounded)	1	LS	$ 232,176.00	$ 232,176
4.0	Site Access Road Improvement	1	LS	$ 17,655.00	$ 17,655
5.0	Clearing (lite vegetation, no trees and mowing in wetlands and uplands)	2	Acre	$ 17,655.00	$ 35,310
6.0	Cofferdam	10,985	SF	$ 53.26	$ 585,061
7.0	Dewatering, Pumping 8 hour days	80	Day	$ 358.85	$ 28,708
8.0	Water treatment	1	LS	$ 200,000.00	$ 200,000
9.0	Excavation (1.67 acres * 3ft. Depth)	8,077	CY	$ 134.00	$ 1,082,318
10.0	Haz Transportation and Disposal with sampling (gravity dewatered and portland added to pass paint filter test)	10,001	Ton	$ 340.00	$ 3,400,340
11.0	Non-Haz Transportation and Disposal	-	Ton	$ -	$ -
12.0	Dewatering of Wetlands Soils - Dewatering Pad	1	LS	$ 120,000.00	$ 120,000
13.0	Disposal of Hazardous Water from Dewatering	273,000	gal	$ 1.75	$ 477,750
14.0	Addition of Portland Cement, processing and testing	6,726	CY	$ 30.00	$ 201,780
15.0	Backfill with Wetland Soil	5,878	CY	$ 200.00	$ 1,175,600
16.0	Backfill with Sand along Shoreline	3,006	CY	$ 65.00	$ 195,390
17.0	Seed and Fertilize Upland Area	100	SY	$ 2.50	$ 250
18.0	Wetland Planting	2,420	SF	$ 12.00	$ 29,040
Contingency					
25%	of Total Construction Activities				$ 1,992,845
Professional/Technical Services					
5%	**Project Management**				$ 398,569
6%	**Remedial Design**				$ 478,283
6%	**Construction Management for On-Site Labor**				$ 478,283
6%	**Specialty Wetlands Subcontractor Markup**				$ 478,283
Site Management Activities					
		ANNUAL LTM COST (YRS 1-5)			**$ 10,000**
		LIFETIME LTM (Net Present Value [NPV])			**$ 47,135**
Wetland Mitigation					$ 10,000
24.0	Annual Wetland Inspection and Mitigation (For 5 years Only - $10k/yr)	1	event	$ 10,000.00	$ 10,000
2.0%	Discount Factor (per Office of Management and Budget [OMB] 30Y A94 Nominal Discount Rate [NDR])				
	TOTAL ESTIMATED NPV ALTERNATIVE COST (Capital + LTM + Maintenance)				$ 11,845,000

Iona Island HTRW Feasibility Study Cost Estimate
Iona Island Naval Ammunition Depot
Formerly Used Defense Site
Stony Point, Rockland County, New York

Alternative 3: Excavation, Ex-Situ Treatment, Offsite Disposal of Lead Contaminated Soil and Sediment as Non-Hazardous Waste, and Backfilling of Area		**Estimated Cost to Implement**			**$ 9,867,000**
		Construction Time			**1 years**
		Post Remediation Monitoring			**5 years**
		Quantity	**Unit**	**Unit Cost**	**Total Cost**
REMEDIAL ACTION TOTAL CAPITAL COST					**$ 9,820,000**
Total of Pre-Construction and Construction Activities					**$ 6,634,869**
Pre-Construction Activities					
1.0	Permitting	1	LS	$ 80,000.00	$ 80,000
2.0	Pre-Characterization and Bench Scale Studies for Ex-Situ Treatment	1	LS	$ 10,000.00	$ 10,000
3.0	Remedial Action Work Plan, federal, state, and municipal deliverables	1	LS	$ 110,000.00	$ 110,000
Construction Activities					
4.0	Mobilization, Demobilization and Site Prep (3% of Subtotal, as rounded)	1	LS	$ 193,249.00	$ 193,249
5.0	Site Access Road Improvement	1	LS	$ 17,655.00	$ 17,655
6.0	Clearing (lite vegetation, no trees and mowing in wetlands and uplands)	2	Acre	$ 17,655.00	$ 35,310
7.0	Stabilization Agent Procurement (5% dosage rate)	545	Ton	$ 526.00	$ 286,670
8.0	Stabilization Agent Delivery (22 tons per truck)	25	Load	$ 5,000.00	$ 125,000
9.0	Cofferdam	10,985	SF	$ 53.26	$ 585,061
10.0	Dewatering, Pumping 8 hour days	80	Day	$ 358.85	$ 28,708
11.0	Water treatment	1	LS	$ 200,000.00	$ 200,000
12.0	Excavation (1.67 acres * 3ft. Depth)	8,077	CY	$ 134.00	$ 1,082,318
13.0	Dewatering of Wetlands Soils - Dewatering Pad	1	LS	$ 120,000.00	$ 120,000
14.0	Ex-Situ Treatment	8,656	CY	$ 18.00	$ 155,808
15.0	Waste Characterization Final Profile Sampling	1	LS	$ 50,000.00	$ 50,000
16.0	Haz Transportation and Disposal with sampling	-	Ton	$ -	$ -
17.0	Non-Haz Transportation and Disposal (gravity dewatered and treated with stab	11,979	Ton	$ 140.00	$ 1,677,060
18.0	Disposal of Hazardous Water from Dewatering	273,000	gal	$ 1.75	$ 477,750
19.0	Backfill with Wetland Soil	5,878	CY	$ 200.00	$ 1,175,600
20.0	Backfill with Sand along Shoreline	3,006	CY	$ 65.00	$ 195,390
21.0	Seed and Fertilize Upland Area	100	SY	$ 2.50	$ 250
22.0	Wetland Planting	2,420	SF	$ 12.00	$ 29,040
Contingency					
25%	of Total Construction Activities				$ 1,658,717
Professional/Technical Services					
5%	**Project Management**				$ 331,743
6%	**Remedial Design**				$ 398,092
6%	**Construction Management for On-Site Labor**				$ 398,092
6%	**Specialty Wetlands Subcontractor Markup**				$ 398,092
Site Management Activities					
		ANNUAL LTM COST (YRS 1-5)			**$ 10,000**
		LIFETIME LTM (NPV)			**$ 47,135**
Wetland Mitigation					$ 10,000
28.0	Annual Wetland Inspection and Mitigation (First 5 years- $10k/yr)	1	event	$ 10,000.00	$ 10,000
2.0%	Discount Factor (per OMB 30Y A94 Nominal Discount Rate)				
	TOTAL ESTIMATED NPV ALTERNATIVE COST (Capital + LTM + Maintenance)				$ 9,867,000

Iona Island HTRW Feasibility Study Cost Estimate
Iona Island Naval Ammunition Depot
Formerly Used Defense Site
Stony Point, Rockland County, New York

Alternative 4: Capping of Contaminated Soil and Sediment Accompanied by Installation of a Permanent Vertical Barrier and Additional LUCs		**Estimated Cost to Implement**			**$ 10,660,000**
		Construction Time			**1 years**
		Post Remediation Monitoring			**30 years**
		Quantity	**Unit**	**Unit Cost**	**Total Cost**
REMEDIAL ACTION TOTAL CAPITAL COST					**$ 7,757,000**
Total of Pre-Construction and Construction Activities					**$ 4,562,924**
Pre-Construction Activities					
1.0	Permitting	1	LS	$ 100,000.00	$ 100,000
1.1	In-Lieu Fee Wetland Mitigation or Compensatory Mitigation	1	LS	$ 500,000.00	$ 500,000
2.0	Remedial Action Work Plan, federal, state, and municipal deliverables	1	LS	$ 150,000.00	$ 150,000
Construction Activities					
3.0	Mobilization, Demobilization and Site Prep (3% of Subtotal, as rounded)	1	LS	$ 132,901.00	$ 132,901
4.0	Site Access Road Improvement	1	LS	$ 17,655.00	$ 17,655
5.0	Clearing (lite vegetation, no trees and mowing in wetlands and uplands)	2	Acre	$ 17,655.00	$ 35,310
6.0	Cofferdam	10,985	SF	$ 53.26	$ 585,061
7.0	Dewatering, pumping 8 hours	120	Day	$ 358.85	$ 43,062
8.0	Water treatment	1	LS	$ 200,000.00	$ 200,000
9.0	Excavation (3 ft depth for vertical barrier and shoreline sediment)	2,702	CY	$ 134.00	$ 362,068
10.0	Drilling and blasting rock, 3 ft depth for vertical barrier	282	CY	$ 215.99	$ 60,909
11.0	Rough grading	1	LS	$ 3,454.85	$ 3,455
12.0	Concrete Vertical Barrier 13 ft height (3 ft into rock, 7 ft above existing grade), includes forming	1,221	CY	$ 541.83	$ 661,574
13.0	Subdrainage piping, 8"	845	LF	$ 32.38	$ 27,361
14.0	Procure and Place Non-Woven Geotextile	8,077	SY	$ 2.67	$ 21,566
15.0	Backfill with Common Fill	11,535	CY	$ 90.00	$ 1,038,150
16.0	Procure and Deliver Topsoil	887	CY	$ 100.00	$ 88,700
17.0	Backfill with Sand along Shoreline	3,006	CY	$ 65.00	$ 195,390
18.0	Wetland Planting	21,780	SF	$ 12.00	$ 261,360
19.0	Seed and Fertilize Upland Area	2,420	SY	$ 2.50	$ 6,050
Land Use Controls					
20.0	Fencing	1,515	LF	$ 36.14	$ 54,752.10
21.0	Gates	2	EA	$ 5,000.00	$ 10,000.00
22.0	Signage (every 20 ft)	76	EA	$ 100.00	$ 7,600.00
Contingency					
25%	of Total Construction Activities				$ 1,140,731
Professional/Technical Services					
5%	**Project Management**				$ 228,146
20%	**Remedial Design**				$ 912,585
10%	**Construction Management for On-Site Labor**				$ 456,292
10%	**Specialty Wetlands Subcontractor Markup**				$ 456,292
Site Management Activities					
		ANNUAL LTM COST (YRS 1-30)			**130,000**
		LIFETIME LTM (NPV)			**2,902,758.00**
Wetland Mitigation					
28.0	Annual Wetland Inspection and Mitigation (For 30 years- $20k/yr)	1	event	$ 20,000.00	$ 20,000
Engineering and Institutional Control Maintenance (Cover, Barrier, Signage, Fence)					
29.0	Annual Inspection and Repairs (For 30 years- $100k/yr)	1	event	$ 100,000.00	$ 100,000.00
Five Year Review					
30.0	Five year review (For 30 years - 6 events)	1	event	$ 50,000.00	$ 50,000.00
2.0%	Discount Factor (per OMB 30Y A94 Nominal Discount Rate)				
	TOTAL ESTIMATED NPV ALTERNATIVE COST (Capital + LTM + Maintenance)				$ 10,660,000

		UNITS	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5
			No Action	Ex-Haz	Ex-Treat	Cover	LUCs
a	**Cap Area (sf)**	sf	--	--	--	72,692	0.0
	------------- acreage	acre		--	--	1.67	
	------------- perimeter	lf				1,515	
b	**Excavation Total (vol)**	cy	--	8,077	8,077	2,702	0.0
	--------------with bulk factor (1.17)	lcy	--	9,450	9,450	--	0.0
	--------------tonnage	ton	--	13,731	13,731	--	0.0
c	**Excavation Total (area)**	sf		72,692	72,692	--	0.0
	------------- acreage	acre		1.67	1.67	--	0.0
	Rock blasting	cy				282	
d	**Excavation Haz T&D with 10% Contingency**	cy	--	8,885	0	--	0.0
	--------------with bulk factor (1.17)	lcy	--	10,395	0	--	0.0
	--------------tonnage	ton	--	15,105	0	--	0.0
e	**Excavation Non-Haz T&D with 10% Contingency**	cy	--	0	8,885	--	0.0
	--------------with bulk factor (1.17)	lcy	--	0	10,395	--	0.0
	--------------tonnage	ton		0	15,105	--	0.0
f	**Sediment Dewatering Water Volume (15% by vol removed)**	gal		273,000	273,000	--	
	Post-Dewatering Sediment Volume	cy		6,726	6,726		
	--------------tonnage	ton		11,434	11,434		
	Post-Portland or Ex Situ Treatment Sediment Volume for disposal	lcy		8,656	8,656		
g	**Backfill with wetland soil**	cy	--	5,344	5,344	0	0.0
h	**Backfill with sand**	cy	--	3,006	3,006	3,006	0.0
	Backfill with common fill	cy	--	0	0	11,535	
	Topsoil	cy				887	
i	**Clearing (lite vegetation, no trees and mowing in wetlands and uplands)**	acre	--	2.00	2.00	2	0.0
j	**Seeding Area**	acre	--	1.1	1.1	1.1	0.0
k	**Wetland Mitigation Area**	acre	--	0.5	0.5	0.5	0.0
l	**Wetland Planting**	sy	--	2,420	2,420	2,420	0.0
m	**Vertical Barrier or Cofferdam (length)**	lf		845	845	845	
	--------------depth	lf		13	13	13	
	--------------width	lf				3	
	--------------volume	cy				1,221	

Iona Island HTRW Feasibility Study Cost Estimate Assumptions
Iona Island Naval Ammunition Depot
Formerly Used Defense Site
Stony Point, Rockland County, New York

Alternative 2: Excavation and Offsite Disposal of Lead-Contaminated Soil and Sediment as Hazardous Waste and Backfilling of Area		
Item	**Description**	**Assumptions**
Pre-Construction Activities		
1.0	Permitting	Based on previous project experience/cost from other NY state excavation project (River Road on Niagara River). Added $20K
2.0	Remedial Action Work Plan	Was based on previous project experience/cost from other NY state excavation project (River Road on Niagara River); revised for comments based on
Construction Activities		
3.0	Mobilization, Demobilization and Site Prep	3% of subtotal for pre-construction and construction activities (items 1, 2, and 4 through 14).
4.0	Site Access Road Improvement	Based on previous project experience/cost from other NY state excavation project (River Road on Niagara River).
5.0	Clearing (lite vegetation, no trees and mowing in wetlands and uplands)	RS Means costs for clearing and grubbing.
6.0	Cofferdam	RS Means costs for cofferdam, shore driven, 13 ft tall (3 ft into rock, 7 ft above
7.0	Dewatering, pumping 8 hours	RS Means cost for dewatering, pumping 8 hrs, manned 2 hrs
8.0	Water treatment	Based on previous project experience/cost from other NYS dredging project
9.0	Excavation (1.66 acres * 3ft. Depth)	$134/CY based on Raymark Superfund Site
10.0	Haz Transportation and Disposal with sampling	$340/ton based on Raymark Superfund Site
11.0	Non-Haz Transportation and Disposal	Not applicable. Assumes soil will be disposed offsite as hazardous waste.
12.0	Dewatering of Wetlands Soils - Dewatering Pad	Construction of dewatering pad based on other NY state sediment excavation project (Dzus Fasteners site)
13.0	Disposal of Hazardous Water from Dewatering	Based on recent quote for Watson Johnson Landfill in southern PA.
14.0	Addition of Portland Cement, processing and testing	Based on other NY state sediment excavation project (Dzus Fasteners site)
15.0	Backfill with Wetland Soil	Average price between RS Means and costs on other similar projects, costs inflated for location and access issues.
16.0	Backfill with Sand along Shoreline	Average price between RS Means and costs on other similar projects, costs inflated for location and access issues.
17.0	Seed and Fertilize Upland Area	RS Means seeding cost.
18.0	Wetland Planting	RS Means seeding cost plus additional cost for specialized plant mix.
Contingency		
19.0	25 Percent of Total Construction Activities	Based on project experience.
Professional/Technical Services		
20.0	Project Management	5 percent of total of pre-construction and construction activities.
21.0	Remedial Design	6 percent of total of pre-construction and construction activities.
22.0	Construction Management for On-Site Labor	6 percent of total of pre-construction and construction activities.
23.0	Specialty Wetlands Subcontractor Markup	6 percent of total of pre-construction and construction activities.
Site Management Activities		
24.0	Annual Wetland Inspection and Mitigation (First 5 years- $10k/yr)	Based on previous project experience/cost from other sites.

Iona Island HTRW Feasibility Study Cost Estimate Assumptions
Iona Island Naval Ammunition Depot
Formerly Used Defense Site
Stony Point, Rockland County, New York

Alternative 3: Excavation, Ex-Situ Treatment, Offsite Disposal of Lead Contaminated Soil and Sediment as Non-Hazardous Waste, and Backfilling of Area		
Item	**Description**	**Assumptions**
Pre-Construction Activities		
1.0	Permitting	Based on previous project experience/cost from other NY state excavation project (River Road on Niagara River).
2.0	Pre-Characterization and Bench Scale Studies for Ex-Situ Treatment	Completed pre-characterization and bench scale study at Tyndall Air Force Base in 2024. Project included pre-design workplan, APP, field effort to collect
3.0	Remedial Action Work Plan	Based on previous project experience/cost from access road improvement at similar site (River Road on Niagara River).
Construction Activities		
4.0	Mobilization, Demobilization and Site Prep (3% of Subtotal)	3% of subtotal for pre-construction and construction activities (items 1, 2, and 4 through 19).
5.0	Site Access Road Improvement	Based on previous project experience/cost from other NY state excavation project (River Road on Niagara River).
6.0	Clearing (lite vegetation, no trees and mowing in wetlands and uplands)	RS Means costs for clearing and grubbing.
7.0	Stabilization Agent Procurement (5% dosage rate)	Based on quote from EnviroBlend for similar project.
8.0	Stabilization Agent Delivery (22 tons per truck)	Based on quote from EnviroBlend for similar project, cost per truckload elevated for longer distance.
9.0	Cofferdam	RS Means costs for cofferdam, shore driven, 13 ft tall (3 ft into rock, 7 ft above
10.0	Dewatering, pumping 8 hours	RS Means cost for dewatering, pumping 8 hrs, manned 2 hrs
11.0	Water treatment	Based on previous project experience/cost from other NYS dredging project
12.0	Excavation (1.66 acres * 3ft. Depth)	$134/CY based on Raymark Superfund Site
13.0	Dewatering of Wetlands Soils	Average price between RS Means and costs on other similar projects.
14.0	Ex-Situ Treatment	Based on quote for similar project.
15.0	Waste Characterization Final Profile Sampling	Based on previous project experience/cost from other NY state excavation project (River Road on Niagara River).
16.0	Haz Transportation and Disposal with sampling	Not applicable. Assumes soil will be treated to below haz soil characterization limits.
17.0	Non-Haz Transportation and Disposal	Based on previous project experience/cost from other NY state excavation project (River Road on Niagara River).
18.0	Disposal of Hazardous Water from Dewatering	Based on recent quote for Watson Johnson Landfill in southern PA.
19.0	Backfill with Wetland Soil	Average price between RS Means and costs on other similar projects, costs
20.0	Backfill with Sand along Shoreline	Average price between RS Means and costs on other similar projects, costs
21.0	Seed and Fertilize Upland Area	RS Means seeding cost.
22.0	Wetland Planting	RS Means seeding cost plus additional cost for specialized plant mix.
Contingency		
23.0	25 Percent of Total Construction Activities	Based on project experience.
Professional/Technical Services		
24.0	Project Management	5 percent of total of pre-construction and construction activities.
25.0	Remedial Design	6 percent of total of pre-construction and construction activities.
26.0	Construction Management for On-Site Labor	6 percent of total of pre-construction and construction activities.
27.0	Specialty Wetlands Subcontractor Markup	6 percent of total of pre-construction and construction activities.
Site Management Activities		
28.0	Annual Wetland Inspection and Mitigation (First 5 years- $10k/yr)	Based on previous project experience/cost from other sites.

Iona Island HTRW Feasibility Study Cost Estimate Assumptions
Iona Island Naval Ammunition Depot
Formerly Used Defense Site
Stony Point, Rockland County, New York

Alternative 4: Capping of Contaminated Soil and Sediment Accompanied by Installation of a Permanent Vertical Barrier and Additional LUCs		
Item	**Description**	**Assumptions**
Pre-Construction Activities		
1.0	Permitting	Based on previous project experience/cost from other NY state excavation project (River Road on Niagara River). Increased from Alternatives 2 and 3 to account for HEC RAS modeling needed for FEMA floodplain development permit.
1.1	In-Lieu Fee Mitigation or Compensatory Mitigation	Based on review of in-lieu fee mitigation pricing through Ducks Unlimited, Inc. and The Wetland Trust; assumes 4:1 requirement
2.0	Remedial Action Work Plan	Based on previous project experience/cost from access road improvement at similar site (River Road on Niagara River). Increased from Alternatives 2 and 3 to account for additional federal deliverables due to wetland filling.
Construction Activities		
3.0	Mobilization, Demobilization and Site Prep (3% of Subtotal)	3% of subtotal for pre-construction and construction activities (items 1, 2, and 4 through end).
4.0	Site Access Road Improvement	Based on previous project experience/cost from other NY state excavation project (River Road on Niagara River).
5.0	Clearing (lite vegetation, no trees and mowing in wetlands and uplands)	RS Means costs for clearing and grubbing.
6.0	Cofferdam	RS Means costs for cofferdam, shore driven, 13 ft tall (3 ft into rock, 7 ft above
7.0	Dewatering, pumping 8 hours	RS Means cost for dewatering, pumping 8 hrs, manned 2 hrs
8.0	Water treatment	Based on previous project experience/cost from other NYS dredging project
9.0	Excavation (3 ft depth, for vertical barrier)	$134/CY based on Raymark Superfund Site
10.0	Drilling and blasting rock, 3 ft depth for vertical barrier	RS Means cost for drilling and blasting rock
11.0	Rough grading	RS Means costs for rough grading with skid steer and labor, 40,000-45,000 SF
12.0	Concrete Vertical Barrier	RS Means costs for cast-in-place concrete retaining wall, including forming
13.0	Subdrainage piping, 8"	RS Means cost for PVC subdrainage piping
14.0	Procure and Place Non-Woven Geotextile	RS Means costs for non-woven geotextile
15.0	Backfill with Common Fill	Based on previous project experience/cost from other NY state excavation project (Dzus on Long Island)
16.0	Procure and deliver topsoil	Based on previous project experience/cost from other NY state excavation project (Dzus on Long Island)
17.0	Backfill with Sand along Shoreline	Average price between RS Means and costs on other similar projects, costs
18.0	Wetland Planting	RS Means seeding cost plus additional cost for specialized plant mix.
19.0	Seed and Fertilize Upland Area	RS Means seeding cost.
20.0	Fencing	RS Means fence costs
21.0	Gates	RS Means gate costs
22.0	Signage	Sign cost from Grainger, plus additional for labor and supplies
Contingency		
23.0	25 Percent of Total Construction Activities	Based on project experience.
Professional/Technical Services		
24.0	Project Management	5 percent of total of pre-construction and construction activities.
25.0	Remedial Design	20 percent of total of pre-construction and construction activities.
26.0	Construction Management for On-Site Labor	10 percent of total of pre-construction and construction activities.
27.0	Specialty Wetlands Subcontractor Markup	10 percent of total of pre-construction and construction activities.
Site Management Activities		
28.0	Annual Wetland Inspection and Mitigation (For 30 years, $20k/yr)	Based on previous project experience/cost from other sites.
29.0	Annual Inspection and Repairs (For 30 years)	Based on project experience/cost from other sites
30.0	Five year review (6 events)	Based on project experience/cost from other sites.

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