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Feasibility Study for Soil and Marine Sediment

Old Fire Fighting Training Area
Naval Station Newport
Newport, Rhode Island

Northern Division
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298
Contract Task Order 0218

April 2001

TETRA TECH NUS, INC.

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FEASIBILITY STUDY
FOR SOIL AND MARINE SEDIMENT
for

OLD FIRE FIGHTING TRAINING AREA
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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TABLE OF CONTENTS
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

SECTION			PAGE
EXECUTIVE SUMMARY			ES-1
1.0	INTRODUCTION		1-1
	1.1	REPORT ORGANIZATION	1-1
	1.2	NAVSTA NEWPORT BACKGROUND INFORMATION	1-1
	1.3	OLD FIRE FIGHTING TRAINING AREA BACKGROUND INFORMATION	1-2
	1.4	GEOLOGY AND HYDROGEOLOGY	1-4
	1.4.1	Regional Geology and Hydrogeology	1-4
	1.4.2	Site Geology and Hydrogeology	1-5
	1.5	TERRESTRIAL HABITATS	1-7
	1.6	MARINE HABITATS	1-8
	1.7	NATURE AND EXTENT OF CONTAMINATION	1-10
	1.8	FATE AND TRANSPORT	1-12
	1.9	HUMAN HEALTH RISK ASSESSMENT	1-12
	1.10	ECOLOGICAL RISK ASSESSMENT	1-13
2.0	DEVELOPMENT OF REMEDIATION OBJECTIVES		2-1
	2.1	ARARs and TBCs	2-1
	2.1.1	Chemical-Specific ARARs and TBCs	2-2
	2.1.2	Location-Specific ARARs and TBCs	2-2
	2.1.3	Action-Specific ARARs and TBCs	2-3
	2.2	DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES	2-3
	2.2.1	Identification of Media of Concern	2-3
	2.2.2	Medium of Concern: Soil	2-6
	2.2.3	Medium of Concern: Sediment	2-12
	2.3	ESTIMATION OF AREAS AND VOLUMES	2-19
	2.3.1	Soil	2-19
	2.3.2	Sediment	2-20
3.0	IDENTIFICATION AND SCREENING OF TECHNOLOGIES		3-1
	3.1	GENERAL RESPONSE ACTIONS	3-1
	3.1.1	No Action	3-2
	3.1.2	Limited Action	3-2
	3.1.3	Containment	3-2
	3.1.4	Removal	3-3
	3.1.5	Disposal	3-3
	3.1.6	Treatment	3-3
	3.2	PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL	3-4
	3.2.1	Preliminary Screening	3-4
	3.2.2	Evaluation of Technologies and Process Options	3-4
	3.2.3	Representative Process Options for Soil	3-27

TABLE OF CONTENTS (cont.)
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

SECTION **PAGE**

3.3 PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SEDIMENT 3-28
3.3.1 Preliminary Screening 3-28
3.3.2 Evaluation of Technologies and Process Options 3-28
3.2.3 Representative Process Options for Sediment 3-49

4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES FOR SOIL 4-1
4.1 RATIONALE FOR DEVELOPMENT OF ALTERNATIVES 4-1
4.2 DESCRIPTION OF ALTERNATIVES 4-3
4.2.1 Soil Alternative 1: No Action 4-4
4.2.2 Soil Alternative 2: Removal, Ex situ Treatment, and Backfill 4-4
4.2.3 Soil Alternative 3: Removal and Disposal 4-5
4.3 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES 4-6
4.4 INDIVIDUAL ANALYSES OF SOIL ALTERNATIVES 4-11
4.4.1 Soil Alternative 1: No Action 4-11
4.4.2 Soil Alternative 2: Removal, Ex situ Treatment, and Backfill 4-13
4.4.3 Soil Alternative 3: Removal and Disposal 4-17
4.5 COMPARATIVE ANALYSIS OF SOIL ALTERNATIVES 4-20

5.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES FOR MARINE SEDIMENT... 5-1
5.1 RATIONALE FOR DEVELOPMENT OF ALTERNATIVES 5-1
5.2 DESCRIPTION OF ALTERNATIVES 5-2
5.2.1 Sediment Alternative 1: No Action 5-2
5.2.2 Sediment Alternative 2: Limited Action 5-3
5.2.3 Sediment Alternative 3: Limited Dredging and Disposal 5-4
5.2 4 Sediment Alternative 4: Dredging and Disposal 5-7
5.3 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES 5-10
5.4 CRITERIA FOR DETAILED ANALYSIS 5-10
5.5 INDIVIDUAL ANALYSES OF MARINE SEDIMENT ALTERNATIVES 5-13
5.5.1 Sediment Alternative 1: No Action 5-14
5.5.2 Sediment Alternative 2: Limited Action 5-15
5.5.3 Sediment Alternative 3: Limited Dredging and Disposal 5-18
5.5.4 Sediment Alternative 4: Dredging and Disposal 5-23
5.6 COMPARATIVE ANALYSIS OF SEDIMENT ALTERNATIVES 5-27

REFERENCES **R-1**

APPENDICES

APPENDIX A PRG DEVELOPMENT FOR SOIL
APPENDIX B PRG DEVELOPMENT FOR SEDIMENT
APPENDIX C AREA AND VOLUME ESTIMATES
APPENDIX D COST ESTIMATES

TABLE OF CONTENTS (cont.)
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

TABLES

NUMBER

1-1 Summary of Receptor Risks and Hazards for Soil
1-2 Summary of Receptor Risks and Hazards for Sediment
2-1 Potential Chemical-Specific ARARs and TBCs
2-2 Potential Location-Specific ARARs and TBCs
2-3 Potential Action-Specific ARARs and TBCs
2-4 Risk-Based COPC Selection for Surface Soil
2-5 Risk-Based COPC Selection for Subsurface Soil
2-6 RIDEM-Based COPC Selection for Surface Soil
2-7 RIDEM-Based COPC Selection for Subsurface Soil
2-8 Selection of Soil COPCs Requiring Further Consideration
2-9 Soil Preliminary Remediation Goals
2-10 Selection of Soil COCs
2-11 Surface Soil Concentrations Exceeding PRGs
2-12 Subsurface Soil Concentrations Exceeding PRGs
2-13 Summary of Sediment COPC Selection
2-14 Summary of Sediment Preliminary Remediation Goals
2-15 Selection of Sediment COCs
2-16 Sediment Concentrations Exceeding PRGs
3-1 Identification and Preliminary Screening of Technologies and Process Options for Soil
3-2 Representative Process Options for Soil
3-3 Identification and Preliminary Screening of Technologies and Process Options for Sediment
3-4 Representative Process Options for Sediment
4-1 Summary of Soil Alternatives
4-2 Summary of Detailed Analyses of Alternatives for Soil Remediation
4-3 Assessment of Chemical-Specific ARARs and TBCs, Soil Alternative 1: No Action
4-4 Assessment of Location-Specific ARARs and TBCs, Soil Alternative 1: No Action
4-5 Assessment of Action-Specific ARARs and TBCs, Soil Alternative 1: No Action
4-6 Assessment of Chemical-Specific ARARs and TBCs, Soil Alternative 2: Removal, Ex Situ Treatment, Backfill
4-7 Assessment of Location-Specific ARARs and TBCs, Soil Alternative 2: Removal, Ex Situ Treatment, Backfill
4-8 Assessment of Action-Specific ARARs and TBCs, Soil Alternative 2: Removal, Ex Situ Treatment, Backfill
4-9 Assessment of Chemical-Specific ARARs and TBCs, Soil Alternative 3: Removal and Disposal
4-10 Assessment of Location-Specific ARARs and TBCs, Soil Alternative 3: Removal and Disposal
4-11 Assessment of Action-Specific ARARs and TBCs, Soil Alternative 3: Removal and Disposal
4-12 Summary of Comparative Analysis of Soil Alternatives
5-1 Summary of Sediment Alternatives
5-2 Summary of Detailed Analyses of Alternatives for Sediment Remediation
5-3 Assessment of Chemical-Specific ARARs and TBCs, Sediment Alternative 1: No Action
5-4 Assessment of Location-Specific ARARs and TBCs, Sediment Alternative 1: No Action
5-5 Assessment of Action-Specific ARARs and TBCs, Sediment Alternative 1: No Action

TABLE OF CONTENTS (cont.)
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Tables (cont.)

NUMBER	
5-6	Assessment of Chemical-Specific ARARs and TBCs, Sediment Alternative 2: Limited Action
5-7	Assessment of Location-Specific ARARs and TBCs, Sediment Alternative 2: Limited Action
5-8	Assessment of Action-Specific ARARs and TBCs, Sediment Alternative 2: Limited Action
5-9	Assessment of Chemical-Specific ARARs and TBCs, Sediment Alternative 3: Limited Dredging and Disposal
5-10	Assessment of Location-Specific ARARs and TBCs, Sediment Alternative 3: Limited Dredging and Disposal
5-11	Assessment of Action-Specific ARARs and TBCs, Sediment Alternative 3: Limited Dredging and Disposal
5-12	Assessment of Chemical-Specific ARARs and TBCs, Sediment Alternative 4: Dredging and Disposal
5-13	Assessment of Location-Specific ARARs and TBCs, Sediment Alternative 4: Dredging and Disposal
5-14	Assessment of Action-Specific ARARs and TBCs, Sediment Alternative 4: Dredging and Disposal
5-15	Summary of Comparative Analysis of Sediment Alternatives

FIGURES

NUMBER	
1-1	Site Locus
1-2	NAVSTA Newport Sites and Study Areas
1-3	OFFTA Location Map
1-4	Site Plan
1-5	1953 Facility Design Map
1-6	1944 Aerial Photo –Coasters Harbor Island
2-1	Soil Areas Exceeding PRGs
2-2	Historical Features Map
2-2	Approximate Depths of Contaminants
2-4	Sediment Areas Exceeding PRGs
5-1	Sediment Alternative 3 – Area of Dredging/Excavation
5-2	Bay Haul Road Elevation
5-3	Sediment Alternative 4 – Area of Dredging/Excavation

TABLE OF CONTENTS (cont.)
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

LIST OF ACRONYMS

ACOE	U.S. Army Corps of Engineers
ARAR	Applicable or Relevant and Appropriate Requirement
AVS	Acid Volatile Sulfides
AWQC	Ambient Water Quality Criteria
BAF	Bioaccumulation Factor
bgs	below ground surface
B&RE	Brown & Root Environmental
BSAF	Biota-Sediment Accumulation Factor
CAA	Clean Air Act
CAD	Contained Aquatic Disposal
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CRDL	Contract Required Detection Limit
CTE	Central Tendency Exposure
CWA	Clean Water Act
ELUR	Environmental Land Usage Restriction
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
ER-L	Effects Range-Low: NOAA Adverse Effects Benchmark Value For Sediment
ER-M	Effects Range-Median: NOAA Adverse Effects Benchmark Value For Sediment
FDA	U.S. Food and Drug Administration
FFA	Federal Facilities Interagency Agreement
FS	Feasibility Study
GRA	General Response Action
HEAST	Health Effects Summary Table
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IDL	Instrument Detection Limit

TABLE OF CONTENTS (cont.)
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

LIST OF ACRONYMS (Continued)

IEUBK	Integrated Exposure and Uptake Biokinetic Model
ILCR	Incremental Lifetime Cancer Risk
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
LDR	Land Disposal Restriction
LTTS	Low-Temperature Thermal Stripping
MCL	Maximum Contaminant Level
NAVSTA	Naval Station
Navy	United States Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NETC	Naval Education and Training Center
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOEC	No Observed Effects Concentration
NORTHDIV	Northern Division
NPL	National Priorities List
O&M	Operation and Maintenance
OFFTA	Old Fire Fighting Training Area
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PDI	Pre-Design Investigation
POTW	Publicly Owned Treatment Work
PPE	Personal Protective Equipment
PRG	Preliminary Remedial Goal
PVC	Polyvinyl Chloride
RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act

LIST OF ACRONYMS (Continued)

RfD	Risk Reference Dose
RI	Remedial Investigation
RIDEM	Rhode Island Department of Environmental Management
RIDOT	Rhode Island Department of Transportation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RPO	Representative Process Option
SAIC	Science Applications International Corporation
SARA	Superfund Amendments and Reauthorization Act
SEM	Simultaneously Extracted Metal
SER	Shore Establishment Realignment Program
SPLP	Synthetic Precipitation Leaching Procedure
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TBC	To Be Considered
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TCR	Tissue Concentration Ratio
TE	Toxicity Equivalency
TEV	Toxicity Effects Value
TEV-HQ	Toxicity Effects Value - Hazard Quotient
TEQ	Toxicity Equivalency
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TRC	TRC Environmental Corporation
TSCA	Toxic Substances Control Act
TSDF	Treatment, Storage, and Disposal Facility
TtNUS	Tetra Tech NUS, Inc.
UCL	Upper Confidence Limit
URI	University of Rhode Island
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
UTL	Upper Tolerance Limit
VOC	Volatile Organic Compound
WQSV	Water Quality Screening Value

EXECUTIVE SUMMARY

OVERVIEW

This Feasibility Study (FS) relates the process used to evaluate a variety of approaches to address contaminated soil and marine sediment at the Old Fire Fighting Training Area at Naval Station Newport in Newport, Rhode Island. Three alternatives are presented for consideration as the Navy's cleanup strategy for the onshore portion of the site. Four alternatives are presented for consideration for the marine sediment located along the shoreline and nearshore portions of the site.

BACKGROUND

The Navy used the information from several studies to develop the FS. These studies included several phases of remedial investigations, a human health risk assessment, and a marine ecological risk assessment. The main findings of these investigations pertinent to this FS are summarized below.

Results of the investigations indicated that site activities have resulted in the release of both organic and inorganic contaminants. Semivolatile organic compounds, metals, total petroleum hydrocarbons, and one pesticide exceeded regulatory levels for residential use of the soil at the site. For sediment, semi-volatile organic compounds and one metal exceeded concentrations protective of human health and the environment. In addition to the contaminated soil and sediment at the site, debris, including granite blocks, concrete slabs, bricks, and asphalt, is present in the mounds at the site, in the subsurface, and along the shoreline.

A human health risk assessment was performed to evaluate exposure to surface soil, subsurface soil, shoreline sediment, and shellfish (lobsters, clams, and mussels). The risk assessment considered exposures under a residential scenario, recreational and visitor scenarios, and a worker scenario, as well as ingestion of shellfish taken recreationally and for subsistence. For surface soil, subsurface soil, and shoreline sediment, the cancer risks for the residential scenario were within the U.S. Environmental Protection Agency's (EPA's) target risk range of 1×10^{-4} to 1×10^{-6} but exceeded Rhode Island's acceptable risk level of 1×10^{-5}. For shellfish ingestion, the cancer risks exceeded EPA's and Rhode Island's acceptable risk levels under the subsistence fishing and lifetime recreational scenarios for lobster, clams, and mussels. None of the media or exposure scenarios posed an unacceptable non-cancer risk.

An ecological risk assessment was performed to assess ecological risks to the offshore environments of Coasters Harbor and Narragansett Bay from contaminants associated with the site and included

exposure and effects assessments, a characterization of risk, risk synthesis, and uncertainty analysis Sample stations were rated based on whether there is high, intermediate, and low probability for adverse risk to receptors present at those stations. The assessment found a high probability for adverse risk at one station along the central shoreline of the site. Intermediate probability for risk was estimated for a number of stations at the nearshore area and in the harbor sediment, and low probability for adverse risk was estimated for the remainder of the stations. The stations rated as intermediate and low risks may be considered acceptable from an ecological perspective. A baseline condition associated with relatively pristine conditions was not observed at any of the stations evaluated in this assessment.

AREAS AND VOLUMES

Based on current data, the area of the onshore soil to be addressed at the site is approximately 229,000 square feet (5.3 acres), and the volume of impacted soil and debris is approximately 49,500 cubic yards. For the shoreline and nearshore portion of the site, approximately 130,500 square feet (3.0 acres) of sediment will be addressed, corresponding to approximately 9,670 cubic yards. An area of 10,800 square feet (0.25 acre) of eelgrass beds is assumed to be present in the area of contaminated sediment.

FEASIBILITY STUDY PROCESS

The FS identified preliminary remediation goals (PRGs) for the soil and the marine sediment at the site. PRGs are concentrations of chemicals that, if allowed to remain in the soil and marine sediment, are not anticipated to pose an increased risk of adverse effects to human health or the environment. Soil and sediment that contain concentrations of contaminants in excess of the PRGs were identified and used to delineate the areas that may require remediation or risk management.

The FS evaluated a range of options to address the soil and the marine sediment. Current technologies were evaluated to determine if they could be effectively used to protect human health and the environment by containing, removing, or treating the contaminants and if they could be implemented in the areas where the contaminants are present. General technology options assessed were excavation of soil and debris, dredging of sediment, on-site treatment, off-site disposal, restricting access to the site, and monitoring concentrations to assess any changes in site conditions and risk.

The remedial action alternatives developed to address the contaminants in the soil and marine sediment were evaluated against seven criteria identified in the National Contingency Plan: overall protection of human health and environment, compliance with environmental laws, long-term effectiveness, reduction of toxicity through treatment, short-term effectiveness, implementability, and cost (for a 30-year period). Two additional criteria identified in the National Contingency Plan, state and public acceptance, will be evaluated in the Record of

Decision following the receipt of public and regulatory comments on the Final Feasibility Study and the proposed remedial action plan.

Remedial alternatives were developed for the two main divisions of the site: (1) the onshore area of soil and debris and (2) the marine sediment, which includes the shoreline and nearshore area. The alternatives evaluated for the soil are (1) no action, (2) removal, treatment, and backfill, and (3) removal and disposal The alternatives evaluated for the marine sediment are (1) no action, (2) limited action (long-term monitoring), (3) limited dredging and disposal, and (4) dredging and disposal. The FS discusses how each alternative meets the seven criteria and evaluates how well each alternative compares to the others.

SUMMARY OF SOIL ALTERNATIVES

Soil Alternative 1, a no action alternative, serves as a baseline consideration or addresses sites that do not require active remediation. This alternative assumes that no remedial action would occur. No land use restrictions would remain or be implemented, and there would be no monitoring of conditions. Natural attenuation could reduce concentrations of chemicals to some extent, but the progress of attenuation would not be monitored. Since contaminants would remain at the site, a 5-year review would be required under law. The present worth cost of this alternative is estimated at $46,000.

Soil Alternative 2 would eliminate long-term management by addressing contaminated soil through excavation and on-site treatment. This alternative would offer aggressive remediation through excavation and treatment by low-temperature thermal stripping and soil washing to reduce the contaminant concentrations to levels below PRGs. Low-temperature thermal stripping uses direct or indirect heating to thermally desorb or volatilize organic contaminants present in soil. Soil washing involves treating soil with wash liquids that would separate the contaminants from the soil media. Removal would involve the excavation of surface and subsurface soils using trackhoes. An estimated 49,500 cubic yards of soil and debris would be excavated and segregated for treatment or disposal. The contaminated portion of the excavated material would be treated on site. Much of the debris would fall into the category of non-hazardous waste and could be disposed of at a municipal landfill. Treated soil would be used for backfilling excavated areas. The present worth cost of this alternative is estimated at $10,975,000.

Soil Alternative 3 would eliminate long-term management by addressing contaminated soil through excavation and disposal. This alternative would offer aggressive remediation through excavation and transportation of contaminated soil to a landfill or a treatment, storage, and disposal facility (TSDF). If the excavated soil meets the requirements for use as a daily cover for a municipal landfill, contaminated soil would be disposed of at permitted landfill; however, if the soil requires treatment, disposal at a TSDF

would be preferred. An estimated 49,500 cubic yards of soil and debris would be excavated, segregated, and disposed of off site. Much of the debris would fall into the category of non-hazardous waste and could be disposed of at municipal landfill. The present worth cost of this alternative is estimated at $7,757,000.

SUMMARY OF MARINE SEDIMENT ALTERNATIVES

Sediment Alternative 1, a no action alternative, would involve no remedial response activities and would provide no additional protection of human health or the environment. However, it would provide a baseline for comparison to other alternatives. Since contamination would remain and unrestricted future use of the nearshore environment would be allowed, 5-year reviews of the no action decision would be required. The present worth cost of this alternative is estimated at $46,000.

Sediment Alternative 2 is a limited action alternative and would involve no direct remedial response activities for contaminated marine sediment in the bay. It would provide no removal or treatment of contaminated material; therefore, it would provide no protection of the environment or ecological receptors. However, it would provide some additional protection of human health by employing access restrictions to augment the protection measures currently in place (fencing and land use restrictions) and a long-term monitoring program to allow evaluation of changing conditions at the site. Because contamination would remain, 5-year reviews of the alternative would be required to evaluate the risks to human health and the environment posed by the site in the future. The present worth cost of this alternative is estimated at $394,000.

Sediment Alternative 3 was developed to reduce the on-site toxicity, mobility, and volume of contaminated marine sediment through removal and disposal while providing protection to potential eelgrass beds. Sediment around the eelgrass beds would remain intact while the rest of the contaminated sediment would be removed from the shoreline and nearshore area using a combination of appropriate excavation and dredging techniques and disposed of off site. For purposes of the FS it was assumed that eelgrass beds cover about 0.25 acre of area. Sediment associated with eelgrass beds accounts for approximately 8 percent of the volume of contaminated sediment. In order to provide protection against this sediment, access restrictions and long-term monitoring would be in place. The present worth cost of this alternative is estimated at $3,937,000.

Sediment Alternative 4 was developed to provide a remedial action that eliminates the on-site toxicity, mobility, and volume of contaminated marine sediment through removal and disposal. Sediment would be removed from the shoreline and nearshore area using appropriate excavation and dredging techniques and disposed of off site. These areas include those presented in Alternative 3 as well as potential eelgrass beds. The present worth cost of this alternative is estimated at $4,302,000.

1.0 INTRODUCTION

This Feasibility Study (FS) report has been prepared for the Old Fire Fighting Training Area (OFFTA) site (Site 09), located at Naval Station Newport (NAVSTA Newport) in Newport, Rhode Island (formerly the Naval Education and Training Center [NETC]) The FS is submitted in fulfillment of the Remedial Investigation/Feasibility Study (RI/FS) for the site. The RI/FS was initiated by TRC Environmental Corporation (TRC) on behalf of the United States Navy (Navy) under Contract Number N62472-86-C-1282 for the Northern Division Naval Facilities Engineering Command (NORTHDIV). The RI/FS is being completed by Tetra Tech NUS, Inc. (TtNUS), formerly Brown & Root Environmental (B&RE), on behalf of the Navy under Contract Number N62472-90-D-1298 for NORTHDIV.

1.1 REPORT ORGANIZATION

This FS report has been divided into five sections, with tables and figures presented in back of the text. This section of the report, Section 1.0, provides background information on the OFFTA site, including the site location and description; site history; site geology and hydrogeology; terrestrial and marine habitats; contaminant nature and distribution in the media of concern; and the results of the site investigations and risk assessments. Section 2.0 describes the development of remediation goals, including identification of potential applicable or relevant and appropriate requirements (ARARs), media and chemicals of concern (COCs) for the FS, and development of preliminary remediation goals (PRGs) and remedial action objectives (RAOs). Section 3.0 describes the general response actions (GRAs) and presents the identification and preliminary screening of potential remedial technologies and the detailed evaluation of candidate technologies and process options. Sections 4.0 and 5.0 describe the remedial alternative development process and provide detailed descriptions of the proposed remedial alternatives for soil and marine sediment, respectively. These sections also provide a detailed analysis of remedial alternatives on the basis of the evaluation criteria specified by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) 300, and a comparative analysis of the remedial alternatives.

1.2 NAVSTA NEWPORT BACKGROUND INFORMATION

NAVSTA Newport is located approximately 60 miles southwest of Boston, Massachusetts, and 25 miles south of Providence, Rhode Island. It occupies approximately 1,063 acres, with portions of the facility located in the City of Newport and Towns of Middletown and Portsmouth, Rhode Island. The facility layout is long and narrow, following the western shoreline of Aquidneck Island for nearly 6 miles facing the east passage of Narragansett Bay. General location maps of the NAVSTA Newport are provided as Figures 1-1 and 1-2.

The NAVSTA Newport facility has been in use by the Navy since the era of the Civil War. During World Wars I and II, military activities at the facility increased significantly and the base provided housing for many servicemen. In subsequent peacetime years, use of on-site facilities was slowly phased out until Newport became the headquarters of the Commander Cruiser-Destroyer Force Atlantic in 1962. In April 1973, the Shore Establishment Realignment Program (SER) resulted in the reorganization of naval forces, and activity again declined. This reorganization resulted in the Navy excessing some 1,629 acres of its 2,420 acres. Portions of the facility are currently leased by the Navy to the State of Rhode Island Port Authority and Economic Development Corporation. Some of these areas are, in turn, subleased to private enterprises.

From 1974 to the present, research and development and training have been the primary activities at Newport. The base was renamed Naval Station Newport in 1998. The major commands currently located at NAVSTA Newport include the Naval Education and Training Center, Surface Warfare Officers School Command, Naval Undersea Warfare Center, and the Naval War College.

The entire NAVSTA Newport was listed on the U.S. Environmental Protection Agency (EPA) National Priorities List (NPL) of abandoned or uncontrolled hazardous waste sites in November 1989. The NPL identifies those sites that pose a significant threat to human health and the environment. Several sites on the base are currently being studied by the Navy under the Department of Defense Installation Restoration Program (IRP). This program is similar to the EPA's Superfund Program authorized under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) in 1986

A Federal Facilities Agreement (FFA) for NAVSTA Newport was signed by the Navy, the State of Rhode Island, and the EPA on March 23, 1992. The FFA outlines response action requirements under the Department of Defense IRP at NAVSTA Newport. The FFA was developed, in part, to ensure that environmental impacts associated with past and present activities at NAVSTA Newport are thoroughly investigated and remediated, as necessary.

1.3 OLD FIRE FIGHTING TRAINING AREA BACKGROUND INFORMATION

The OFFTA site is located at the northern end of Coasters Harbor Island (see Figure 1-3). The site occupies approximately 5.5 acres and is bordered by Taylor Drive to the south and is surrounded by Coasters Harbor (part of Narragansett Bay) to the east, north, and, west. The site contains a picnic area, playground, and baseball field. A one-story concrete block building (Building 144) is located along the

southern side of the site. The building and recreational facilities at the site are not currently in use Access to the site is restricted by a chain link fence along its eastern, southern, and western sides.

Unique topographic features at the site include three soil mounds: one that is approximately 20 feet high (30 feet above mean low water) located in the center of the site, another that is approximately 6 feet high (16 feet above mean low water) located on the western side of the site, and a third smaller mound at the far west end of the site. The rest of the site is generally flat, with surface elevations ranging from 8 to 12 feet above mean low water. With the exception of the baseball infields, the site is entirely vegetated with grass. A site plan is presented as Figure 1-4.

The site was home to a Navy fire fighting training facility from World War II until 1972. During the training operations, fuel oils were ignited in various structures at the site that simulated shipboard compartments, and then extinguished by sailors. The general layout of the training facility is shown on a 1953 drawing, which details the planned design of the facility (Figure 1-5). It is not known whether the facility was constructed exactly as shown on this design drawing; however, a 1944 aerial photo of Coasters Harbor Island (Figure 1-6) confirms that the drawing is a reasonable representation of the facility at that time.

It was reported that the two buildings labeled "Carrier Compartment" on Figure 1-5 had a water/oil mixture injected into them which was set on fire for fire fighting practice. Underground piping reportedly carried the water/oil mixture to the buildings and from the buildings to the oil-water separator shown on the figure. No other known information is available concerning the prior fire fighting training operations.

The fire fighting training facility was closed in 1972. Upon closure, the training structures were reportedly demolished and buried in mounds on the site, and then the entire area was covered with topsoil. The site was then converted to a recreational area with a playground, a picnic area with an open pavilion and barbecue grills, and a baseball field. The field was dedicated on July 4, 1976, and used as a recreational area until its closure in October 1998 due to potential environmental and human health concerns.

In its 22 years of use as a recreational area, the site was used for organized activities including youth day camps, picnic functions, and little league baseball (1 year only), as well as for general recreation. A child day care center operated out of Building 144 on the site from approximately 1983 through January 1994 when it was relocated off site to a larger facility on base.

Aerial photos and facility maps for the period from 1939 through 1988 were reviewed to better evaluate the site history. Activity on the site appears to date back to approximately 1943. A 1953 facility design map (Figure 1-5) indicates the locations of structures and site features associated with fire fighting

training exercises An aerial photo taken in May 1944 (Figure 1-6) depicts the site with structures in a similar layout to that shown on the 1953 facility design map. Based on the design map and subsequent facility condition maps, on-site structures included an administration building, hose house, two carrier compartments, smothering pit, separator pit, foam pit, simulated ship structures, suction pumps, and oil tanks.

The indexes that accompanied some of the facility conditions maps indicate that the on-site structure that was used in recent years as a day care center was once used as "wash and dressing rooms " No significant visible site changes are noted from 1944 until a 1975 aerial photo of the site, when the structures and facilities associated with the fire fighting training area are no longer evident, with exception of the "hose house" and day care center structure. As of 1987, the site appears similar to its current condition, with soil mounds visible in the central and western portions of the site and a pavilion in the east-central portion of the site.

1.4 GEOLOGY AND HYDROGEOLOGY

This section presents a summary of the regional and site geologic and hydrogeologic features. This information is based on the RI drilling program and data from previously published literature and reports of other contractors, which are presented in the RI Report (TtNUS, 2001).

1.4.1 Regional Geology and Hydrogeology

The NAVSTA Newport site is located at the southeastern end of the Narragansett Basin. The rocks of the Narragansett Basin are non-marine sedimentary rocks of Pennsylvanian age. The bedrock at the NAVSTA Newport facility is almost entirely of the Rhode Island Formation. A few areas of thick conglomerates are present within the Rhode Island Formation. They consist of pebbles, cobbles, and boulders interbedded with sandstone and graywacke. Coasters Harbor Island (Figure 1-3) is mostly covered with this conglomerate material. Overlying the Pennsylvanian rocks of the Narragansett Basin are surficial deposits of Pleistocene sediments. These unconsolidated, glacial sediments range in thickness from 1 to 150 feet and consist of till, sand, gravel, and silt.

Many areas on Aquidneck Island, on which the NAVSTA Newport is located, obtain potable water from wells. Groundwater is obtained from the unconsolidated glacial till and outwash deposits, and from the underlying Pennsylvanian bedrock. The average depth to groundwater is 14 feet. In the NAVSTA Newport area, glacial till deposits are typically less than 20 feet thick. Well yields in these materials range from 1 to 120 gallons per minute. Although till is considered an unconsolidated deposit, the upper limit of this well yield is likely from an outwash deposit that is well sorted and stratified. Till wells typically

yield a few hundred gallons of water per day, or less than 1 gallon per minute. Bedrock well yields range from less than 1 to as much as 55 gallons per minute and are highly dependent on the presence of joints and fractures. Most groundwater is soft or moderately hard In scattered locations, pumping has led to salt water intrusion.

1.4.2 Site Geology and Hydrogeology

The geologic and hydrogeologic conditions at the OFFTA site have been determined using data from the various site investigations. This evaluation indicates that the site is underlain by the following materials: fill, consisting of construction debris and sand and gravel; silty sand and gravel; sand and gravel; peat and silt layer; and glacial till, consisting of silt sand and gravel. The thickness of the overburden deposits range from about 6 to 27 feet thick, excluding the elevated mound areas located on the site. The data from the monitoring wells indicate that the groundwater table occurs in the overburden across most of the site, but the water table lies in the bedrock in the eastern and southeastern portions of the site.

Soil present at the OFFTA site consists of native soil as well as imported soil used as fill and top soil in the various stages of the site's development. Upon closure of the fire fighting training facility in 1972, the training structures were reportedly demolished and buried in two mounds on the site, and the entire area was covered with topsoil. The origin of the imported soil is unknown.

The native soil was produced by the combination of physical and chemical processes acting upon the glacial till and regional and local bedrock materials present, which determine the mineralogical and chemical composition of the soil. The bedrock in the area (Rhode Island Formation) contains beds of meta-anthracite and anthracite that may be associated with elevated concentrations of arsenic and beryllium. Arsenic and beryllium are trace constituents of anthracite and other coal and petroleum-related minerals. It appears that the rock is a similar type (clastic metasedimentary rock type containing carbonate and sulfide minerals) to the bedrock that has been associated with elevated arsenic concentrations in groundwater in various locations throughout New England. If this rock type does contribute high levels of arsenic to groundwater, it is likely that soils generated from degradation of this material would also be anomalously high in arsenic and potentially other constituents, such as beryllium, related to the high carbon content (i.e., graphite, anthracite coal).

The bedrock at the site has been described as a conglomerate. The bedrock may contain localized units of sandstone. In addition, the conglomerate is believed to be in contact with the Rhode Island Formation. The Rhode Island Formation consists of metaconglomerates and metasandstones, as well as schist, carbonaceous schist, and graphite. The bedrock in the central portion of the site was blasted as

part of the development of the site. The blasting may have increased the fracture density in the bedrock in the areas of blasting and resulted in localized areas of higher hydraulic conductivity.

The groundwater elevations indicate that the groundwater at the site in general flows toward Narragansett Bay and Coasters Harbor located to the north to northwest and the east to northeast of the site, respectively. The depth to groundwater ranges from 4 to 9 feet below ground surface (bgs). Further review of the groundwater maps indicates that locally the groundwater flow can be impacted by groundwater recharge events such as rainstorms. This change in the groundwater flow pattern is believed to be caused by the presence of relatively impermeable paved areas on the site and adjacent to the site. These paved areas reduce the rate of groundwater recharge compared to the unpaved areas of the site.

A tidal influence study indicates that a tidal influence is felt along the shoreline in both the overburden and bedrock aquifers, but this influence does not extend beyond the shoreline.

The vertical groundwater gradients observed at monitoring well clusters indicate that both upward and downward vertical gradients were observed during the investigation (TtNUS, 2001). The vertical gradients in the upgradient monitoring well cluster MW-6 vary seasonally in response to changes in seasonal recharge events. The direction and magnitude of the vertical gradients in the shoreline well clusters MW-2 and MW-11 appear to be influenced by the changes in surface water elevations caused by the tides.

The horizontal groundwater gradients at the site were greater in the central and eastern portions of the site. The western portion of the site had a smaller gradient compared to the eastern portions of the site. This smaller gradient is due to the greater thickness of the overburden at this location.

The hydraulic conductivity of the overburden and bedrock aquifers was estimated using slug tests. This testing indicated that the hydraulic conductivity in the bedrock ranged from 0.61 feet per day at MW-6R to 120 feet per day at MW-11S. The well screen at MW-11S is set in fill material that includes construction debris and is not considered to be representative of the natural deposits. Hydraulic conductivity in the natural overburden deposits at the site ranges from 0.74 to 41 feet per day. The higher values are associated with the sand and gravel deposits at the site, and the lower values are associated with the silty sandy gravels The highest bedrock hydraulic conductivity measured was at monitoring well MW-8. This well is located in the area of the site where blasting was conducted as part of the site development activities.

The estimated average linear groundwater velocity at the site ranged from 0.39 feet per day to 3.1 feet per day. The higher values were calculated for the western portion of the site where the hydraulic conductivity of the overburden is greatest.

The overall conclusions regarding the site hydrogeology are as follows:

- Groundwater flows from the site and any potential source areas toward Narragansett Bay and Coasters Harbor.
- The groundwater flow rate is higher in the overburden compared to the bedrock aquifer.
- The groundwater migrates at the site at an estimated rate of between 145 feet per year (0.39 feet per day) and 1,131 feet per year (3.1 feet per day). At this rate of groundwater movement, it is estimated that groundwater from the upgradient side of the site would discharge into the surface water within 1 to 2 years or sooner. The actual time would depend on the location of the release relative to the surface water and the actual groundwater velocity.

1.5 TERRESTRIAL HABITATS

In 1976, OFFTA was converted from a training facility to a maintained recreational area called Katy Field. After the fire fighting activities ceased and the facility was demolished, the site was covered by a layer of topsoil ranging from 0.5 to 2 feet in depth. A playground, picnic area with an open pavilion and barbecue grills, and a baseball field were constructed on the property. The terrestrial habitat of the OFFTA property is a maintained (i e., mowed) grass lawn. The lawn extends north to the shoreline but is not found around the baseball infield, some of the playground areas, and areas otherwise occupied by buildings or pavement. A few trees, Austrian black pines and red cedars, are growing on the property (SAIC, 2000). In November 1998, the property was enclosed with a chain-link fence, and the recreational facility was closed.

The gravel and cobble shoreline to the north shows signs of erosion from wave action. Stone and construction debris have been placed in this area in an effort to retain the bank and reduce erosion. Construction debris includes granite blocks, concrete slabs, bricks, and asphalt.

In 1994, surveys conducted by Menzie-Cura & Associates, Inc., identified habitats and wildlife in the vicinity of OFFTA. The methods and detailed results of those surveys are reported in the Menzie-Cura & Associates 1994 report (SAIC, 2000).

1.6 MARINE HABITATS

The marine habitat discussion presented in this section is based on data collected during the marine Ecological Risk Assessment (ERA) for the OFFTA. Refer to the Ecological Risk Assessment Report (SAIC, 2000) for complete details.

Coasters Harbor is a shallow cove connected to the East Passage of Narragansett Bay. The harbor is open at each end, north and south of Coasters Harbor Island. A wide mouth faces west at the north end of the island, and a narrow opening at the head faces south at the south end of the island. The depth of the harbor at the mouth is approximately 20 feet at mean low water. At the head, the depth of the harbor is approximately 3 feet at mean low water. A tidal difference of approximately 3.5 feet has been recorded for Coasters Harbor. Circulation patterns and energies within the harbor are dominated by the tides and wind-driven flow. Hydrographic studies performed in 1996 indicate that water enters and exits at both the west and south openings and does not show a consistent directional flow pattern (Kincaid, Ellis, and DeLeo, 1996).

The estuarine system in the vicinity of OFFTA primarily includes subtidal environments, sand- or silt-substrate, with some eelgrass. The dominant taxa in the silty, subtidal, infaunal communities (less than 60 percent sand content) of Coasters Harbor included the bivalve *Nucula proxima*, *oligochaetes* species (aquatic worms), and the arthropod *Microdeutopsis*. The sandy, intertidal, infaunal communities (greater than 70 percent sand content) were found north of Coasters Harbor. Organisms and species that numerically dominated the benthic community at sandy intertidal stations included the snail *Littorina littorea*, the blue mussel *Mytilus edulis*, and, to a lesser extent, *oligochaetes* (SAIC, 2000).

The infaunal benthic, epibenthic, and pelagic communities in Coasters Harbor represent important marine habitats. Infaunal benthic communities exist within sediment depositional areas. Epibenthic communities exist on sediment depositional areas. Pelagic communities exist within the open water. Species within some of these communities are highlighted below.

The blue mussel is an epibenthic species. This species is a locally abundant and ecologically important filter-feeding bivalve found in subtidal and intertidal habitats. It is an important food source for fish, birds, starfish, and occasionally humans (SAIC, 2000). In the ERA this species was identified as a target receptor in the intertidal environment. Blue mussels in Coasters Harbor were considered surrogates for epibenthic species that are potentially exposed to water-borne and particulate-bound contaminants, which presumably originate from OFFTA.

The lobster (*Homarus americanus*) is also an epibenthic species. This species is locally abundant and an ecologically and economically important subtidal crustacean which feeds opportunistically as a scavenger. It is an important food source for fish and humans (SAIC, 2000). In the ERA this species was identified as a target epibenthic receptor in the subtidal environment. Lobsters in Coasters Harbor are potentially exposed to bulk sediment and water-borne contaminants, which presumably originate from OFFTA.

Hard clams (*Mercenaria mercenaria/Pitar morrhuana*) represent infaunal benthic species. These bivalve filter feeders are locally abundant, ecologically and economically important, and they provide a food source for birds and occasionally humans. In the ERA these species were identified as target receptors in the subtidal environment. *Mercenaria mercenaria* was used in the ERA as an indicator species for infaunal bivalves. Hard clams in Coasters Harbor are potentially exposed to bulk sediment and porewater contaminants, which presumably originate from OFFTA. In Narragansett Bay, *Mercenaria mercenaria* is an important commercial species for Rhode Island.

Cunner (*Tautogolabrus adspersus*) are pelagic finfish species. These species are locally abundant and ecologically important estuarine fish, which feed opportunistically upon both plants and animals (SAIC, 2000). They may serve as an important food source for birds and other fish. In the ERA these species were identified as target receptors in the pelagic community. Cunner were considered a surrogate for other pelagic fish species potentially exposed to contaminants in bulk sediment and the water column, which presumably originate from OFFTA.

Other species found during field investigations of the marine environment include oysters and bay scallops. Both of these bivalves are epibenthic and very important, both commercially and ecologically. Their presence in this area shows evidence of overall good health of the epibenthic environment in the subtidal areas. The benthic community is ecologically important and serves as a major food source for birds and fish, as well as for benthic and epibenthic invertebrates. As a whole, this community is potentially exposed to bulk sediment and water-borne contaminants, which presumably originate from OFFTA.

Note that the Rhode Island Department of Environmental Management (RIDEM) has designated the area of Narragansett Bay along the NAVSTA Newport shoreline, including Coasters Harbor, as a shellfish closure area due to known or potential sewage discharges in the area. However, the effectiveness of the ban for preventing shellfishing is uncertain, and the ban applies only to a few species of shellfish (bivalves only); it does not apply to lobster or finfish.

1.7 NATURE AND EXTENT OF CONTAMINATION

Results of the investigations indicated that site activities have resulted in the release of both organic and inorganic contaminants. A summary of the nature and extent of site contamination follows. A few volatile organic compounds (VOCs) were detected in surface soil, subsurface soil, and shoreline sediment at low concentrations below RIDEM residential soil criteria. VOCs were also detected in groundwater at concentrations below RIDEM criteria.

Semivolatile organic compounds (SVOCs) were detected in all media across the site. The most prevalent detected SVOCs were polynuclear aromatic hydrocarbons (PAHs). PAHs were detected at their highest concentrations in surface and subsurface soil and groundwater sample locations adjacent to Coasters Harbor. PAHs were also detected in all shoreline sediment locations, marine sediment stations, and storm water samples. The highest concentrations in marine sediment were detected at sampling stations nearest the shore in the vicinity of the central portion of the site. Only non-carcinogenic PAHs were detected in storm water samples. PAHs were detected in biota samples from all sampling stations. In clam tissue samples, the highest concentrations were detected in samples northwest of the site and at the reference station. In blue mussel tissue samples, the highest concentrations were detected in samples near the shore east of the site and at the reference station. In lobster tissue samples, the highest concentrations were detected in samples from a distant area opposite the central portion of the site. In fish tissue samples, the highest concentrations were detected in samples nearest the shore in the vicinity of the central portion of the site. Concentrations of PAHs in surface soil, subsurface soil, and shoreline sediment exceeded RIDEM Residential Direct Exposure Criteria for soil. Other SVOCs, other than PAHs, were detected infrequently and in low concentrations in surface soil and subsurface soil; none of these exceeded RIDEM Residential Direct Exposure Criteria for soil. They were also detected in groundwater at concentrations below RIDEM criteria.

Pesticides were detected in surface soil and subsurface soil across the site, in storm water, marine sediment, and in biota samples. Only one pesticide, endrin, was detected in groundwater. All pesticide concentrations were low. Among biota, the highest pesticide concentrations were detected in lobster. The highest marine sediment pesticide concentrations were detected offshore east of the site.

Polychlorinated biphenyls (PCBs) were detected infrequently in surface and subsurface soil at concentrations below RIDEM Residential Direct Exposure Criteria for soil. PCBs were detected frequently in biota tissue samples. In clam tissue samples, the highest concentrations were detected in samples offshore near the central portion of the site. In blue mussel tissue samples, the highest concentrations were detected in samples near the shore in the vicinity of the central portion of the site. In lobster tissue samples, the highest concentrations were detected in samples from a distant area

opposite the central portion of the site. In fish tissue samples, the highest concentrations were detected in samples in the nearshore area at the west end of the site. The fish tissues were found to contain higher concentrations of PBCs relative to other organisms.

Metals were detected throughout the site. Many are the result of the natural breakdown of soils and the parent bedrock and are naturally occurring in low concentrations. Concentrations of metals in site soil and groundwater were compared to site-specific background or upgradient samples. In general, metals were detected in higher concentrations on site. In surface soil the metals detected most frequently at concentrations greater than background were arsenic, magnesium, and potassium. Arsenic, beryllium, lead, and manganese in surface soil exceeded the RIDEM Residential Direct Exposure Criteria for soil. The highest concentrations of arsenic were detected in surface soil from the central portion of the site. In subsurface soil the metals detected most frequently at concentrations greater than background were barium, calcium, copper, lead, potassium, and zinc. Arsenic, antimony, beryllium, lead, and manganese in subsurface soil exceeded the RIDEM Residential Direct Exposure Criteria for soil. The highest concentrations of arsenic were detected in subsurface soil from the central portion of the site. The Navy's background study showed that on Coasters Harbor Island background arsenic concentrations are higher in the subsurface soils than in the surface soils. The elevated arsenic concentrations in the Coasters Harbor Island soils are believed to be attributable to the composition of the local and regional bedrock formations and the shallow depth of bedrock and glacial till in the area (TtNUS, 2000).

Concentrations of metals in site groundwater were compared to upgradient samples. In groundwater the metals detected most frequently at concentrations greater than upgradient groundwater samples were calcium, iron, magnesium, potassium, and sodium. The highest concentrations of metals were detected in samples from the north and central portions of the site. Nickel and copper concentrations in storm water samples exceeded marine ambient water quality criteria (AWQC).

Metal concentrations detected in shoreline sediment were comparable to surface soil samples. Arsenic, beryllium, lead, and manganese in shoreline sediment exceeded the RIDEM Residential Direct Exposure Criteria for soil. No spatial pattern was evident for metals in marine sediment samples. Metals detected in biota samples revealed no relative differences between samples and no differences from reference stations, with the exception of silver concentrations in lobster. Concentrations of silver in lobster tissue samples obtained from the western boundary of the study area were greater than other areas.

All surface soil samples analyzed for dioxins detected low dioxin concentrations toxicity equivalency (TEQ) well below the accepted dioxin residential clean-up goal of 1 ug/kg.

Total petroleum hydrocarbons (TPH) were detected in subsurface soil throughout the site. Detected TPH concentrations exceed the RIDEM Residential Direct Exposure Criteria for soil at depths of 3-11 feet bgs. Visually observable petroleum contamination was noted in the central portion of the site in soil sampled immediately above the water table.

1.8 FATE AND TRANSPORT

Spills and leaks of petroleum-based fuels and deposition of fuel combustion byproducts have introduced a wide range of petroleum hydrocarbons into the OFFTA site soil. Over the many years since fire fighting training activities have ceased, most of the volatile and soluble petroleum hydrocarbons have apparently partitioned to the vapor phase or dissolved phase and have been degraded or transported off site, leaving behind a relatively insoluble and recalcitrant petroleum residue. The much less soluble and volatile PAHs are still present at high concentrations in the soil in the central portion of the site. These contaminants will continue to leach into the groundwater, but the solubility and adsorptive properties of these contaminants should keep groundwater PAH concentrations low. As stated in the RI Report, the PAHs in the nearshore marine sediment likely originated from off-site as well as on-site sources.

Most of the arsenic and chromium in the OFFTA soil and groundwater may be naturally occurring. The near neutral pH and low dissolved oxygen content of the groundwater enhance the mobility of arsenic. By contrast, the presence of organic carbon in the soil zone and reducing conditions in the aquifer reduce the mobility of chromium in both environments. Off-site sources are probably a major contributor to the high chromium concentrations observed in marine sediment.

Lead concentrations in soil samples were often much higher than those in background samples, indicating the presence of lead contamination in the site soil. The lead appears to be immobilized by mineral solubility constraints and adsorption to soil organic matter, clay minerals, and metal oxyhydroxides. The lead in the marine sediment probably originated from both on-site and off-site sources.

1.9 HUMAN HEALTH RISK ASSESSMENT

The Baseline Human Health Risk Assessment (HHRA) evaluated exposure to surface soil, subsurface soil, shoreline sediment, and shellfish (lobsters, clams, and mussels). Although finfish samples were collected at the site, the fish collected are not an edible species, and it is believed that the shellfish ingestion would pose a higher and thus more conservative risk. This risk assessment considered exposures under a residential scenario, recreational and visitor scenarios, and a worker scenario, as well as ingestion of shellfish taken recreationally and for subsistence. Summaries of the risks and hazards

resulting from soil and sediment are presented in Tables 1-1 and 1-2, respectively. The EPA's target risk range is 1×10^{-4} to 1×10^{-6}, and RIDEM's benchmark is 1×10^{-5}.

For surface soil, the cancer risks under the residential, recreational, and worker scenarios were 2.5×10^{-5}, 5.4×10^{-6}, and below 1×10^{-6}, respectively. For subsurface soil, cancer risks under the residential and worker scenarios were 4.0×10^{-5} and 1.4×10^{-6}, respectively. No recreational exposures were calculated for subsurface soil. Non-cancer risks for surface and subsurface soil under all scenarios did not exceed 1.0 for any target organ group.

For shoreline sediment (sediment collected from the area between mean high water and mean low water), the cancer risks under the residential and recreational (shoreline visitor) scenarios were 2.2×10^{-5} and 1.6×10^{-6}, respectively. Non-cancer risks for shoreline sediment did not exceed 1.0 for any target organ group. Subtidal sediment was not evaluated under the human health risk scenarios.

For shellfish ingestion, the cancer risks exceeded the risk range of 1×10^{-4} to 1×10^{-6} under the subsistence fishing and lifetime recreational scenarios for lobster, clams, and mussels. The primary contributor to these risks is arsenic, and other contributors include PCBs, PAHs, mercury, cadmium, and chromium as calculated from analytical results.

Note that the subsistence fishing scenario is not likely to exist and is unlikely in the future because of the unsubstantiated assumption that all of the fisherman's catch would be obtained continually from waters adjacent to the OFFTA site, and because there are no local cultures (such as Native Americans) involved in subsistence fishing in this limited area

Arsenic is present in fish and shellfish tissue in the organic form of arsenobetanine, which is non-toxic. The risk calculations are performed based on the presence of this arsenic in its inorganic form. Therefore, the risk values for seafood ingestion from this site are biased high and could be overestimated by as much as a factor of 10. In addition, the exposure scenarios used for the risk assessment, particularly the use of subsistence fishing, are biased high, and it is highly unlikely that exposures to the degree used for risk estimation could effectively be achieved.

1.10 ECOLOGICAL RISK ASSESSMENT

The ERA (SAIC, 2000) was performed to assess ecological risks to the offshore environments of Coasters Harbor and Narragansett Bay from contaminants associated with OFFTA and included exposure and effects assessments, a characterization of risk, risk synthesis, and uncertainty analysis.

Risks were identified by stations based on summaries of each weight of evidence, focusing on the exposure (contaminants present) correlated to effects (reproduction and growth inhibitions, etc). Stations were rated from these summaries to exhibit properties where there is high, intermediate, and low probability for adverse risk to receptors present at those stations.

The assessment found a high probability for adverse risk at one station (Station 5), close to the outfall at the central shoreline of the site, likely from PAHs and metals present at this area. Intermediate probability for risk was estimated for a number of stations at the nearshore area and in the harbor sediment, including one reference station south of Coasters Harbor, but because a clear exposure-response relationship was not found, these risks may be considered acceptable from an ecological perspective. Low probability for adverse risk was estimated for the remainder of the stations, including one reference station and the nearshore stations more exposed to rough water conditions. The observed risks at these stations are considered acceptable from an ecological perspective. A baseline condition associated with relatively pristine conditions was not observed at any of the site or reference stations evaluated in this assessment.

2.0 DEVELOPMENT OF REMEDIATION OBJECTIVES

This section presents the initial steps in developing remedial alternatives to address the human health and ecological concerns identified at OFFTA and to comply with all applicable regulations. The process includes:

- Identifying ARARs and other environmental criteria that must be considered in developing RAOs (Section 2.1).

- Developing media-specific RAOs that are protective of human health and the environment and comply with ARARs. RAOs may specify COCs, exposure pathways and receptors, and preliminary remediation goals (PRGs) that identify potentially acceptable contaminant levels or ranges of levels for each exposure route (Section 2.2).

- Developing initial estimates of areas or volumes of media that should be addressed by the remedial alternatives (Section 2.3).

After these steps are completed, GRAs that will satisfy the site-specific RAOs can be formulated, and applicable technologies identified and evaluated. GRA development and technology identification, screening, and evaluation are presented in Section 3.0.

2.1 ARARs AND TBCs

ARARs and guidance to be considered (TBCs) are the regulatory and non-regulatory environmental criteria that must be considered while planning and implementing remedial actions. This section summarizes what constitutes ARARs and TBCs, and the various types of ARARs that must be considered in the FS.

ARARs are promulgated federal and state environmental and facility siting requirements that are determined to be legally applicable or relevant and appropriate to the hazardous substances, remedial actions, or other circumstances at a CERCLA site. The two categories of requirements are defined below.

- Applicable Requirements - Section 300.5 of the NCP defines applicable requirements as "those cleanup standards, standards of control, and other substantive 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 found at a CERCLA site."

- Relevant and Appropriate Requirements - Section 300.5 of the NCP defines relevant and appropriate requirements as "those cleanup standards, standards of control, and other substantive 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."

The NCP Section 300.430(E) states that on-site remedial actions at CERCLA sites must meet ARARs unless there are grounds for invoking a waiver. A waiver is required if ARARs cannot be achieved.

TBCs are non-promulgated criteria, advisories, and guidance issued by the federal or state governments. Along with ARARs, TBCs may be used to develop the remedial action alternatives necessary to protect human health and the environment.

ARARs and TBCs are further divided into three categories: chemical-specific, location-specific, and action-specific. These categories are briefly discussed in Sections 2.1.1 through 2.1.3.

2.1.1 Chemical-Specific ARARs and TBCs

Chemical-specific ARARs and TBCs are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in numerical values that establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. In general, chemical-specific requirements are set for a single chemical or a closely related group of chemicals. These requirements do not consider the mixture of chemicals. A set of chemical-specific ARARs and TBCs that may be applied to the OFFTA site is presented in Table 2-1.

2.1.2 Location-Specific ARARs and TBCs

Location-specific ARARs and TBCs are restrictions placed on the concentrations of hazardous substances or the conduct of activities solely because they are in specific areas. The general types of location-specific requirements that may be applied to the OFFTA site include coastal zone, water resources, and floodplain regulations. Location-specific ARARs and TBCs for the OFFTA site are presented in Table 2-2.

2.1.3 Action-Specific ARARs and TBCs

Action-specific ARARs and TBCs are usually technology- or activity-based requirements or limitations on actions taken with respect to managing hazardous substances, pollutants, or contaminants. These requirements generally focus on actions taken to remediate, handle, treat, transport, or dispose of hazardous substances, pollutants, or contaminants. These action-specific requirements determine how a selected alternative must be implemented. A set of potential action-specific ARARs and TBCs for the OFFTA site are presented in Table 2-3. However, action-specific ARARs can be unique to different alternatives evaluated and thus may be modified for each alternative later in this FS.

2.2 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

RAOs consist of medium-specific goals for protecting human health and the environment. The RAOs specify the media and COCs, exposure pathways and receptors, and acceptable contaminant levels or range of levels for each exposure pathway. By specifying both an exposure pathway and target contaminant level(s), the RAOs permit development of a range of alternatives that may achieve protectiveness by reducing exposure to contaminated media or reducing contaminant concentrations.

The following sections present the major components of the RAO development process: identification of the media of concern, identification of the chemicals of potential concern (COPCs) for each medium, development of PRGs, identification of COCs, and formulation of RAOs. Section 2.2.1 identifies the media of concern. Sections 2.2.2, 2.2.3, and their subsections then present the COPCs, PRGs, COCs, and RAOs for the selected medium.

2.2.1 Identification of Media of Concern

The media of concern are identified based on the results of site investigations, the site-specific HHRA and marine ERA, and an evaluation of compliance with chemical-specific ARARs. Site investigations have identified soil and sediment as potential media of concern. Shellfish are an indirect medium of concern, as it is assumed that they continue to be affected by sediment contaminants. Groundwater was not identified as a medium of concern because no contaminants were found at concentrations above applicable regulatory criteria. Surface water was also not selected as a medium of concern because there is no surface water at the site other than Narragansett Bay, which was not investigated during the RI. There are no continuing releases of contaminants to the air, and therefore air was not selected a medium of concern.

A brief discussion of each investigated medium is provided below.

Soil

During the various OFFTA site investigations, a total of 80 surface soil samples and 56 subsurface soil samples (excluding duplicates) were collected. Analyses performed on these samples include VOCs, SVOCs, pesticides/PCBs, metals, dioxins/furans, and TPH, although not all analyses were performed on all samples.

As presented in the RI Report (TtNUS, 2001), the estimated reasonable maximum exposure (RME) incremental cancer risks for a lifetime resident exposed to surface soil and subsurface soil were 2.5×10^{-5} and 4.0×10^{-5}, respectively. Both values are within EPA's target risk range of 1×10^{-4} to 1×10^{-6} but slightly greater than the 1×10^{-5} benchmark used by RIDEM. Non-carcinogenic risks for the residential child and residential adult did not exceed an HI of 1.0 for any target group for surface or subsurface soil. Both carcinogenic and non-carcinogenic risks were below EPA's risk range and RIDEM's benchmarks for recreational receptors and excavation workers.

The estimated percentage of children exposed to subsurface soil that are predicted to exhibit a blood lead level above 10 µg/dL is 18.6 percent. This exceeds EPA's protective level cutoff of 5 percent and indicates that adverse effects cannot be ruled out from lead exposure to residential children under these conditions.

Sediment

Samples were collected and analyzed for shoreline sediment (along the mid-tide line), nearshore sediment (along the low-tide line), and offshore sediment (beyond the low-tide line)

Five shoreline sediment samples were collected approximately midway between the mean low water and mean high water along the shoreline. The samples were all collected from the 0- to 0.5-foot depth interval and analyzed for VOCs, SVOCs, and metals. These samples were used in the HHRA to evaluate potential risk to people walking or playing along the shoreline.

Twenty-three sampling stations, located in Coasters Harbor, both immediately adjacent to and in the wider area surrounding the site were established for marine sediment (both nearshore and offshore) and biota sampling. Sediment and biota collected from these samples were used in the marine ERA to evaluate potential ecological risk.

Standards for contaminants in sediment are not set forth by state or federal government; therefore, the contaminants in sediment are evaluated as described in Section 7 of the RI Report (TtNUS, 2001).

Elevated levels of SVOCs and metals were found in both the shoreline and the marine sediment. Elevated levels of pesticides/PCBs were also found in the marine sediment.

As presented in the RI Report (TtNUS, 2001), the estimated RME cancer risk for a lifetime resident and a shoreline visitor exposed to sediment were 2.2×10^{-5} and 1.1×10^{-6}, respectively. The lifetime resident value is within EPA's target risk range of 1×10^{-4} to 1×10^{-6} but slightly greater than the 1×10^{-5} benchmark used by RIDEM. Non-carcinogenic risks for the adult and child residents and visitors did not exceed an HI of 1.0 for any target organ.

Shellfish

Natural populations of blue mussels, hard clams, cunner fish, and lobster were collected at a subset of the marine sediment sampling stations during the ERA and analyzed for SVOCs, pesticides/PCBs, and metals. These samples were used in the HHRA to evaluate potential risk from the ingestion of shellfish.

Standards for some contaminants in biota are set forth by the U.S. Food and Drug Administration (FDA). SVOCs, pesticides/PCBs, and metals were found in the biota samples; however, all detected concentrations of contaminants in biota tested at the site were below FDA action levels.

For shellfish ingestion, the cancer risks exceeded the risk range of 1×10^{-4} to 1×10^{-6} under the primary subsistence fishing and lifetime recreation scenarios for lobster, clams, and mussels.

Because shellfish are an indirect medium of concern and are only exposed to contamination via marine sediment, they will be addressed as part of the sediment evaluation.

Groundwater

A total of 34 groundwater samples (excluding duplicates) were collected during the various OFFTA site investigations. Groundwater contaminant levels were compared to the GB Groundwater Objectives for GB aquifers established in the RIDEM Remediation Regulations. The groundwater beneath Coasters Harbor Island (locality of the OFFTA site) is classified as GB, indicating that it is not suitable for use as a current or potential source of drinking water, as described in Rule 9.01(c) of the Rhode Island Rules and Regulations for Groundwater Quality. Because the aquifer will not be used for drinking water, the contaminant levels were not compared to maximum contaminant levels (MCLs) promulgated under the Safe Drinking Water Act.

The groundwater contaminant levels do not exceed RIDEM GB Groundwater Objectives for any contaminant, although RIDEM does not provide values for SVOCs, pesticides, or metals for GB aquifers. Because there are

no exceedances of the RIDEM GB Groundwater Objectives and federal MCLs are not applicable, groundwater is eliminated as a medium of concern.

2.2.2 Medium of Concern: Soil

For each medium of concern, the remaining components of the RAO development process will be completed: identification of the COPCs, development of PRGs, identification of the COCs, and formulation of RAOs. The following subsections present these elements for soil.

2.2.2.1 Identification of Chemicals of Potential Concern in Soil

COPCs for soil were identified in the RI Report (TtNUS, 2001). These COPCs were selected primarily based on the maximum concentration exceeding the associated risk-based concentration (RBC) based on a target cancer risk of 1×10^{-6} or a non-cancer hazard quotient (HQ) of 0.1. The RBCs used for comparison were obtained from the EPA Region 3 listing for residential soil exposure (with RBCs based on non-cancer effects adjusted from an HQ of 1.0 to an HQ of 0.1 to protect against the possibility of additive toxic effects from multiple chemicals). However, the COPC selection in the RI did not consider the Direct Exposure Criteria or the Leachability Criteria from the RIDEM Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases, DEM-DSR-01-93, or more commonly known by its short title, Remediation Regulations. Examination of the soil database indicated that there would be several chemicals that had not been selected as COPCs that exceeded the RIDEM Residential Direct Exposure Criteria. Therefore, the COPC selection process has been reconsidered for the purposes of this FS.

For many remedial sites under the authority of CERCLA, the COPCs are determined using the same methodology as used in the OFFTA RI Report – screening against RBC tables. Once the list of COPCs is determined, site-specific RBCs are calculated for each of the chemicals and may include several exposure pathways, including direct exposure and leachability. These site-specific RBCs, as well as other considerations such as background concentrations, quantitation limits, and ARARs, are used to develop PRGs for each chemical. A comparison of the PRGs is made against the database, and any chemical with a concentration exceeding its PRG is selected as a COC. Any soil above PRGs will require remediation or risk management.

This primarily risk-based process for selecting COPCs, PRGs, and COCs, which is common at CERCLA sites, will still be used in this FS. However, a second parallel process that considers the requirements of the RIDEM Remediation Regulations will also be used to select COPCs, PRGs, and COCs. For each process, a list of COPCs requiring further consideration will be developed; these lists will subsequently be combined to form a comprehensive list of COPCs requiring further consideration. PRGs will be selected for the combined list by using the more conservative value from each process and then making any adjustments for background

concentrations, quantitation limits, and ARARs. The two processes, termed Risk-Based COPC Selection and RIDEM-Based COPC Selection for purposes of this FS, are described in the following sections.

Risk-Based COPC Selection

As previously mentioned, COPCs for soil were identified in the RI Report. The Navy Interim Final Policy on the Use of Background Chemical Levels requires the initial screening to be comparison to risk-based benchmarks followed by a screening comparison to background. These COPCs were selected primarily based on the maximum concentration exceeding the associated Region 3 RBC for residential soil exposure based on a target cancer risk of 1×10^{-6} or a non-cancer HQ of 0.1. These COPCs are retained for further consideration. A qualitative risk evaluation of those chemicals that were screened out is provided in the HHRA.

According to Navy Policy, baseline risk assessments should not be conducted on chemicals that are present at levels less than background chemical levels. The policy requires that all chemicals that are screened out as a result of background considerations be discussed and documented in the risk characterization section of the baseline risk assessment report.

The HHRA presented in the RI Report indicated that higher-than-acceptable risk might occur through future on-site residential exposures to soil. A summary of the risk assessment results is presented in Table 1-1. The pathways that generate the greatest risk are the lifetime resident direct exposure to soil for carcinogens and the child resident direct exposure to soil for non-carcinogens. Therefore, the assumptions used in these scenarios were used to calculate site-specific RBCs The list of COPCs and associated site-specific RBCs are presented in Tables 2-4 and 2-5 for surface soil and subsurface soil, respectively. The tables also include detection frequency and maximum detected concentrations. A chemical was selected as a COPC requiring further evaluation if its maximum detected concentration exceeded the RBC for either carcinogenic or non-carcinogenic risk. The site-specific RBCs are based on a risk of 1×10^{-6} for carcinogens and an HQ of 1.0 for non-carcinogens. A check of the cumulative risk from all chemicals left in the soil will be performed later in the process to determine if it exceeds 1×10^{-5} for carcinogens and a hazard index (HI) of 1.0.

Essential nutrients were not considered as COPCs, including calcium, chloride, magnesium, potassium, and sodium. In addition, several specific metals (aluminum, cobalt, copper, and iron) were excluded from consideration as COPCs because these substances have only provisional toxicity criteria, based on risk assessment guidance from EPA Region I (EPA, 1994). Therefore, these common minerals/essential nutrients were not considered as inorganic COPCs.

RIDEM-Based COPC Selection

Because the COPC selection in the RI did not consider the Direct Exposure Criteria or the Leachability Criteria from the RIDEM Remediation Regulations, the COPC selection process has been reconsidered. To broaden the list of COPCs, a conservative approach was taken to identify all chemicals detected in the soil as COPCs. These chemicals are listed in Tables 2-6 and 2-7 for surface and subsurface soil, respectively. As with the Risk-Based Selection, essential nutrients were not considered as COPCs, including calcium, chloride, magnesium, potassium, and sodium. Aluminum, cobalt, copper, and iron were also excluded from consideration as COPCs because of the lack of finalized toxicity criteria.

The Remediation Regulations provide the methodology for determining remedial objectives for soil. The soil objectives are broken into two components: Direct Exposure Criteria and Leachability Criteria. The Direct Exposure Criteria can be applied to either residential or industrial/commercial scenarios, and the Leachability Criteria is applied depending on the classification of the underlying groundwater. For the OFFTA site, residential reuse is assumed for the direct exposure route, and the groundwater beneath the site is classified GB. GB groundwater is designated as not suitable for public or private drinking water use.

The Remediation Regulations divide the Direct Exposure Criteria and Leachability Criteria into Method Requirements. Method 1 Soil Objectives are published in tables in the regulation, and site concentrations are compared directly to these numbers. If no Method 1 Soil Objective has been promulgated for a specific chemical, then a Method 2 Soil Objective is calculated for the site using the prescribed method and assumptions provided in the regulation. For direct exposure, the Method 2 calculations are the same as those for the Method 1, but for the leachability calculations, Method 2 allows for the consideration of limited site-specific information. The regulations also provide for Method 3 objectives, which are calculated using highly site-specific information; however, no Method 3 objectives have been calculated for the OFFTA site.

Many of the chemicals detected at OFFTA have Method 1 Objectives listed in the tables. For those chemicals not listed, Method 2 Direct Exposure Criteria were calculated for use in the screening process. These calculations are presented in Appendix A.

The list of RIDEM-Based COPCs and associated criteria for Residential Direct Exposure and GB Leachability are presented in Tables 2-6 and 2-7 for surface soil and subsurface soil, respectively. The tables also include detection frequency and maximum detected concentrations. Chemicals exceeding either the direct exposure criteria or leachability criteria are retained as COPCs requiring further consideration.

Combined List of COPCs

The screening process resulted in two sets of COPCs (Risk-Based and RIDEM-Based) which are combined to form a comprehensive list of COPCs requiring further consideration. Table 2-8 presents the combined list and a summary of the selection.

2.2.2.2 Development of Preliminary Remediation Goals for Soil

PRGs are developed to determine the degree of remediation necessary to protect human health and the environment. PRGs can be developed based on chemical-specific ARARs, when available, or risk-based factors. The PRGs must be protective of each of the principal receptors identified at the site (future residents for the soil at OFFTA), and they should be reasonable and practical to implement.

As with the selection of COPCs, PRGs were developed using both a risk-based approach and a RIDEM-based approach. In addition, chemical-specific ARARs and TBCs, inorganic background concentrations, and analytical detection limits are considered in developing PRGs. Each of these methods used in developing the PRGs is discussed below. Table 2-9 presents the candidate list of PRG numerical values identified for each COPC in soil requiring further consideration.

Risk-Based PRGs: The RBCs calculated for the risk-based COPC selection were used as the risk-based PRGs. PRGs for carcinogens were based on a risk of 1×10^{-6} for carcinogens and an HQ of 1.0 for non-carcinogens, with the more conservative of the two being chosen as the risk-based PRG.

RIDEM-Based PRGs: The lower of the Residential Direct Exposure Criteria and GB Leachability Criteria was used as the RIDEM-based PRG for each chemical.

Chemical-Specific ARARs/TBCs: PRGs for three chemicals are determined by guidance and TBCs. These chemicals are Aroclor-1254, lead, and 2,3,7,8-TCDD. EPA's OSWER Directive 9355.3-01, *Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (October 1988) recommends an acceptable value of 1 mg/kg PCBs for residential sites. For lead, a value of 400 mg/kg has been established for residential areas based on the Lead-Uptake/Bio-Kinetic Model, Version 0.4, developed by EPA's Office of Health and Environmental Assessment. OSWER Directive 9200.4-26, *Approaches for Addressing Dioxins in Soil at CERCLA and RCRA Sites* (April 13, 1998) provides guidance in establishing cleanup levels for dioxins. A concentration of 1 μg/kg of dioxins (as 2,3,7,8-TCDD TE) has been established for soil involving future residential exposure scenarios.

Background Concentrations: Because they are naturally present in soil, some inorganics may be present in the background areas not affected by past site activities or releases at concentrations higher than risk-based PRGs or RIDEM remediation standards. Because it may not be reasonable or possible to remediate the site soil to concentrations lower than levels naturally present in the area soil, background concentrations may be considered as PRGs for inorganic contaminants. The background concentration values (95 percent upper tolerance levels), based on data from undisturbed locations on Coasters Harbor Island sampled during February 2000 for the Background Soil Investigation Report (TtNUS, 2000), were calculated and are included in Table 2-9. The background concentration value for arsenic was calculated by RIDEM and is based on the same dataset.

In the background study conducted by the Navy to establish background levels for metals in soils at the OFFTA site, surface and subsurface soil samples were collected from areas at the south end of Coasters Harbor Island determined to be unaffected by the site or by other non-uniformly distributed anthropogenic sources. The areas selected for background sampling all had the same USDA soil classification as those at the OFFTA site (Udorthents-Urban Land Complex). Data analysis and statistical testing were then performed on validated data to determine appropriate background metals values for the site.

In general, the Navy's background study showed that background metals concentrations are higher in the subsurface soils than in the surface soils. The calculated background values for two metals in surface soil (arsenic and beryllium) and three metals in subsurface soil (arsenic, beryllium, and manganese) exceed the RIDEM Direct Exposure Criteria. The calculated arsenic background [upper tolerance limit (UTL)] value for subsurface soil (42.8 mg/kg) is considerably higher than both the calculated surface soil background value (5.55 mg/kg) and the RIDEM soil criteria for arsenic (1.7 mg/kg). The elevated metals concentrations in the Coasters Harbor Island soils are believed to be attributable to the composition of the local and regional bedrock formations and the shallow depth of bedrock and glacial till in the area (TtNUS, 2000).

RIDEM performed a separate statistical evaluation of the background data and developed a combined surface and subsurface arsenic level of 6.2 mg/kg (Kulpa, 2000; Kulpa, 2001). Although RIDEM provided a discussion of their statistical approach which included combining the surface and subsurface soil data sets and in deleting higher values from the background data set. RIDEM did not provide supporting calculations.

The Navy did not agree with RIDEM's approach. As discussed above, the Navy's evaluation shows that there is a significant difference between the surface and subsurface metal data sets, and a higher background value for arsenic in subsurface soils is supported by the analysis. Despite these objections, to maintain progress in the OFFTA site remediation the Navy accepted RIDEM's arsenic soil background level of 6.2 mg/kg as a proposed PRG for OFFTA surface and subsurface soils (Shafer, 2001).

Detection Limits: The analytical detection limits for the organic and inorganic chemicals were also considered in developing the PRGs. Because the PRGs have to be detectable by current analytical means to ascertain attainment of these levels, analytical detection limits were designated as the lowest achievable PRGs. Two chemicals, benzo(a)pyrene and dibenz(a,h)anthracene, are controlled by quantitation limits, as footnoted in the RIDEM Method 1 Direct Exposure tables.

After consideration of the above criteria, Table 2-9 presents the proposed soil PRGs and the basis for their selection. The proposed PRGs are the chemical concentrations that would provide the highest level of protection of human health given the nature of the site, and the availability of a regulatory standard, and is reasonably achievable by current remediation techniques. The PRG values in Table 2-9 indicate that RIDEM remediation standards are, in general, more conservative than the risk-based standards.

One additional criterion of the RIDEM Remediation Regulations must be checked to ensure that the selected PRGs are protective of human health. As part of the RIDEM remedial objectives, the cumulative excess lifetime cancer risk posed by the contaminated site must not exceed 1×10^{-5}, and the cumulative HI posed by the site must not exceed 1 for any target organ. This check will be performed after the COCs are selected.

2.2.2.3 Identification of Chemicals of Concern in Soil

COCs serve to focus the RAOs to those contaminants that pose a potential threat to human health or the environment. For each soil COPC retained for further consideration, the maximum detected concentration is compared with its PRG. Any chemical with an exceedance is retained as a COC. Table 2-10 presents such a comparison and lists the chemicals retained as COCs. For each COC, all detected concentrations are compared with the corresponding PRG to delineate the extent of contamination requiring remediation. Tables 2-11 and 2-12 present the list of COCs and PRG exceedances for surface soil and subsurface soil, respectively.

Because the PRGs for carcinogens were developed using a risk of 1×10^{-6} for each individual chemical, the risk due to COCs at the site will be beneath the 1×10^{-5} level as long as there are less than 10 chemicals present at a given location. By reviewing Tables 2-11 and 2-12 which list the PRG exceedances, only two samples have more than 10 COCs. However, these samples, MW102 and TP3, do not contain more than 10 *carcinogenic* COCs. Therefore, the selected PRGs are consistent with the site's meeting the 1×10^{-5} risk level. The HHRA presented in the RI was used to check the requirement that the cumulative HI not exceed 1 for any target organ. The risk assessment identifies no exposure scenario in which the HI exceeds 1, indicating compliance even if no remediation takes place at the site. Therefore, no adjustments are required for the soil PRGs.

2.2.2.4 Remedial Action Objectives for Soil

RAOs consist of medium-specific or operable unit-specific goals for protecting human health and the environment. The objectives should be as specific as possible but not so specific that the range of alternatives that can be developed is unduly limited.

The findings of the RI and HHRA and the RIDEM Remediation Regulations were used in developing the RAOs for contaminated soil. As presented in the RI, the estimated risks associated with ingestion of and dermal contact with site soil by future adult and child residents exceed RIDEM's target incremental lifetime cancer risk (ILCR) of 1×10^{-5}. Contaminants in the soil also exceed RIDEM's direct exposure criteria and GB leachability criteria (leachability for TPH only in seven samples). The soil contamination also exceeds EPA guidelines for lead. Therefore, long-term soil response actions are necessary to protect human health and groundwater quality.

Future use of the site can also be considered in the formulation of RAOs. The Navy has indicated that the OFFTA site should be available for unrestricted, residential use after the remedial action has taken place. Further, the Navy wishes the time duration of remediation to be as short as possible, to allow redevelopment of the site in a timely manner.

The soil RAOs for protection of human health are:

- Prevent the ingestion of and direct contact with vadose zone soil containing contaminants that exceed PRGs developed for the OFFTA site.
- Allow reuse of the site as an unrestricted, residential area as soon as reasonably practicable. Part of the unrestricted use includes no controls on the vadose zone soil.

The soil RAO for the protection of the environment is:

- Prevent, to the extent practicable, the migration of TPH in soil to groundwater.

2.2.3 Medium of Concern: Sediment

The following subsections present the identification of the COPCs, development of PRGs, identification of COCs, and formulation of RAOs for sediment.

2.2.3.1 Identification of Chemicals of Potential Concern in Sediment

The sediment COPCs are those chemicals that were found to present increased incremental human health or ecological risks. A summary of the risk assessment results is presented in Section 1.0. Sediment contaminants that pose excess human carcinogenic risk greater than 1×10^{-6} or have chemical-specific hazard quotients greater than 1.0 for human non-cancer risk are selected as COPCs for sediment. Sediment was found to pose cancer risks through direct contact to human receptors above the target level. The chemicals exceeding are arsenic, benzo(a)pyrene, benzo(a)anthracene, benzo(k)fluoranthene, and dibenz(a,h)anthracene. Increased risk through one other human exposure scenario was also noted via ingestion of shellfish. Those contaminants that posed excess risk for shellfish ingestion were dominated by arsenic, but included the same chemicals as for direct exposure, as well as indeno(1,2,3-cd)pyrene, PCBs, cadmium, chromium, and mercury. All of these chemicals are selected as COPCs for shellfish ingestion.

Note that the risk described in Section 1.0 reflects risk calculated based on the inorganic form of arsenic. This may be an overly conservative assumption, considering that it has been documented that arsenic in shellfish is 80 to 90 percent organic, which is not toxic (FDA, 1993). Therefore, while arsenic contributes to elevated risk, risk managers should consider arsenic as a secondary contributor only. Proper adjustments are made to account for the presence of organic arsenic during the development of PRGs as described in the following sections.

Sediment COPCs were also selected based on the ERA (SAIC, 2000). The COPCs identified as posing potential increased risk for ecological receptors as well as those selected based on human health risk are presented in Table 2-13.

2.2.3.2 Development of Preliminary Remediation Goals for Sediment

The objective of the PRG development process is to select a manageable number of COCs and corresponding concentrations that, when implemented as cleanup criteria, will address the areas of unacceptable human health and/or ecological risk. The PRGs must be protective of each of the principal receptors identified at the site (humans and aquatic organisms) and should be reasonable and practical to implement. The complete PRG development process for this site is presented in Appendix B.

At the OFFTA site, actionable risk was estimated and calculated in the RI Report and supporting documents for sediment under the following receptor scenarios:

- Human lifetime resident exposure to shoreline sediment
- Subsistence and lifetime shellfish ingestion

- Ecological risk associated with the nearshore and offshore sediment

To establish cleanup goals for these three receptor scenarios, PRGs have been developed for each scenario separately and applied to the exposure areas described below. Where PRGs overlap, the more conservative will apply. For the purposes of this PRG approach and for the FS, the following clarifications are made:

Shoreline Sediment – Area along the mid-tide line (Sampling Stations SSD-333 through SSD-337). Samples were collected and used for human health risk (shoreline visitor scenario) only. Shellfish are not present in this area. Data available include bulk chemistry.

Nearshore Marine Sediment – Area along the low-tide line (Sampling Stations OFF-1 through OFF-7). Data available include bulk sediment chemistry, some shellfish, and porewater. Samples were collected for ecological risk, but shellfish data were also used for human health risk evaluation under shellfish ingestion scenarios.

Offshore Marine Sediment – Area beyond the low-tide line (Sampling Stations OFF-8 through OFF-21). Data available include bulk sediment chemistry, fish, shellfish, benthic diversity, elutriate, toxicity, and porewater. Samples were collected for ecological risk, but shellfish data were also used for human health risk evaluation under shellfish ingestion scenarios.

PRGs have been developed for the three exposure pathways for sediment and shellfish: human lifetime resident exposure to shoreline sediment, shellfish consumption, and ecological risk. The methodology for each of these is summarized below. Appendix B of this report provides detail for development and selection of PRGs. Calculated PRG values are presented in Table 2-14.

Sediment PRGs Based on Human Lifetime Resident Exposure to Shoreline Sediment

Evaluation of risks presented in the OFFTA RI for shoreline sediment indicates that cancer risks exceeded 1×10^{-5} and non-cancer risks did not exceed an HI of 1 for any target organ.

PRGs are back-calculated from the target risk for the lifetime resident exposure to sediment for contaminants that exceed a contaminant specific risk of 1×10^{-6} in the RI Report. These contaminants include arsenic, benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, and dibenz(a,h)anthracene. PRGs are developed for site-specific contaminants targeted to the 1×10^{-6} risk level to ensure total cancer risks are less than the RIDEM criteria of 1×10^{-5}. The risk-based PRG for arsenic is compared to the background arsenic level (6.2 mg/kg) to assure that the final PRG is not below background.

Sediment PRGs Based on Shellfish Consumption

Evaluation of risks presented in the OFFTA RI for shellfish ingestion indicates that cancer risks in lobster exceeded 1×10^{-5} for arsenic for recreational fishermen and subsistence fishermen and for PCBs, benzo(a)pyrene, and benzo(b)fluoranthene for only the subsistence fishermen. Subsistence fishing is typically evaluated as a matter of course in the HHRA process. However, the risk assessment uncertainties explain that the subsistence fisherman scenario does not exist at the site and is unlikely in the foreseeable future. Although the study area is within an area closed to shellfishing, EPA reports that some amount of lobster collection may occur in Coasters Harbor. Based on the presence of recreational fishing and commercial lobster pots, there is a need to address this risk endpoint.

In order to address the risk associated with shellfish collections from this area, PRGs are developed for shellfish ingestion. Contaminants that were predicted in the RI Report to provide a cancer risk of 1×10^{-6} and/or an HQ of 1.0 under the subsistence fishing/ingestion of lobster and shellfish scenario are selected as COPCs. This scenario/endpoint was particularly selected because it provided the highest risk and the largest list of COPCs. The risk assessment notes that arsenic dominates the risk under the shellfish ingestion scenarios. This is likely because arsenic risks from shellfish are based on EPA's slope factor, accepted for inorganic forms of arsenic in the environment. However, arsenic in seafood exists in an organic state known as arsenobetaine. Approximately 80 to 90 percent of the arsenic in seafood is not toxic (FDA, 1993). To adjust for this overestimate, the equation for target arsenic concentrations in the shellfish tissue includes a 10 percent adjustment factor before sediment PRG calculation.

The target tissue concentrations are back-calculated using the equations and ingestion rates for recreational exposure to tissue concentrations presented in the RI Report. These tissue concentrations are then converted to sediment concentrations using average Bioaccumulation Factors (BAFs) and Biota-Sediment Accumulation Factors (BSAFs) from co-located shellfish/sediment sampling stations to yield an estimate of the total organic carbon (TOC)-normalized sediment COPC concentration. BAFs are coefficients used to predict metals accumulation in animal tissues from at each station. BSAFs are the coefficients used to predict accumulation of organic chemicals in tissues. For this site, both types of coefficients were calculated in the ERA using station-specific data normalized for TOC and lipid content as appropriate.

The shellfish tissue COPC concentration corresponding to a target cancer risk of 1×10^{-6} and/or HQ of 1.0 for the lifetime recreational fishing scenario is divided by the average BSAF, and the resulting values are adopted as the human-health based PRG for offshore sediment. Since there are only ten COPCs for shellfish ingestion, this approach ensures that the aggregate cancer risk from all COCs combined will not exceed 1×10^{-5}.

Conversion of tissue PRGs to sediment PRGs is performed using BAF (metals) and BSAF (organics). Calculations for sediment/ tissue PRG conversions are described below:

For metals, the BAF = median across all sampling locations of the ratio:

- (Tissue Conc. at location / Sediment Conc. at location)

For organics, the BSAF = median across all sampling locations of the ratio:

- (Tissue Conc. (dry wt.) at location / Lipid Conc. at location) / (Sediment Conc. at location / TOC Conc. at location)

Note that sediment data are in dry weight units and tissue data are in dry weight units for the BSAF and BAF values to be meaningful. This requires that the tissue toxicity effects value (TEV) be converted to a dry weight value as follows:

- tissue TEV (dry wt.) = tissue TEV (wet wt.) * 100 / (average % moisture of tissue samples)

The human health sediment PRG is then calculated as follows:

- human health sediment PRG for metals = tissue TEV (dry wt.) / BAF

- human health sediment PRG for organics = [average TOC conc * tissue TEV (dry wt.) / average tissue lipid conc.] / [BSAF]

Appendix B provides input and resulting values for the calculations described above. Table 2-14 presents the calculated PRG values.

Sediment PRGs Based on Ecological Risk

Evaluation of the risks presented in the ERA for the OFFTA site indicate that high potential for risk to ecological receptors is present at one nearshore sediment station (correlated exposure and effects relationships identified) and that an intermediate potential for risk to ecological receptors is present at eight other stations (exposure and/or effects measured). These risks are likely present due primarily to PAHs and, to a lesser degree, metals in sediment. However, the metals in the sediment are unlikely to be toxic, based on the simultaneous extracted metal and acid volatile sulfides (SEM-AVS) data.

EPA has developed Draft Sediment Guidelines for six metals (cadmium, copper, lead, nickel, silver, and zinc) (EPA, 2001). Appendix B of this report details how these guidelines are applied to the site sediment data. The basic premise of the SEM-AVS guideline is that if there is more AVS than SEM (on a molar basis) in a sample, than the AVS will bind the six metals and they will not be toxic (EPA, 2000). The following equation is used to represent this process:

$$\sum \text{SEM} - \text{AVS} \leq 1.0 = \text{non-toxic sediment from the SEM metals}$$

Appendix B summarizes the SEM-AVS results for each station and the sediment concentrations for the metals that are included in the SEM analysis. These results indicate high AVS in sediment at the site, indicating no toxic effects from the metals present. Note that although silver was not included in the SEM analysis, when AVS is present, any silver in the sediment is not of toxicological concern, and none should occur in the interstitial water (EPA, 2000). For the OFFTA site, PRGs are not calculated for the six SEM metals (cadmium, copper, lead, nickel, silver, and zinc) because none of these metals is expected to cause toxicity.

The following steps are used in the PRG process to calculate the Ecological Risk-Based PRGs:

Step 1: Identify the water quality screening value (WQSV) that will be used for comparison to the porewater concentrations.

Step 2: Determine the porewater concentrations for the sediment samples.

Step 3: Classify the toxicity test samples as toxic or non-toxic.

Step 4: Group the samples as toxic or non-toxic for each receptor. Do not include the reference stations in these groupings.

Step 5: Summarize the results of the toxic and non-toxic samples using site-specific toxicity data to determine a No Observed Effects Concentration (NOEC).

Step 6: Compare the aquatic NOEC (in Step 5) to the Reference Station porewater concentration (RSV) to ensure that the PRGs will not be below the reference concentrations.

Step 7: Divide the porewater concentrations by the TEVs at each station (except the reference stations) to get the TEV-Hazard Quotient (TEV-HQ) to limit the number of chemicals for which PRGs are developed to the chemicals that are causing the highest risk at each station.

Step 8: Calculate and develop the sediment baseline PRG:

$$PRG = Cs * (TEV) / (PW)$$

Where:

TEV	=	Toxicity Effects Value (μg/L)
Cs	=	Chemical concentration in the sediment (μg/kg)
PW	=	Porewater concentration for the chemical (μg/L)

The final step of the PRG development process for sediment is to define recommended PRG values from the baseline PRGs calculated. This is typically done to rectify the resulting action areas to the areas of the site where elevated potential for risk was determined in the ERA. However, for this site, the calculated PRGs focus on high-risk areas and the areas immediately surrounding those areas; this step does not appear necessary, and the calculated baseline PRGs are recommended for implementation

A summary of all sediment PRGs is provided in Table 2-14.

2.2.3.3 Identification of Chemicals of Concern in Sediment

For each sediment COPC retained for further consideration, the maximum detected concentration is compared with its PRG. Any chemical with an exceedance is retained as a COC. Table 2-15 presents such a comparison and lists the chemicals retained as COCs. For each COC, all detected concentrations are compared with the corresponding PRG to delineate the extent of contamination requiring remediation. Table 2-16 presents the list of COCs and PRG exceedances for sediment.

One PRG exceedance was noted for the offshore sediment. 2-methylnaphthalene was detected at 210 μg/kg in deep sediment (1.6-1.8 feet below surface) at station OFF-18, located at the former area of a boathouse and bridge noted in Figures 1-5 and 1-6. Surface sediment at this location (0-0.5 feet) is below PRG concentrations, and deeper sediment (3.5-3.6 feet) is also below PRG concentrations. These data indicate the presence of a small pocket of slightly elevated PAHs, with only one exceedance of an OFFTA PRG. Because this small area does not impact surface sediment where bioturbation is expected to occur, and because the location indicates another possible source long since removed, it is not recommended that this area be considered a remedial action area for OFFTA.

2.2.3.4 Remedial Action Objectives for Sediment

RAOs for site sediment were formulated based on the site-specific risk assessments, the RI marine investigations, COC identification, and PRG development presented in the preceding sections. RAOs were identified for the marine portions of the site as an entire area, since, although physical separations are within the study area, no specific areas pose different receptor risks. Therefore, all marine sediments were considered in developing RAOs and in developing and evaluating remedial alternatives.

The RAOs for the sediment address the COC-related risks identified in the HHRA and the marine ERA. In accordance with CERCLA, the RAOs developed for these areas address unacceptable risks to humans identified in the HHRA and potential risks to aquatic organisms identified in the marine ERA. The RAOs identified for the Coasters Harbor marine sediment are presented below.
The RAOs for the protection of human health are:

- Prevent direct contact of shoreline sediment to a recreational user.
- Prevent human ingestion of shellfish that are impacted by sediment with COC concentrations exceeding the selected PRGs.

As shown on Table 2-16, no sediment sampled from this site exceeds the PRGs calculated for shellfish ingestion. Therefore, while the RAO for protection of persons ingesting shellfish is still valid, it is presumed to be already met unless additional data are collected that would prove otherwise.

The RAO for the protection of the environment and ecological receptors is:

- Prevent exposure of aquatic organisms to sediment with COC concentrations exceeding the recommended PRGs.

2.3 ESTIMATION OF AREAS AND VOLUMES

The areas and volumes of soil and sediment to be considered for remediation were estimated based on current data and the PRGs identified in Sections 2.2.2 and 2.2.3.

2.3.1 Soil

The samples exceeding soil PRGs have been identified on Figure 2-1 along with their corresponding concentrations. Separate indications are made for the surface and subsurface samples that exceed PRGs.

Figure 2-2 shows the former location of the OFFTA facility overlaid on samples exceeding PRGs. This indicates the correlation between the old facility and the location of contaminated soil.

Areas and volume estimates for the soil were calculated based on the samples exceeding PRGs listed in the exceedance table. The basis for these volume estimates is presented in Appendix C. The first estimate of volume made was for the three mounds on the site. It is assumed that the mounds consist mostly of debris with a layer of topsoil and vegetation on top. For the remaining surrounding terrain, the site was divided into several areas, and estimates were made for depths of excavation for each area (Figure 2-3). The depth of each area was used to determine volumes.

After the volumes were determined, an estimate of the percentages of soil and debris were made. For the mounds, 50 percent of the volume is assumed to be debris. For the remaining parts of the site, 20 percent of the volume was estimated to be debris.

The areas and volumes to be addressed in the FS are as follows:

- The total volume of the mounds is 10,900 cubic yards (cy). The subtotals for each mound are 6,900 cy for the central mound, 3,400 cy for the western mound, and 600 cy for the small, far-western mound.

- The areal extent of contaminated soil is approximately 229,000 square feet (5 3 acres).

- The volume of debris and contaminated soil in the vadose zone (excluding the mounds) is approximately 38,600 cy.

A summary of the volumes is as follows:

Cubic Yards of:	Mounds	Remaining Areas	TOTAL
Debris	5,450	7,720	13,170
Soil	5,450	30,880	36,330
TOTAL	10,900	38,600	49,500

2.3.2 Sediment

The areas of concern and the receptors for each area of sediment are presented on Figure 2-4. Areas and volume estimates for these areas are presented below. The basis for these volume estimates is presented in Appendix C.

Sediment samples were collected in three different areas along the shore. Samples SSD-333 through SSD-337 were collected along the shoreline at the mid-tide line. Samples OFF-1 through OFF-7 were collected from the nearshore marine sediment at and immediately below the low-tide line. The remaining samples, OFF-8 through OFF-23, were collected from offshore marine sediment seaward of the low-tide line.

The areas surrounding samples SSD-333 through SSD-337 are areas of concern based on those samples exceeding human health PRGs. The areas surrounding samples OFF-3, OFF-5, and OFF-6 are also areas of concern based on those samples exceeding ecological PRGs. In addition, the area around OFF-4 is included as an area of concern because of being situated between areas 3 and 5. By including area 4, the area of concern becomes one contiguous area. Sample OFF-18 exceeded PRGs based on ecological risk; however, it is not included as an area of concern because of its location near a former boathouse in Coasters Harbor.

Samples at all stations included a depth interval of 0-0.5 feet. At three locations, 5, 5E and 6, sediment samples were collected to a maximum depth of approximately 3.5 feet These samples revealed concentrations of COCs above PRGs only within the upper intervals (maximum depth of approximately one foot). Therefore a depth of 2 feet has been selected as a conservative target interval for determination of sediment volume for this FS.

Based on current data, the areas and volumes to be addressed in the FS are as follows:

- The areas surrounding the shoreline samples along the mid-tide line were estimated by extending inward to the shoreline and outward to the low-tide line. The area exceeding the shoreline PRGs is approximately 37,270 square feet. The volume is approximately 2,760 cy.

- The areas surrounding the ecological sample locations exceeding PRGs along the low-tide line were extended inward to the shoreline and seaward to the midpoint of the low-tide line and the offshore samples. The area exceeding the nearshore PRGs is approximately 86,380 square feet. The volume is approximately 6,400 cy.

- The area around nearshore sample OFF-4 is also considered for remediation due to its proximity to other contaminated samples. Its area is 27,440 square feet, and its volume is 2,030 cy.

- Because of the overlap of the shoreline and nearshore areas, the total volume of remediation will be less than the sum of the above numbers. Also, in the area where shoreline sediment will be remediated but nearshore sediment will not, a 10 percent contingency has been added to the shoreline

area. After making these adjustments, the total volume of sediment, both shoreline and nearshore, to be remediated is 9,670 cy.

Areas of eelgrass may be present beyond the low tide line. If necessary, the location of any eelgrass beds will be determined during the predesign steps. Until then, it is assumed that eelgrass is present in 25 percent of the contaminated area beyond the low tide line in areas 3, 4, and 5.

- The area of eelgrass in this contaminated zone is assumed to be approximately 10,800 square feet. The associated volume of the sediment in the eelgrass beds using a 2-foot depth is 800 cy.

A summary of the areas and volumes is as follows:

Medium	Area (sq. ft)	Volume (cy)
Sediment	130,500	9,670
Eelgrass	10,800	800

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Technology identification and screening are important preliminary steps in developing remedial alternatives. In this phase of the FS, potentially applicable technology types and process options are identified. The technologies and process options are then screened by evaluating each with respect to technical implementability, thereby reducing the number considered further. The technologies and process options considered to be implementable are then evaluated in greater detail, and representative options are selected for subsequent development and evaluation of remedial alternatives.

The identification, screening, and evaluation of technology types and process options are summarized below by completing the following steps:

- Developing GRAs for each medium of concern that will satisfy the RAOs.
- Identifying and screening remedial technologies applicable to each general response action.
- Evaluating and selecting representative technology types and process options.

Section 3.1 identifies the GRAs that may be implemented at the site. Section 3.2 discusses the technologies to be considered and provides a preliminary screening to focus the technology types deemed applicable. Section 3.3 presents a discussion of the final evaluation and selection of representative technologies. A summary of the technologies retained for further consideration in site-specific remedial alternatives is provided in Section 3.4.

3.1 GENERAL RESPONSE ACTIONS

General response actions describe categories of actions that could be implemented to satisfy the RAOs for each medium of concern at a site. GRAs may include treatment, containment, excavation, extraction, disposal, institutional controls, or a combination. Typically, in developing remedial alternatives, combinations of GRAs may be identified to fully address all the RAOs.

GRAs identified as applicable for remediating soil and marine sediment at the site include the following:

- No Action
- Limited Action
- Containment
- Removal

- Disposal
- Treatment

These GRAs are summarized below.

3.1.1 No Action

Under the no action option, the site is left "as is," without implementing institutional controls, containment, removal, or treatment. This option, furthermore, does not provide for monitoring or placing access restrictions on contaminated media at the site. However, examination of this option is retained throughout the FS process, as required by the NCP. Although this option requires no remedial action, it provides a baseline against which other GRAs can be evaluated.

3.1.2 Limited Action

The limited action option is comprised primarily of institutional controls and access restrictions that may limit use or access to the site to reduce or eliminate risks of exposure to hazardous materials. Limited actions also include implementing a long-term monitoring program to assess changes in environmental conditions existing at the site. While institutional controls and access restrictions alone do not reduce the toxicity, mobility, or volume of contaminated media through direct means, naturally occurring attenuation processes may reduce contaminant concentrations over an extended period of time. Data generated from long-term monitoring activities would provide information to assist in determining the rate of natural attenuation, as well as the potential migration of COCs from the soil and marine sediment. Monitoring would also provide information on which to base a decision regarding the need to implement additional remedial actions should migration be observed.

3.1.3 Containment

Containment options reduce potential exposure risks through the application of physical means. Physical barriers prevent direct contact with contaminated media as well as managing potential erosion or migration. Barriers may consist of permeable or impermeable caps and may be comprised of natural and/or synthetic materials. Containment may also reduce the mobility of the contaminated media but does not affect toxicity or volume.

Containment of sediment in an underwater, marine environment also involves issues related to settling of the capping material during placement, and both permeability and transmissivity of the cap once in place. The cap must also be designed to withstand erosion forces of tides, waves, and localized currents.

3.1.4 Removal

Removal technologies are used to collect contaminated media from their present locations and move them for subsequent disposal. For soil, removal is typically performed by excavation equipment, such as trackhoes, backhoes, and pan scrapers. For marine sediment, removal is typically performed by the use of excavation and/or dredging equipment. Removal reduces the volume of contaminated media remaining on site and allows site conditions to attenuate more rapidly than they would under natural conditions.

Removal of marine sediment also involves materials-handling issues related to sediment suspension, sediment dewatering, and residual water treatment/disposal. Sediment dewatering is necessary as a processing step to render the removed material suitable for disposal as a consolidated solid. Residual water generated from dewatering the sediment removed from the marine environment may require treatment prior to direct discharge into Narragansett Bay or disposal at a local publicly owned treatment work (POTW).

3.1.5 Disposal

Disposal technologies are combined with removal and/or treatment technologies to develop alternatives to clean up contaminated media at the site. Depending on the nature of the contaminated media, disposal may include the following options: disposal at an off-base Resource Conservation and Recovery Act (RCRA) Subtitle C/RCRA Subtitle D landfill or treatment, storage, and disposal facility (TSDF); disposal on land at a designated on-site/on-base location; or, for marine sediment, contained aquatic disposal (CAD). Disposal in a properly secured and maintained manner reduces the mobility of the contaminated media.

3.1.6 Treatment

Treatment technologies can be implemented in situ or combined with removal and disposal options. Following removal, contaminated sediment may require treatment to reduce their volume, mobility, and/or toxicity prior to disposal. Treatment options include technology types and process options using thermal, physical, chemical, and/or biological means. Treatment options include in situ and ex situ processes. Ex situ processes may further include both on-site/on-base and off-base options.

For sediment, in situ treatment options may not be viable, primarily due to the location of the remedial areas within the marine environment. The nature of the contaminants, their relatively low concentrations, and the extremely low PRGs set for the coastal area may further deem in situ options ineffective and

inefficient in achieving the RAOs. However, options are identified and evaluated for applicability in Section 3.2.

Ex situ treatment options are included for consideration in combination with off-base disposal options. Based on existing analytical data, marine sediment removed from the site is expected to be of acceptable quality for direct disposal in a RCRA Subtitle D landfill without pretreatment. However, because the available data regarding contaminant concentrations at depth is limited, and sediment has not been sampled for all disposal parameters, contingency has been included for treating a fraction of the materials removed. This contingency includes treating approximately 20 percent of the material from the site area because of elevated concentrations of metals and PAHs. In addition, use of a bulking agent may be necessary for all materials dredged due to the free liquids that may be present.

3.2 PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL

3.2.1 Preliminary Screening

A variety of technologies and process options exist for each GRA described in Section 3.1. A range of these technology types and process options was identified and screened to focus on relevant technologies and process options. Summaries of the identification and preliminary screening of technologies and process options appropriate for soil are provided in Table 3-1. Many options are eliminated based on technology screening. All options not eliminated due to overall applicability concerns (technical implementability) are retained for a more detailed evaluation in Section 3.2.2.

3.2.2 Evaluation of Technologies and Process Options

In this step, process options considered implementable following preliminary screening are evaluated in greater detail prior to selecting representative process options to use in developing remedial alternatives. One representative process option is selected, if possible, from each technology category to simplify subsequent development and evaluation of alternatives without limiting flexibility during remedy selection or remedial design. The evaluation criteria include effectiveness, implementability, and cost, with a focus on effectiveness. Brief descriptions of the criteria are as follows:

- Effectiveness focuses on the potential ability of a process option to handle the estimated areas or volumes of media, and to meet the remediation goals identified in the RAOs, the potential impacts to human health and the environment during construction and implementation, and the technical

reliability (effectiveness of innovative versus well-proven technologies) with respect to the contaminants and conditions at a site.

- Implementability encompasses both the technical and institutional feasibility of implementing a process. The preliminary screening of technology types and process options was based on an evaluation of technical implementability issues in order to eliminate options that were clearly ineffective or unworkable at a site. The subsequent, more detailed, evaluation places greater emphasis on the institutional aspects of implementability [coordination with various regulatory agencies and contractors; the availability of treatment, storage, and disposal services; and the availability of necessary equipment and skilled workers to provide long-term operation and maintenance (O&M) services, etc.].

- Cost plays a limited role in the screening of process options. Options are evaluated based on relative capital and O&M costs (whether the costs are high, medium, or low relative to the other options in the same technology type). At this point in the evaluation, the cost analysis is based on engineering judgment and not on detailed estimates.

A discussion of the screening and detailed evaluation of technology types and process options using these criteria is provided in the following sections.

3.2.2.1 No Action

The no action scenario is considered to provide a baseline level to which other remedial technologies and alternatives can be compared. Under this scenario, no removal or treatment of the contaminated soil would occur.

Assessment of this option is as follows:

- Effectiveness: The no action option would not achieve any of the remedial objectives. Human health risks associated with exposure to carcinogenic and non-carcinogenic contaminants in the soil could become greater over time as a result of erosion; long-term protection of groundwater would not be provided since the contaminants in the soil would potentially continue to migrate into the groundwater; and re-use of the property would be impeded. Because contaminated soil would remain on site, 5-year site reviews would be conducted to evaluate the contamination status of the area. Other effectiveness criteria are not applicable for the no action scenario.

- Implementability: No implementability considerations are associated with the no action scenario.

- Cost: Because no actions would be taken other than 5-year reviews of site status, capital and O&M costs would be negligible.

The no action scenario is retained as a baseline, as required by the NCP.

3.2.2.2 Limited Action

The components of limited action that are evaluated in this screening are deed restrictions, fencing, posting of signs, and monitoring.

Deed Restrictions

Deed restrictions are institutional controls that are placed on property deeds. These restrictions are used to limit future activities or uses of a site to prevent human contact with contaminated soil or groundwater. Deed restrictions commonly used to reduce exposure to contaminated media include prohibitions on installing water supply wells, restrictions on types of development allowed (e.g., no residential use), and limitations on certain types of construction (e.g., excavation, buildings with basements).

The State of Rhode Island requires Environmental Land Usage Restrictions (ELURs) in most cases where contaminants are left in place at concentrations greater than those protective against direct exposure associated with residential land usage. The decision document describes the types of pollutants, location of pollutants, and what activities and uses are prohibited.

Assessment of this option is as follows:

- Effectiveness: Deed restrictions could be applied to limit construction activities and future residential or commercial/industrial land use of the area. However, historically these restrictions, by themselves, have not proven to be reliable because they are difficult to enforce and would not address the contaminant migration component of the remedial objectives. They are also not effective for ecological receptors. Deed restrictions, by themselves, are not effective in the long term to reduce risk and, therefore, would not achieve the RAOs. No additional risks to human health and the environment would directly result from the imposition of deed restrictions.

- Implementability: Deed restrictions may be implemented by the property owners or by state and local authorities. If property owners are not willing to place the desired restrictions on the property deeds, legal action by state or local authorities would be necessary to implement the

deed restrictions. Deed restrictions are typically difficult to implement. Consideration of the availability of TSDFs and the need for permits are not applicable to deed restrictions.

- Cost: Because only administrative actions would be taken, capital costs would be very low and no O&M costs would be incurred.

Deed restrictions are not effective as a stand-alone action, although they can be used in conjunction with other technologies to restrict future exposure to surface or subsurface contaminants. However, they do not meet the RAO to allow unrestricted residential use of the site. Therefore, deed restrictions are eliminated from further consideration.

Fencing

Fencing may be used as a barrier to restrict access to areas where contaminants are present at or near the surface, thereby limiting direct contact exposure. Access to the OFFTA, where contaminated soil is present, is currently restricted by fencing.

Assessment of this option is as follows:

- Effectiveness: Fencing would not meet RAOs because it does not reliably prevent access to contaminated soil and would not reduce leaching of contamination to groundwater and surface water. Fencing provides limited protection of human health by discouraging trespasser access to areas where subsurface contamination is present. The effectiveness of fencing in reducing access and thereby reducing exposure to contaminants is highly dependent on fence maintenance and on the determination of the would-be trespasser. Even well-maintained fencing is not likely to be completely effective in restricting access, particularly by a determined trespasser. Fencing would not be effective in the long term to eliminate risk. Fencing would not protect ecological receptors or groundwater nor limit the migration of contaminants from source areas and may impede re-use of the property. No additional risks to human health and the environment would result from the installation of fencing.

- Implementability: Installation of new fencing is readily implementable. Contractors and equipment are readily available for fence installation and maintenance.

- Cost: The capital and O&M costs for fencing would be low.

Fencing is not effective for achieving RAOs because it does not allow unrestricted residential reuse of the site. Fence installation is eliminated from further consideration.

Post Signs

The posting of signs may be used as a means of indicating areas where contaminants are present at or near the surface, thereby preventing direct contact exposure. The OFFTA, where contaminated soil is present beneath the surface, is currently posted with warning signs.

Assessment of this option is as follows:

- Effectiveness: Sign posting would not meet RAOs because it does not reliably prevent access to contaminated soil and would not reduce leaching of contamination to groundwater and surface water. Signs provide only limited protection of human health by discouraging trespasser access to areas where subsurface contamination is present. Signs would not be effective in the long term to eliminate risk, nor would they protect ecological receptors or groundwater nor limit the migration of contaminants from source areas. No additional risks to human health and the environment would result from the installation of signs.

- Implementability: Installation of new signs is readily implementable. Contractors and equipment are readily available for sign installation and maintenance.

- Cost: The capital and O&M costs for posting signs would be low.

Signs are not effective for achieving RAOs because they do not allow unrestricted residential reuse of the site. Sign installation is eliminated from further consideration.

Monitoring

Sampling and analysis of groundwater and soil at the OFFTA could be used to evaluate potential leaching and migration of contaminants from contaminant source areas. Monitoring will be required for any technologies and process options where contaminated soil remains in place.

Assessment of this option is as follows:

- Effectiveness: Monitoring would not reduce the toxicity, mobility, or volume of contaminants in the soil or groundwater. Monitoring would not provide any additional protection to the environment

since contaminants could spread into uncontaminated or less contaminated areas. However, by serving as a warning mechanism, periodic monitoring would allow the responsible agency to gauge contaminant migration and determine whether future actions are necessary to mitigate risk. Monitoring will facilitate evaluating the effectiveness of source control measures in preventing contaminant leaching.

- Implementability: A monitoring program could be readily implemented at the OFFTA, using existing monitoring wells. For soil samples, additional borings or hand augers would be necessary.

- Cost: The capital and O&M costs for periodic monitoring would be moderate.

Monitoring would be an effective and easily implementable method of observing contaminant migration and the progress of remediation. Alone, it would provide no additional protection of human health or the environment. Monitoring will be required for any technologies and process options where contaminated soil remains in place. As a result, monitoring will be retained for consideration only in combination with other process options.

3.2.2.3 Containment

The following containment technologies and process options for contaminated soil are evaluated in this section.

- Impermeable Cap
- Permeable Cover

Impermeable Cap

Capping involves installing an impermeable barrier over the contaminated soil to restrict access and reduce infiltration of precipitation into the subsurface. Impermeable and low-permeability barriers are appropriate where soil contamination threatens groundwater or surface water. Regrading of soil prior to capping may be required. Cap materials can either be natural or synthetic. Frequently used materials include low-permeability clays such as bentonite and synthetic membranes such as high-density polyethylene, polyvinyl chloride, and Hypalon. These materials are typically covered with a clean fill and vegetation (grass) or asphalt to protect them against damage caused by puncturing and weathering. Capping will involve regrading to provide for erosion and drainage control.

Assessment of this option is as follows:

- Effectiveness: Capping can achieve RAOs associated with preventing exposure to contaminated soil and minimizing the migration of contaminants from the site, although it would not meet the RAO of allowing unrestricted residential reuse of the site. Capping is a reliable technology that would reduce risk to human health by providing a barrier between contaminated soil and potential receptors, thus significantly limiting fugitive dust emissions and direct contact with contaminated soil. Capping would be effective in limiting the infiltration of precipitation and consequently the potential leaching of contaminants from unsaturated soil to groundwater. Capping alone would not prevent potential contaminant leaching to groundwater from saturated soil. Because capping does not alter the natural flow of groundwater through the subsurface, any contaminated saturated zone soil would remain a continuing source of contamination to groundwater. Capping only isolates existing contamination, offering no decrease in contaminant levels. Since contaminants remain in place, the long-term effectiveness of capping depends on adequate long-term cap maintenance. During remedial activities, fugitive dust emissions would have to be controlled to minimize effects on human health and the environment. Emissions can be safely and adequately controlled using standard engineering controls such as dust suppressants and enclosures.

- Implementability: The construction of an impermeable cap is readily implementable at the OFFTA. A variety of proven capping materials can be used, including soil, clay soil, geosynthetic membranes, and combinations of these materials. Due to the mounds and grade differential across the OFFTA, significant earthwork may be required to achieve proper slopes for cap stability and surface water runoff control. Remedial activities involving capping are relatively common and can be conducted by many contractors. No permits or other administrative requirements would be necessary for on-site activities. Because the contaminated soil would remain in place, the need for TSDFs is not a concern. However, deed restrictions and ELURs would be required in conjunction with capping to limit the future use of the capped areas or actions that may damage the cap. Long-term groundwater monitoring would also be implemented.

- Cost: The capital costs for conventional cap construction are expected to be moderate. O&M costs are low for an impermeable cap.

Capping with an impermeable barrier would prevent exposure to contaminated soil and minimize migration of source contaminants, but it would also prevent unrestricted residential reuse. It will be eliminated from further consideration.

Permeable Cover

Permeable covers and soil caps are lower cost alternatives to conventional caps. Permeable covers and soil caps are placed over contaminated soil to prevent access to surficial and near-surface contaminants. Because they provide little or no reduction in infiltration, they are appropriate for use where direct exposure to contaminated material is to be prevented and contaminant leaching to groundwater is not a concern.

Assessment of this option is as follows:

- Effectiveness: Installation of a permeable cover or soil cap would achieve the RAO for preventing direct exposure to contaminated soil but would not achieve the RAO for protection of the environment, which is to minimize leaching of contaminants to groundwater or the RAO that the site be available for unrestricted residential reuse. A permeable cover or soil cap would not be effective in preventing infiltration or potential leaching of soil to groundwater. Because contaminated soil remains in place, the effectiveness of a permeable cover or soil cap in preventing direct exposure to contaminants depends on adequate cover maintenance.

- Implementability: Construction of a permeable cover or soil cap is readily implementable at the OFFTA. Specialized construction techniques are not required, and qualified contractors and necessary cover materials are readily available. Earthwork requirements would be similar to those described for an impermeable cap. No permits or other administrative requirements would be necessary. Because no off-site activities would be occurring, the need for TSDFs is not a concern. Deed restrictions and ELURs would be required in conjunction with the cover to limit the future use of or intrusion into the covered areas.

- Cost: The capital and O&M costs for a permeable cover are low.

Because a permeable cover or soil cap would not achieve all RAOs, use of a permeable cover or soil cap will be eliminated from further consideration.

3.2.2.4 Removal

The only component of removal that is evaluated in this screening is bulk excavation.

Bulk Excavation

Bulk excavation involves the large-scale removal of soil and debris. Traditional excavation equipment such as hydraulic excavators, scrapers, bulldozers, wheel loaders, and off-road dump trucks are typically used. The excavated material could be loaded onto trucks and hauled to an approved treatment or disposal facility, or could be treated and/or relocated at the site or another location on base. Backfilling open excavations would require the use of clean fill or decontaminated, solidified/stabilized soil.

Assessment of this option is as follows:

- Effectiveness: Bulk excavation would be effective for handling the volume of contaminated soil and noncontaminated debris at the OFFTA. Control of fugitive dust would be required during excavation to protect on-site workers and the surrounding community. Standard engineering controls such as dust suppressants and negative pressure enclosures would adequately and safely collect and control airborne contaminants. This technology, combined with subsequent treatment and/or disposal, would be a permanent solution and attain the goals outlined in the RAOs. The quantities of material involved and the types of soil at the study area can be excavated.

- Implementability: Excavation is readily implementable for shallow, easily accessible soil. Deeper soil and saturated soil at or near the water table are somewhat more difficult to excavate. Excavation would most likely be accomplished in a staged approach to minimize adverse conditions. Contractors for this type of excavation are readily available in this area. If excavated materials are disposed of off base, transportation and TSDF requirements must be met.

- Cost: The costs range from moderate for shallow soil to high for deeper, saturated soil.

Removal of contaminated soil by bulk excavation is retained for further evaluation in conjunction with other process options.

3.2.2.5 Disposal

Landfills

Contaminated soil and debris may ultimately be disposed of at a regulated landfill. Depending on the contaminants and their concentrations, the material may or may not require treatment prior to landfilling.

The treatment, if necessary, can be part of a process option chosen in the selected remedy or can be provided by the operator of the landfill as part of the disposal service.

The types of landfills considered are hazardous waste landfills and non-hazardous waste landfills. The principal differences between these landfills are the administrative requirements and the design of the cap and base to prevent infiltration and leaching. These two types of landfills are described as follows:

- **Hazardous Waste Landfill**

Hazardous waste landfills are regulated by the landfill and post-closure requirements of RCRA (40 CFR 264 and 265, Subparts G and N), the Toxic Substances Control Act (TSCA) for PCBs, and state and local laws. Among the requirements are foundations, double liner systems, leak detection systems, leachate collection and treatment systems, capping, post-closure inspections and maintenance of the landfill (30-year period), and post-closure groundwater monitoring (30-year period).

- **Non-hazardous Landfill**

Non-hazardous landfills include municipal waste landfills and construction/demolition waste landfills. Design and operating practices are somewhat similar to hazardous waste landfills; however, the permitting requirements are not as stringent. These landfills may be used for wastes that are not classified as hazardous but may still significantly contaminate groundwater. Among the design and operating requirements are foundations, liner systems, leak detection systems, leachate collection and treatment systems, capping, post-closure inspection and maintenance of the landfill, and post-closure groundwater monitoring.

Hazardous and non-hazardous landfills are currently available off base to accept wastes.

Assessment of this option is as follows:

- Effectiveness: Disposal of soil and debris at a landfill would achieve the RAOs by preventing direct exposure to and the leaching of contaminated soil. Since a significant portion of the soil is contaminated with metals, which are not easily treated, a landfill may be required for ultimate disposal. The options available include a secure hazardous waste landfill and a non-hazardous landfill. The selection of one landfill over another depends on the relative toxicity of the soil and debris, the risks associated with their disposal, and the regulatory requirements. The contaminated soil contains elevated levels of metals and organics.

Soil containing contaminants restricted under RCRA land disposal restriction (LDR) regulations would have to be treated to acceptable levels prior to landfilling In addition to these RCRA-mandated LDRs, pre-treatment requirements are typically established by individual landfill operators to comply with their respective permit conditions. The treatment can usually be provided by the operator of the landfill as part of a turnkey package of the disposal service.

Disposal of hazardous substances would have to comply with the CERCLA Off-site Rule 40 CFR 300.440), which establishes criteria for selecting an appropriate TSDF and prohibits the use of a RCRA facility for off-site management of Superfund hazardous substances if the facility has significant RCRA violations.

A hazardous waste landfill is appropriate for disposal of most contaminated soil, and a non-hazardous landfill may be appropriate for slightly contaminated soil or those that have been treated by a process option.

Landfills should be capable of handling the volumes of contaminated soil and debris from the OFFTA. Landfilling alone would achieve some of the remediation objectives. Because concentrations of leachable metals are present in the site soil, some treatment (either as part of the selected remedy or by the landfill operator) would likely be required prior to landfilling the contaminated soil. Risks to human health and the environment associated with implementing landfilling are considered minor.

- Implementability: Landfill disposal is implementable, although availability of off-base landfill capacity may be limited. For off-base landfill disposal, transportation requirements must be met to transport the various types of wastes from the base. Treatment of the wastes in compliance with RCRA LDRs prior to landfilling may be required for some of the soil. Off-base TSDFs are available to receive this waste, although the high volume of soil and debris from the OFFTA may limit the number of facilities willing to accept the material. Also, no hazardous waste landfills are located in Rhode Island (the closest is Model City, New York). Equipment and resources needed to transport the soil are readily available.

- Cost: For disposal in off-base landfills, the relative capital costs are moderate to high (depending on the distance of transportation of wastes). Disposal in hazardous waste landfills is the most expensive of the landfill options, while disposal in a non-hazardous landfill is less expensive.

Landfilling is an effective containment option for the contaminated soil and is implementable when using existing off-base facilities. As a result, off-base landfill disposal is retained for further consideration.

On-Site Backfill

Treated or clean soil would be used to backfill any excavated areas at the site. If an on-site treatment process is also used in conjunction with excavation, backfilling is accomplished using the treated soil. After the contaminated soil has been treated and certified as being "clean," it is placed back in the excavated areas from which it was removed. If no treatment process is included with the excavation, clean soil would be brought in from off site to use for backfill.

Assessment of this option is as follows:

- Effectiveness: Backfilling is an effective method for disposing of treated soil. Clean, off-site soil could also be effectively used as backfill if no treatment process is used at the site.

- Implementability: Backfilling with treated soil is implementable when used in conjunction with a treatment process. No treatment is necessary if clean backfill is brought in from an off-site location.

- Cost: Backfilling costs are considered to be minimal.

Backfilling with either treated soil or clean, off-site soil is retained for further consideration.

Treatment, Storage, or Disposal Facility

A TSDF is a facility that accepts contaminated material for disposal and provides treatment prior to landfilling, if necessary. A TSDF is similar to a landfill facility other than the treatment aspect; in fact, many landfill operators also operate TSDFs. TSDFs are controlled by regulations contained in 40 CFR Parts 264 and 265. The TSDF and the transporter would be selected during the remedial design phase of the remediation program from an approved list generated by RIDEM.

Several factors should be considered when selecting a TSDF for treatment of hazardous wastes. RCRA permits are likely to be required. Other federal and state hazardous waste permits as well as air quality permits might also be required.

The generator must be careful when choosing a TSDF because some may still be under interim status, which could cause a liability problem. Usually, a facility can accept several types of waste but offers only one waste management technology, such as a secure landfill, solvent extraction, or incineration.

References should be checked and validated before choosing a TSDF. Also, a reliable hazardous waste transporter should be chosen.

Assessment of this option is as follows:

- Effectiveness: TSDFs, if operated properly, are effective in treating, storing, and disposing of hazardous wastes.

- Implementability: The TSDF option is implementable. Facilities are available to accept the types and volumes of waste from the OFFTA, although an out-of-state facility would likely be required

- Cost: Costs for TSDFs are high.

The use of TSDFs is retained for further consideration.

3.2.2.6 Treatment

The following treatment technologies and process options for contaminated soil are evaluated in this section.

- Immobilization
  - Solidification/Stabilization
- Thermal Treatment
  - Incineration
  - Low-Temperature Thermal Stripping
  - Vitrification
- Physical Treatment
  - Soil Flushing
  - Soil Washing
- Chemical Treatment
  - Solvent Extraction
- Biological Treatment
  - Aerobic Biodegradation

Discussion of in situ treatment indicates that treatment takes place in the ground without excavation. Ex situ treatment implies the removal of waste from the ground and transport to a treatment unit either on the site or off base.

Solidification/Stabilization

Solidification/stabilization processes involve mixing excavated contaminated materials with proportional amounts of treatment reagents to physically or chemically decrease the mobility of contaminants in the waste and convert the contaminants to a less soluble, less mobile, or less toxic form. The end product may be a standing monolithic solid or may have a crumbly, soil-like consistency, depending on the amount and type of reagent added. A typical ex situ treatment system consists of a materials feed system, a reaction tank equipped with mixing equipment, and an area for curing. For in situ treatment, the treatment reagent is mixed into the soil using large augers or tilling equipment. The effectiveness of the immobilization process is evaluated by running leaching tests such as the Toxicity Characteristic Leaching Procedure (TCLP) or the Synthetic Precipitation Leaching Procedure (SPLP) on the treated materials.

Portland cement and pozzolanic (silica-bearing substances) materials such as fly ash are widely used as immobilization reagents because of their ready availability and effectiveness in binding contaminants to minimize leaching. A number of additives have been developed for use with cement and pozzolanic materials to improve the physical characteristics and decrease the leaching losses from the resulting solidified material. In addition to cement and pozzolanic materials, other reagents such as organic polymers, thermoplastic materials, and sorbents are also utilized; however, these materials are less effective in binding the contaminants, and the resultant products are more susceptible to degradation and leaching than materials stabilized with cement or pozzolanic materials.

Solidification/stabilization has reportedly been capable of immobilizing up to 99 percent of inorganic contaminants at some sites, but was not successful at significantly immobilizing organic contaminants (EPA, 1989a). One study indicated that VOCs did not leach from the solidified matrix; however, the study attributed the removal of VOCs in part to volatilization during extraction and mixing (Longest, 1989). Another study found that PCBs were 100 percent immobilized, but also suggested that TCLP results from samples of the soil before treatment indicated no PCB leaching (EPA, 1989b).

Assessment of this option is as follows:

- Effectiveness: Solidification/stabilization processes have been widely demonstrated in full-scale remediation projects to immobilize metals in soil. Cement- and pozzolan-based methods have been effective for immobilizing heavy metals including lead. Additionally, the cured mix can be solidified as a soil-like product that could be more easily placed as fill.

Immobilizing of organic compounds may be effective in some cases. Data from several bench-scale studies indicate that immobilization of SVOCs, particularly PAHs, is possible. PCB immobilization may be effective, particularly where initial concentrations are low. However, limited test data are available to support this conclusion (EPA, 1990). Solidification/stabilization would likely be effective in immobilizing lead and other metals, even at high concentrations, to prevent their leaching into the groundwater; however, immobilization of all organic contaminants is unlikely, although some reduction in leachability for select organics may occur.

Solidification should be capable of handling the volume of contaminated soil at the site. The process should be effective in significantly reducing the mobility of the COC metals present in the soil. The treated residual must be tested prior to disposal to ensure that disposal requirements are met. Implementation should not cause any adverse effects on human health and the environment.

Solidification/stabilization can be performed either ex situ or in situ. However, the ex situ process is more easily controlled and is therefore easier to ensure effective treatment. In situ treatment may prove more difficult to ensure complete mixing of treatment reagents, especially at depth.

- Implementability: Solidification/stabilization is an implementable technology for soil at the site but would require significant staging. The equipment and resources necessary to treat the soil are available, with several vendors capable of performing this work. If treatment is conducted on site, either in situ or ex situ, space is necessary to build or stage treatment equipment; constraints such as meeting TSDF requirements and facility monitoring are also concerns. If the treatment is conducted off base, some facilities are available that would be able to treat this waste. Transportation and TSDF requirements must be met for off-base treatment. If solidification is chosen as a treatment option, it would probably be better implemented in situ at the site due to the large extent of contaminated soil. Also, less effort would be required to stage equipment for in situ treatment than for ex situ treatment.

- Cost: The relative capital and O&M costs are moderate for cement-based solidification/ stabilization methods.

In situ solidification/stabilization is an effective and implementable technology for immobilizing metals in contaminated soil and can provide stabilization for some organics. Ex situ cement-based solidification of the contaminated soil should be effective to immobilize COC metals in the soil but may be difficult to implement; in situ solidification may be more easily implemented but may be less effective. Both in situ and ex situ cement-based solidification are retained for further consideration.

Incineration

Incineration is a thermal oxidation process that uses high-temperature, controlled flame combustion in an enclosed reactor to decompose organics in solids, liquids, and gases. Carbon and hydrogen waste components are converted to carbon dioxide and water, respectively. Chlorine, if present, is mostly converted to hydrochloric acid. Other combustion products are also formed in smaller quantities and may include carbon monoxide, nitrogen oxides, and free chlorine and fluorine. Inorganics are not treated in incineration and, in some situations, the end product may become more toxic due to a concentration effect. Incineration produces a solid stream from the incombustible portion of the original material, which is removed as bottom and fly ash, detoxified soil, and possibly other solid treatment residuals. If a wet scrubber air pollution control system is used, a liquid waste stream could also be generated. Depending on the original waste stream, process residuals may require further treatment and/or disposal (for example, residuals may need treatment to remove or immobilize metals). The rotary kiln incinerator, which is capable of burning a broad range of hazardous solids, slurries, liquids, and gases, is the most common and versatile type of incinerator. Other types of incinerators capable of treating contaminated soil include the circulating bed, multiple hearth, and infrared incinerators.

Assessment of this option is as follows:

- Effectiveness: Incineration is a highly proven technology to treat wastes containing high concentrations of organics. Incinerators have successfully been demonstrated to destroy refractory compounds such as PCBs as well as other organic contaminants at efficiencies in excess of 99.99 percent. Incineration should be capable of achieving the remediation goals for organics. Incineration does not destroy metals or other inorganics. Metals in the waste matrix will form metal oxides that enter the gas stream or will be concentrated in the treated soil. Treated soil may require additional treatment to remove or immobilize metals prior to disposal. Conventional air pollution control equipment such as scrubbers and baghouse dust filters would be required to remove acid gas and particulates. Air emissions from the incinerator would be monitored closely to ensure that human health and the environment are not adversely affected.

- Implementability: Incineration, whether conducted on or off base, is implementable. The equipment and resources necessary to incinerate soil are available, and several vendors are capable of performing this work. The large volume of contaminated soil at the site may pose logistical problems for incineration; several facilities would likely be needed to treat the large volume. Off-base TSDFs are available that could treat the OFFTA soil. If incineration is conducted off base, transportation requirements would be applicable and the off-base facility would have to meet RCRA permit requirements.

- Cost: The relative capital and O&M costs are high for incineration.

Incineration is an effective option for destroying the organics present in the contaminated soil; however, inorganics would be left untreated. Incineration would require substantial logistics and restrictions due to the large volumes to be treated. Due to the lack of treatment of inorganic contaminants and its high cost, incineration is eliminated from further consideration.

Low-Temperature Thermal Stripping (LTTS)

LTTS is a treatment process that uses heat and physical agitation to volatilize organic contaminants from soil; the resulting vapor stream is subsequently treated to collect or destroy the contaminants. A typical LTTS system consists of a rotary drum thermal processor equipped with heat transfer surfaces, and a vapor treatment system. Direct-fired and indirectly heated systems (generally heated by circulating hot oil) are available. Temperatures used in the thermal processor are contaminant- and matrix-specific, with a range of approximately 150 to 800°F. Most units incorporate mechanical agitation during treatment to facilitate complete desorption of organics. An induced air flow conveys the volatilized organics through a gas treatment system, such as a carbon adsorption unit, a thermal oxidizer, or a condenser unit. The air stream is then discharged through a stack. LTTS is a well-demonstrated technology for industrial sludge and product drying applications, but its use for remediation of soil is less demonstrated. The process is most effective on VOCs, but units operating at higher temperatures are also capable of treating SVOCs and PCBs.

Assessment of this option is as follows:

- Effectiveness: LTTS should be capable of accommodating the volumes of contaminated soil at the site. LTTS at a relatively high temperature would be expected to achieve the remediation goals for the SVOCs in the soil. Metals would not be addressed by this technology. The effectiveness of LTTS is dependent primarily on the boiling point of the contaminant. For VOCs with relatively low boiling points, nearly complete removal from the soil would be expected at relatively low operating temperatures. Many of the organics present in the contaminated soil, such as PAHs, have much higher boiling points. The upper temperature range for LTTS approaches the lower temperature range for incineration, and some LTTS systems are permitted as incinerators.

- Implementability: LTTS is implementable. The equipment and resources necessary to treat the soil are available, with several vendors capable of performing this work. Rhode Island Air Quality Standards would have to be met. Few, if any, off-base LTTS facilities would be able to accept the

soil; therefore, consideration of LTTS is effectively limited to on-site treatment. LTTS, if selected, would likely be included as part of a treatment train of multiple process options due to its ineffectiveness for inorganic contaminants.

- Cost: The relative capital and O&M costs for LTTS are moderate.

LTTS is an effective and implementable technology to remove organics from contaminated soil. LTTS will be retained for further consideration for treating contaminated soil.

Vitrification

Vitrification is a thermal destruction process that immobilizes soil contaminants by converting the contaminated soil to a chemically inert, stable, glass product. In situ vitrification is conducted by applying energy through electrodes inserted around the area to be melted. Wastes are heated to temperatures of 1,350 to 3,000°F, forming a molten glass and thereby destroying organics and immobilizing metals. Organics in the waste matrix are volatilized, and the resulting gases are oxidized. Metals are retained in the glass which, when cooled, is a stable, non-leachable, vitreous solid. In situ vitrification reduces the volume of the soil column, so clean backfill is placed on top of the solidified mass.

Assessment of this option is as follows:

- Effectiveness: Vitrification is an effective technology to destroy organics and immobilize metals. The vitrification process should be capable of achieving the remediation goals for organics and metals. Using this process, inorganic contaminants would be immobilized while organic contaminants would be destroyed to below clean-up levels. Human health and environmental concerns are similar to those for incineration. Air pollution control equipment would be necessary to remove particulates and acid gases. Vitrification should be reliable with respect to the site contaminants and conditions. Short-term concerns associated with vitrification are the potential risks resulting from volatilization; however, the site soil contains few VOCs.

- Implementability: Vitrification is implementable for site soil, and the equipment and resources necessary to vitrify the soil are commercially available from a few vendors. However, the vitrification process is extremely energy intensive and requires sophisticated machinery and highly trained personnel for operation. Also, it is more difficult to implement and more energy intensive when the water table is high. Application of this technology has been primarily limited to treating radioactive or highly toxic wastes.

- Cost: The relative capital costs are high. Operation costs are also high because of intensive energy usage, although maintenance costs are low.

Vitrification is eliminated from further consideration due to its high costs.

Soil Flushing

Soil flushing is a process that uses a closed loop recirculation system of injection and extraction wells to remove contaminants from the saturated and unsaturated soil. Under soil flushing, water, with or without other additives, is sprayed onto or injected into the soil. Additives are used to increase the mobility of the contaminants. To remove organics, surfactants or alkalis are commonly used. Acids, alkalis, oxidizers, reducing agents, and/or complexing agents are commonly used to remove inorganics. Collection of the flushing agent solvent is an important step. At the collection point, treatment systems such as air stripping or carbon adsorption are then utilized to separate the contaminants from the extracted water. The treated water is recirculated through the system by reinjection into the contaminated soil.

Assessment of this option is as follows:

- Effectiveness: Soil flushing may be effective in treating some of the organic and inorganic contaminants at the site; however, several factors can limit its effectiveness. Of primary concern is the difficulty of treating organics and inorganics simultaneously and the ability to capture mobilized contaminants. Some other effectiveness concerns are the ability to contact all the soil, the ability to separate the contaminants from the flushing agent, and the ability to monitor compliance. The heterogeneity and stratification of the soil make contact with soil and capture of mobilized contaminants uncertain. Additionally, the burdened flushing fluids would likely contain significant concentrations of contaminants in highly mobile forms; a significant threat to human health and the environment might result if the contaminated fluids are not completely captured.

- Implementability: Soil flushing would be difficult to implement at the site. A primary concern is the difficulty of ensuring complete capture of mobilized contaminants and restrictions on underground injection of wastes mandated by state and federal regulations. If treatment of extracted groundwater/flushing fluids is conducted at the site, space is necessary to build or stage treatment equipment. TSDF requirements must be met, and facility monitoring would be required. If soil flushing is chosen, then consideration of capturing the groundwater and recovering the flushed contaminants is critical. Off-base TSDFs may be necessary if residuals such as spent carbon or biomass are generated during treatment of the captured water. The

equipment and resources necessary to implement soil flushing are available, and a few vendors are capable of performing this work.

- Cost: The capital and O&M costs of soil flushing are highly dependent on the cost of treating the extracted water. Because of the complex mixture of contaminants in the soil, the cost of implementing soil flushing at the site is likely to be moderate.

Due to several effectiveness and implementability concerns, including a potential risk to human health and the environment, soil flushing will be eliminated from further consideration as a process option.

Soil Washing

Soil washing is an ex situ treatment process that removes contaminants from soil by either dissolving or suspending them in the wash solution (which is later treated by conventional water treatment methods) or by concentrating them into a smaller volume of soil through standard particle size separation techniques. The concept of reducing soil contamination by particle size separation is based on the finding that most organic and inorganic contaminants in soil tend to bind to fine-sized clay and silt particles through surface adsorption. Soil washing relies heavily on this principle of separating highly contaminated fine materials from washed coarse materials to decrease the volume of particles that require treatment.

Soil washing is generally a water-based process; however, chemicals such as surfactants are sometimes added to the wash fluid to enhance removal of specific contaminants. Organic or inorganic compounds can be removed using this process. In the washing process, soil is screened and then scrubbed to break up soil aggregates and liberate fines. The surfaces of the coarse particles are "washed" by abrasive action and by desorption of contaminants upon contact with the washing solution. The contaminated fine particles typically require further treatment. Applicable processes to treat fine particles may include chemical extraction, biodegradation, immobilization, or destruction processes

Assessment of this option is as follows:

- Effectiveness: Depending on the proportion of coarse and fine materials in the contaminated soil, soil washing can be effective in reducing the volume of material that requires intensive treatment. Soil washing would be effective for removal of both organic and inorganic contaminants from coarse material within the area, minimizing the volume of materials requiring intensive treatment. Contaminants would be concentrated in the relatively smaller fine soil fraction or the wash solution; contaminant extraction from the fine fraction by the soil washing process would likely be

incomplete. The fine fraction and wash solution would likely require additional treatment. Effective removal of the contaminants in the site soil may require multiple cycles of treatment

- Implementability: Soil washing is a proven and reliable technology to remove organic and inorganic contaminants from soil with a relatively small fines fraction. The equipment and resources necessary to treat the soil are available, and several vendors are capable of performing this work. If treatment is conducted at the site, space is necessary to build or stage treatment equipment; constraints such as meeting TSDF requirements and facility monitoring are also concerns. Few, if any, off-site TSDFs would be able to accept and treat the large volume of contaminated soil from the site. This shortage effectively limits consideration of soil washing technologies to on-base processes.

- Cost: The relative capital and O&M costs are moderate to high.

Soil washing is an effective and implementable technology to remove organics and inorganics from contaminated soil. Soil washing will be retained for further consideration for treating site soil.

Solvent Extraction

Solvent extraction is an ex situ treatment technology that employs a solvent to extract contaminants from soil, sediment, sludge, or wastewater. Extraction of organics is accomplished by various mechanisms including dissolution, formation of an emulsion or soluble chelation product, and chemical reaction. For metal extraction, acidification and chelation are the predominant mechanisms. The selection of the appropriate solvent depends on the chemical and physical properties of the contaminants present. Aqueous solutions including surfactants can be used to enhance removal or emulsification of a wide range of hydrophobic organic compounds. Dilute solutions of acids and bases can remove a wide range of metal ions.

Typical solvent extraction units include countercurrent extraction equipment, a pug mill, or a truck-loaded cement mixer. After contact and mixing, the solvent laden with contaminants is removed from the soil by methods such as centrifugation or filtration. The extraction process results in a cleaned soil and a liquid waste stream that concentrates the extracted contaminants within the recovered solvent.

Contaminants within the waste stream are not destroyed, and the waste stream requires additional treatment or disposal. In many cases, contaminants retained in the solvent can be separated out, and the solvent can be re-used in the extraction process. Depending on the solvents used and the contaminants

to be removed, the soil may require supplemental treatment by soil washing or by extraction using additional solvents to target different contaminants.

Assessment of this option is as follows:

- Effectiveness: Solvent extraction is an effective technology to remove a wide range of inorganic and organic contaminants from medium to coarse soil. Commercial processes using secondary and tertiary amines have effectively removed PCBs, VOCs, and SVOCs from contaminated soil. Acid and alkaline solutions have been used to remove a wide range of metals The process may have limited effectiveness for the site soil due to the difficulty in formulating a suitable extraction fluid to treat a complex mixture of contaminants. Additionally, the variations in contaminant concentrations and contaminant distribution in the soil may require frequent adjustment or reformulation of the extraction fluid. The removal of metals and organics would likely have to be conducted in stages, using different solvents. A treatability study would likely be required to select the appropriate extraction solutions and determine operating parameters to ascertain whether effective treatment is possible.

- Implementability: Solvent extraction is a widely demonstrated and reliable technology for the treatment of simple waste streams. Several commercial vendors are available that provide solvents to treat a variety of organic and inorganic contaminants. If treatment is conducted on base, space is necessary to build or stage treatment equipment. Few, if any, off-base TSDFs using solvent extraction would be able to accept and treat the large volume of contaminated soil from the site. This shortage effectively limits consideration of extraction technologies to an on-base system.

- Cost: The relative capital and O&M costs of solvent extraction are moderate.

Solvent extraction is an effective and implementable technology to remove organics and inorganics from contaminated soil. Solvent extraction will be retained for further consideration.

Aerobic Biodegradation

Ex situ aerobic biodegradation is a destruction process that uses microorganisms to chemically break down and detoxify organic compounds in the presence of oxygen. The organic compounds are used as energy sources and are metabolized by microorganisms such as bacteria, actinomycetes, and fungi. Biodegradation process residuals are carbon dioxide, water, and biomass. The biomass, which consists

mainly of cell protein but also contains partially degraded constituents and intermediate biodegradation products, must be tested and may require additional treatment prior to disposal.

Several types of aerobic biodegradation have been used to treat contaminated soil. The primary ex situ methods are (1) slurrying the waste and treating it in a bioreactor and (2) using standard irrigation and soil mixing techniques to treat the soil directly on land (landfarming) or in an above-ground cell (composting). Landfarming is generally less effective than other ex situ techniques because operating parameters are difficult to control.

Assessment of this option is as follows:

- Effectiveness: The effectiveness of biodegradation is highly dependent on the nature and concentration of the contaminants. In general, aerobic biodegradation of organics is applicable to petroleum hydrocarbons, halogenated and non-halogenated aromatics, phenols, biphenyls, and pesticides (EPA, 1985). It may be less effective for PAHs and residual, weathered petroleum in the site soil. Metals are not destroyed in the process, and high metals concentrations may be toxic to the microorganisms. Aerobic biodegradation may be effective for treating some of the organics in site soil, although it may be difficult to reach PRGs, and the metals present in the soil would not be treated.

- Implementability: The equipment and resources necessary to conduct ex situ biodegradation are readily available, and several vendors are capable of performing this work. Aerobic biodegradation is an implementable technology for the site soil. However, due to the concentrations of difficult-to-degrade contaminants, the throughput capacity of the units is expected to be relatively low for treating the soil. If treatment is conducted on base, space is necessary to build or stage treatment equipment; constraints such as meeting TSDF requirements and facility monitoring are also concerns. If the treatment is conducted off base, few, if any, facilities would be able to treat this waste. Lack of off-base treatment capacity effectively limits consideration of bioremediation to an on-base process.

- Cost: The relative capital and O&M costs are low for in situ and ex situ aerobic biodegradation.

Because of concerns about the effectiveness of this process for site organic contaminants, its inability to treat metals, and the anticipated low throughput capacity for treating the soil, aerobic bioremediation is eliminated from further consideration.

3.2.3 Representative Process Options for Soil

EPA guidance for conducting FSs (EPA, 1988) recommends that one representative process option (RPO) be selected for each technology type to simplify the subsequent development and evaluation of alternatives without limiting flexibility during remedial design. RPOs are selected from the treatment techniques remaining after screening based on effectiveness, implementability, and cost. The RPOs selected provide a basis for developing performance specifications during preliminary design. Although specific process options are selected for alternative development and evaluation, these process options are intended to represent the broader range of process options within a general technology type. The specific process for implementation of the remedial action may not be selected until the remedial design phase.

Table 3-2 identifies the soil RPO(s) chosen for each technology type. The RAOs specify that the goal of remediation is to restore the site for residential use without any restrictions. In order to meet this requirement, technologies involving containment and/or in situ technologies that require long-term monitoring are not considered, and, therefore, the selected RPOs primarily reflect removal, treatment, and disposal options. No action, low-temperature thermal stripping, soil washing, clean backfilling, and removal to a TSDF have been selected as the RPOs. Excavation is considered as part of the removal and treatment/disposal options.

The no action option consists of undertaking no remedial action at a particular site. Inclusion of the no action alternative is required under CERCLA guidance, and this alternative is used as a baseline consideration in the detailed evaluation or to address sites that do not require any active remediation. No technologies or process options are associated with this RPO.

LTTS was chosen over other treatment processes because of its effectiveness in removing organics at a lower cost. It also has fewer implementation requirements than do the other processes. LTTS uses direct or indirect heating to thermally desorb or volatilize organic contaminants present in soil. LTTS is a proven method that provides immediate results, and the experience resulting from its use at other sites has been positive.

Soil washing was selected as an RPO for ex situ physical/chemical treatment based on its cost effectiveness at removing metals from soil. It also has the ability to treat both organics and inorganics. Solvent extraction is a similar technology, but soil washing is a potentially more versatile technology and is therefore retained as the RPO.

Clean backfilling was chosen as an RPO because it is an effective, low-cost method of disposing of clean, treated soil and the easiest method to fill excavated sites. The source of the backfill material would be treated soil (with chemical concentrations below PRGs) or clean soil from off site. Backfilling would be implemented in conjunction with removal or an ex situ treatment process. If treated soil is used as backfill, verification would be required to confirm that the backfill soil is not contaminated. The backfilled areas would be contoured to the desired grades.

Disposal at a TSDF was also retained as an RPO for the disposal GRA for use either in conjunction with a remediation process that produces residuals that must be disposed of off base or for disposal of contaminated soil. Use of a TSDF would be a very effective, long-term solution to contaminated soil disposal.

3.3 PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SEDIMENT

3.3.1 Preliminary Screening

As with the soil technologies, a variety of technologies and process options exist for sediment for each GRA described in Section 3.1. A range of these technology types and process options was identified and screened to focus on relevant technologies and process options. Summaries of the identification and preliminary screening of technologies and process options appropriate for sediment are provided in Table 3-3. Many options are eliminated based on technology screening. All options not eliminated due to overall applicability concerns (technical implementability) are retained for a more detailed evaluation in Section 3.3.2.

3.3.2 Evaluation of Technologies and Process Options

In this step, process options considered implementable following preliminary screening are evaluated in greater detail prior to selecting representative process options to use in developing remedial alternatives. One representative process option is selected, if possible, from each technology category to simplify subsequent development and evaluation of alternatives without limiting flexibility during remedy selection or remedial design. The evaluation criteria include effectiveness, implementability, and cost, with a focus on effectiveness. Brief descriptions of the criteria are provided in Section 3.2.2.

A discussion of the screening and detailed evaluation of technology types and process options using these criteria is provided in the following sections.

3.3.2.1 No Action

The no action scenario is considered to provide a baseline level to which other remedial technologies and alternatives can be compared. Under this scenario, no removal or treatment of the contaminated sediment would occur.

Assessment of this option is as follows:

- Effectiveness: The option would not be effective in achieving the RAOs for contaminated marine sediment. Contaminants would remain and could continue to pose a risk to the marine environment and/or human health. Impacted sediment could migrate to other areas within Narragansett Bay and connected waterways.

- Implementability: No implementability considerations are associated with the no action scenario.

- Cost: Because no actions would be taken other than 5-year reviews of site status, capital and O&M costs would be negligible.

The no action scenario is retained as a baseline, as required by the NCP.

3.3.2.2 Limited Action

The limited action GRA consists of activities designed to minimize potential risks to human health and the environment primarily by prohibiting or controlling access to impacted areas. The technology types/process options include institutional controls, access restrictions, and long-term monitoring. These options may be conducted independently or in conjunction with other process options to protect human health and the environment.

Institutional Controls

Institutional controls include administrative actions to restrict future use of the site that may result in exposure risks. The intertidal and subtidal areas are property of the State of Rhode Island, so any efforts to restrict access or activities must be coordinated with and approved by the state. Use restrictions could prohibit recreational use of the site.

Assessment of this option is as follows:

- Effectiveness: Since the option would offer no containment or removal of contaminated marine sediment, it would not be effective in achieving all the RAOs. Institutional controls would not prevent contaminant migration, reduce toxicity, or reduce contaminated sediment volume, and they would not protect marine biota. New use restrictions, such as bans on swimming and diving in the area, could be placed to provide additional protection. However, additional restrictions may not provide substantially more protection, and the effectiveness of such restrictions would also depend on adequate enforcement by RIDEM and the land owner of the shoreline. No additional risks to human health and the environment would result from implementation of use restrictions.

- Implementability: The Navy currently has a no swimming rule for the NAVSTA Newport shoreline. Additional use restrictions could be implemented by the State of Rhode Island to prohibit general recreational use (diving/bathing) of contaminated areas if the property is excessed. However, adopting the new controls may be difficult and take considerable time. RIDEM enforcement of the bans would be necessary since the restrictions would be placed on state-owned or privately held land. Navy assistance and coordination with Rhode Island authorities would likely be necessary to enhance enforcement of the restrictions.

- Cost: The capital and O&M costs for administrative actions and 5-year reviews would be relatively low.

New institutional controls are eliminated from further consideration for the shoreline and nearshore area because restrictions on recreational use would be difficult to implement and would likely provide no additional reduction in risk.

Access Restrictions

Access restrictions include placing physical barriers or markings to limit site use. Placement of fencing, signs, and buoys would demarcate the impacted area and identify the use restrictions and associated risks. These actions would deter access to the site and the impacted sediment.

Assessment of this option is as follows:

- Effectiveness: Since access restrictions would offer no containment or removal of contaminated marine sediment, they would not be effective in achieving all the RAOs. Access restrictions would not prevent contaminant migration, reduce toxicity, or reduce contaminated sediment volume. They would provide no protection of ecological receptors or the environment.

Access restrictions such as signs on fencing and buoys would notify people of the existing state shellfishing ban and warn people of the hazards present. These restrictions may deter fishermen and recreational users from walking/wading along the shoreline, shellfishing, or diving in the area, but would not prevent public access. Since the access restrictions would be used to reinforce the existing use restrictions on state-owned land, RIDEM enforcement would be necessary. The current restrictions are reportedly not strictly enforced. Navy assistance and coordination with Rhode Island authorities would likely be necessary to enhance enforcement of the restrictions; however, ultimately RIDEM would be responsible for enforcement. Adequate enforcement would be difficult to ensure, particularly in the long term.

- Implementability: The NAVSTA Newport may be able to limit shellfishing and access to contaminated sediment in the state-owned nearshore area by placing fencing, buoys, and signs in the intertidal zone warning people of the existing shellfishing ban and the hazards in the area. Fencing would be placed perpendicular to the shoreline, from the top of the slope to below the mean low water line at the eastern and western ends of the OFFTA area, and the buoys would be placed along the perimeter of the impacted area, seaward of the mean low water line.

  Installing and maintaining fencing and signs on Navy-owned land above the high-tide line would be readily implemented. Coordination with the state would be required to install and maintain fencing and buoys on state-owned land below the high tide line. However, because the access restrictions would be used to reinforce existing, state-imposed use restrictions, coordination with the state is not expected to be an impediment to placement. Buoy and fence placement would be conducted in accordance with all applicable state and federal regulations.

  The fence and buoy system would require at least yearly maintenance to remain effective. Routine maintenance of the access restrictions by the Navy would be readily implementable.

- Cost: The capital and O&M costs for placement of fencing, buoys, and signs would be relatively low.

Access restrictions are retained for further consideration for the shoreline and nearshore area. Signs and buoys would be placed to identify and demarcate areas of risk in order to deter human access and use of the area for shellfishing. Fencing would be installed in the intertidal zone to deter site access from both the eastern and western directions along the shoreline. Buoys would deter access to the site by water. No protection would be provided to marine biota.

Long-Term Monitoring

Long-term monitoring includes collecting sediment samples from selected locations to assess the migration of contaminants within the contaminated media (sediment) and to adjacent media (porewater, and subsequently into Narragansett Bay). Monitoring would also provide a means of measuring any natural attenuation processes (intrinsic abiotic and biotic degradation) occurring within the contaminated marine sediment or determining if any of the contaminants present have been diluted or covered by sedimentation processes. It would also provide information to assess potential needs for future remedial action.

Assessment of this option is as follows:

- Effectiveness: Monitoring would not be effective in preventing contaminant migration or reducing toxicity, mobility, or volume of contaminated sediment. However, data collected from monitoring activities would help to identify trends in contaminant concentrations associated with natural attenuation and potential migration off site. Monitoring could also provide information to assess the need for future remedial action, as well as to monitor the effectiveness of any remedial action being conducted. Short-term risks to human health during monitoring activities would be minimized by the use of personal protective equipment (PPE).

- Implementability: A long-term monitoring plan would be readily implementable, since trained personnel are available for sample collection and analysis.

- Cost: The capital and O&M costs for a periodic sediment monitoring program would be relatively low for the nearshore area and low to moderate for the offshore area.

The long-term monitoring option is retained for further consideration. While providing no direct protection of human health and the environment, monitoring would provide a means of assessing exposure risks and potential for contaminant migration existing at the site at any point in time. Combined with other process options, monitoring would further provide a means of determining the effectiveness of remedial action activities.

3.3.2.3 Containment

The containment GRA involves using engineering controls to limit potential risks to human health and the environment. It consists of installing and maintaining physical barriers to isolate and contain the contaminated marine sediment. Containment was eliminated from further consideration during

preliminary screening (see Table 3-3) because installation of a cap would significantly alter the bay/harbor bottom elevations and access to Coasters Harbor.

3.3.2.4 Removal

Removal technologies are included as key components of both the removal/disposal and the removal/treatment/disposal GRAs. Removal activities involve excavating and/or dredging contaminated sediment to reduce or eliminate on-site toxicity, mobility, and volume. These operations require instituting sediment resuspension/turbidity control measures, transporting removed materials, dewatering sediment, treating water generated during dewatering activities, and restoring altered intertidal and subtidal habitats. Sediment consolidated from dewatering activities would also require disposal or treatment.

In general, selection of the most efficient and cost-effective excavation and/or dredging techniques depends on sediment removal rates which, in turn, depend on the following factors:

- Equipment (type and size)
- Volume and depth of contaminated material
- Sediment characteristics (amount of debris, sediment grain size, and water content)
- Location/navigational constraints (bridges, water depth, currents, etc.)
- Weather conditions
- Pretreatment requirements (dewatering, water treatment and disposal, etc.)
- Marine ecological concerns related to resuspension of contaminated sediment during removal and associated turbidity control (silt curtains, booms, etc.)
- Health and safety issues related to handling contaminated sediment
- Transport
- Method of disposal or treatment

Removal of sediment from the shoreline and nearshore area is expected to be conducted from the shoreline in areas where access is possible and there is adequate shallow area in which to work. Land-based removal would be conducted with the assistance of a temporary cofferdam system and continuous dewatering to keep the area relatively dry. Use of a cofferdam system would allow greater access to deeper sediment, possibly extending beyond the intertidal zone. Contaminated sediment that cannot be reached from the shoreline would be reached by building a bay haul road out into the water and using land-based excavation or dredging equipment or would be removed using barge-mounted dredging equipment. A preliminary design investigation (PDI) would further evaluate the feasibility of removing sediment, either using land-based or barge-mounted equipment.

The sediment removal options may include the following excavation and dredging technology types.

Mechanical Dredging and Excavation

Mechanical dredging and excavation may be conducted using a number of techniques including clamshells, dippers, bucket ladders, draglines, and conventional earth-moving equipment. This equipment operates by the direct application of mechanical force to dislodge materials to be removed.

Clamshells: The most commonly used mechanical dredge for removing contaminated soil and sediment is the clamshell dredge. Clamshells can recover all types of material and debris, except highly consolidated sediment. This type of dredge is generally equipped with an open, hinged bucket with a capacity of 1 to 12 cy. The bucket is attached by a cable to a land-based crane or flat-bottomed barge. The clamshell dredge can excavate to practically any depth, restricted only by the crane lifting capacity.

The clamshell dredge is operated by opening the jaws of the bucket, lowering the bucket into the material to be removed, closing the jaws, and hoisting the bucket by means of the crane cable. The dredge removes a heaped bucket of material, part of which is excavated by drag forces during hoisting. If properly operated, conventional clamshell dredges can operate with limited loss of sediment and can efficiently remove a large volume of material. For marine dredging applications, a modified, watertight bucket is sometimes used to minimize the resuspension of solids into the water column. However, the large rocks and debris within the sediment to be dredged would frequently prevent the bucket from closing, thereby reducing the effectiveness of the watertight bucket.

Dippers: The dipper is a powered 8 to 12 cy shovel designed for digging out rock and very hard, compacted material. Its use is suited for excavation of soft rock and highly consolidated sediment within a working depth of 50 feet. Since this technique operates with a violent digging action and tends to drop small particles, its application for marine dredging is often limited. However, it may be well suited for removing debris and large rocks. It could be operated from the shoreline or a barge to remove contaminated sediment.

Bucket Ladders: A bucket ladder dredge is comprised of a submersible ladder that supports a continuous chain of buckets that rotate around two pivots. When the buckets rotate around the underside of the ladder, they scoop up material and transport it up the ladder for discharge into a storage bin. These dredges are most commonly used in mining operations abroad, such as sand and gravel production. The bucket ladder dredge generates considerable turbidity because of the mechanical agitation of sediment and leakage from the bucket. Therefore, its use is limited to removal of contaminated sediment exposed during low tide.

Draglines: Draglines use the same basic equipment as the clamshell dredge. However, the dragline operates by the use of a drag cable to pull the bucket through the material being excavated toward the crane. Dragline dredges typically provide for a longer reach than clamshell dredges operated by the same crane. Since draglines cause a great deal of mechanical agitation of the material being removed and because the buckets are generally open, their use generally results in excessive sediment resuspension. However, use of dragline dredges may be required to remove materials in hard-to-reach areas. If possible, their use should be limited to removing contaminated sediment exposed during low tide.

Conventional Earth-Moving Equipment: Conventional, track-mounted, earth-moving equipment (excavators, front-end loaders, backhoes, and bulldozers) have limited application in removing contaminated sediment from underwater locations; however, they may be well suited to removing consolidated sediment and debris from the shoreline and shallow nearshore area. Front-end loaders and bulldozers are generally used to remove loose or soft materials from a few feet above to a few feet below grade. Since they must be in close proximity (both horizontally and vertically) to the material being removed, shore-based or barge-mounted operations are not practical; however, bulldozers and front-end loaders could be employed to excavate materials behind a cofferdam. Excavators and trackhoes, typically used for trenching and other subsurface excavations, consist of a bucket on a fixed arm and have reaches of up to 100 feet. They can be operated from the shoreline or mounted on a barge.

A brief summary of the advantages and disadvantages of mechanical dredging is as follows:

> Advantages of mechanical dredging include the fact that excavation can be conducted to maximize the solids content and, thereby, minimize the scale of the dewatering and handling activities. Mechanical dredges are highly maneuverable, can remove many types of debris, and provide dredging accuracy. Clamshell dredges and excavators are further capable of efficiently removing materials with depth. Many techniques are available for shoreline use, while fewer options are suited for barge-mounted operation.
>
> Disadvantages of mechanical dredging include the potential to resuspend large amounts of sediment, as well as offering a lower production capacity and typically higher costs than other dredging techniques. Mechanical dredging operations also require significant rehandling of materials.

Assessment of this option is as follows:

- Effectiveness: Mechanical dredging would be effective in removing contaminated sediment from the marine environment. Removal would minimize future exposure risks to human health and the marine environment while preventing contaminant migration within Narragansett Bay. The effectiveness of mechanical dredging is limited by difficulty of achieving complete removal in an underwater environment. Multiple passes over the contaminated area may be required to remove all contaminated materials. The effectiveness can be improved, but not to 100 percent, by state-of-the-art positioning equipment. The use of appropriate turbidity control measures during marine sediment dredging would minimize contaminant migration during implementation. Any aquatic habitats that are altered by the remedy would require mitigation measures to offset the aquatic habitat loss. Restoration of the habitat would be accomplished by refilling the excavated area to the existing grade using materials similar to the existing substrate. Additionally, if necessary, active restoration of any impacted eelgrass beds could be attempted. However, successful restoration of eelgrass beds has not been widely demonstrated.

- Implementability: Mechanical dredging is readily implementable by companies with trained personnel qualified to handle contaminated sediment dredging operations. Fewer companies are available with direct experience in associated contaminated sediment dewatering and treatment techniques; however, qualified companies are assumed to be available within the Rhode Island coastal business community. All on-site personnel must be trained in hazardous waste site operations due to the nature of the sediment to be removed.

  Mechanical dredging is implementable by both shoreline and barge-mounted operations. However, technical issues related to implementation are challenging for both types of operations. Removal using conventional earth-moving equipment would be possible from the shoreline or a haul road constructed into the water. Barge-mounted operations are limited by the draft requirements of the vessel and the reach of the mechanical dredge (up to 100 feet). Because of the weight and size of the equipment required for dredging and processing the sediment on the barge, the barge is expected to require 6 to 10 feet of water for operation. Because the water in the nearshore area is relatively shallow, some locations may be difficult to access by barge. It may be difficult to replace the aquatic communities destroyed by the dredging activities, although the backfill material would provide habitat structure suitable for regrowth of these aquatic communities.

- Cost: The capital costs are moderate to high for dredging of contaminated materials. No O&M costs are associated with dredging, but some O&M would be required in the first few years following dredging to monitor the aquatic habitat restoration. Overall O&M costs would be low.

Mechanical dredging is a viable removal option for nearshore areas and has therefore been retained for further consideration. Contaminated sediment removal activities may include both conventional earth-moving excavation techniques from the shoreline or a haul road constructed in the water and mechanical dredging using barge-mounted equipment for sediment inaccessible from the land.

Hydraulic Dredging

Hydraulic dredges use centrifugal pumps to remove sediment in a liquid slurry form and transport the slurry by suction to a designated location on a barge or along the shoreline. Slurries of 10 to 20 percent solids by weight are typically achieved. A cutterhead, or similar device, is often fitted at the suction end of the dredge to assist in dislodging bottom materials and allowing for transport to the suction pipe. The cutterhead is probably the most efficient and versatile type of hydraulic dredge available. However, new hydraulic dredge designs are available that attempt to increase the solids content of the pumped slurry while minimizing the sediment resuspension caused by the dredging activity.

Both cutterhead and plain suction hydraulic dredges can efficiently remove large volumes of relatively small materials. Typical hydraulic dredges cannot remove stones or debris larger than approximately 4 to 6 inches in diameter because they are limited by the size of the suction head and slurry pipeline. The plain suction dredges are capable of removing relatively free-flowing sediment (sand, gravel, and unconsolidated material), while cutterhead dredges are capable of removing free-flowing as well as very hard and cohesive sediment. Portable dredges (with or without a cutterhead) can be used to remove moderate volumes of materials that are more surficial in nature (depths of up to approximately 18 inches). The cutterhead, plain suction, and portable dredges can all be operated from the shoreline or from barge-mounted equipment.

A brief summary of the advantages and disadvantages of hydraulic dredging is as follows:

> Advantages of hydraulic dredging include limiting the resuspension of sediment and minimizing the handling of dredged material by transporting the dredged slurries by suction through pipelines. The cutterhead can efficiently dredge and pump all types of alluvial materials or compacted deposits, such as clay or hardpan. The cutterhead is also capable of grading and finishing slopes efficiently.
>
> Disadvantages of hydraulic dredging include the fact that large volumes of water, which may require treatment prior to disposal or release, are typically removed along with the sediment (80 to 90 percent water by weight). The slurry pipelines used to transport dredged material may temporarily obstruct navigational traffic. Nonhopper dredges cannot be operated in rough water,

and hopper dredges may require drafts of over 10 feet. The presence of large stones and concrete may limit the effectiveness and suitability of hydraulic dredging in some areas, particularly the nearshore areas 3 and 4. Hydraulic dredges cannot remove material with diameters greater than the diameter of the suction head or slurry pipeline.

Assessment of this option is as follows:

- Effectiveness: Hydraulic dredging would be effective in removing contaminated marine sediment. However, in areas where the marine environment contains rocks or debris greater than the diameter of the dredge, mechanical excavation and dredging techniques may be required to prepare the area prior to hydraulic dredging. The effectiveness of hydraulic dredging is limited by difficulty of achieving complete removal in an underwater environment. Multiple passes over the contaminated area may be required to remove all contaminated materials. The effectiveness can be improved, but not to 100 percent, by state-of-the-art positioning equipment. Removal of impacted sediment would minimize future exposure risks to human health and the marine environment, and prevent contaminant migration within Narragansett Bay. The use of appropriate turbidity control measures during dredging activities would minimize contaminant migration during implementation. Any aquatic habitats that are altered by the remedy would require mitigation measures to offset the aquatic habitat loss. Restoration of the habitat would be accomplished by refilling the excavated area to the existing grade using materials similar to the existing substrate. Additionally, if necessary, active restoration of any impacted eelgrass beds could be attempted. However, successful restoration of eelgrass beds has not been widely demonstrated.

- Implementability: Hydraulic dredging is readily implementable by companies with trained personnel qualified to handle contaminated sediment dredging operations. All on-site personnel must be trained in hazardous waste site operations. Fewer companies are available with direct experience in associated contaminated sediment dewatering and treatment techniques; however, qualified companies are assumed to be available within the Rhode Island coastal business community.

  Hydraulic dredging is implementable by both shoreline and barge-mounted operations. Barge-mounted operations are limited by the draft requirements of the vessel (6 to 10 feet) and the reach of the hydraulic dredge. Because the water in the nearshore area is relatively shallow, some locations may be difficult to access by barge. It may be difficult to replace the aquatic communities destroyed by the dredging activities, although the backfill material would provide habitat structure suitable for regrowth of these aquatic communities.

- Cost: The capital costs are moderate for hydraulic dredging of contaminated materials. No O&M costs are associated with dredging, but some O&M would be required in the first few years following dredging to monitor the aquatic habitat restoration. Overall O&M costs would be low.

Hydraulic dredging in the nearshore area has been eliminated from further consideration due to the nature of the substrate. Mechanical equipment is necessary to remove subsurface debris prior to sediment removal activities, and mechanical excavation/dredging would be more efficient for removing the contaminated sediment present.

Materials Handling and Disposal

Disposal technologies are included as key components of the removal GRAs. Disposal media include any debris and sediment excavated and/or dredged from the marine environment. Disposal options may include both on-base and off-base locations.

Additional activities associated with excavation/dredging operations are related to materials handling. These activities include transporting dredged materials for processing, screening, and dewatering sediment, and treating/disposing of both the residual water and the dewatered sediment.

Transportation of Excavated/Dredged Materials

Marine sediment removed from the impacted areas would be transported for processing (removal of debris, dewatering, etc.) prior to disposal. The type of transport depends on the method of excavation/dredging (mechanical transport for mechanical removal activities and hydraulic transport through suction pipelines for hydraulic dredging). Final transportation methods would be selected after the dredging method is selected.

Initial Processing

Processing would take place either at a designated shoreline location or on a barge/scow located near the removal location. All excavated/dredged materials are expected to be placed directly on a barge or scow for processing or on a staging area at the OFFTA site.

Dewatering Activities: Dewatering is the first step of processing dredged materials. This is generally required to reduce the moisture content of the sediment, enhance the handling characteristics, and prepare the sediment for further treatment and disposal. Typically, dredged material is screened to remove large objects and debris that may plug or foul the dewatering equipment.

Dewatering technologies appropriate for marine sediment include centrifuging, filtration, and gravity thickening. The effectiveness of these technologies can be influenced by the content of clay, silt, and organic matter in the sediment.

Centrifuging techniques use the force developed by the fast rotation of a cylindrical drum or bowl to separate solids and liquids due to differences in densities. They can generally achieve a product composed of 10 to 35 percent solids. The effectiveness of using centrifuges is limited by sediment containing tars, small particle sizes, low density particles, large objects, or fibrous materials. Centrifuges are generally compact and are, therefore, well-suited for use in areas with space limitations.

Filtration is a physical process whereby liquid is forced through a permeable medium and dewatered solids are retained. Filtration techniques are able to dewater fine-grained sediment over a wide range of solids concentrations. The effectiveness depends on the type of filter, the particle size, and the water content of the sediment. Three commonly used filtration systems include belt press filtration, vacuum filtration, and pressure filtration. The achievable solids content of dewatered sediment is expected to be in the range of 10 to 50 percent.

Gravity thickeners concentrate solids in a tank, similar to a conventional sedimentation tank or clarifier. They can concentrate dredged sediment slurries of nearly any grain size to at least 2 to 15 percent solids. Heavier material will dewater quickly and more efficiently than fine-grained material. Thickened material is typically further dewatered by other methods. The use of gravity thickening techniques for dewatering marine sediment has limited applicability. However, it may be used as a preliminary dewatering technique in cases when the solids content is very low, as in the case of slurries generated from hydraulic dredging operations.

The selection of a dewatering process or combination of processes depends on the sediment volume and solids content (a function of the dredging technique), available land space, and degree of dewatering required. The system may be operated on the barge/scow or at the onshore portions of the site in the vicinity of the removal activities.

Treatment/Disposal of Residual Water: The water generated from sediment dewatering processes may require treatment to remove dissolved and colloidal contaminants prior to disposal.

Treatment can take place on the dredging platform or at a NAVSTA Newport-owned shoreline property, through a skid-mounted clarifier and membrane filter prior to discharge into Narragansett Bay. The clarifier would remove inorganic constituents by metals precipitation. Unsettled metals precipitant and other

suspended particles would be removed by sedimentation and/or filtration. Organic constituents (PAHs) are expected to be adsorbed onto the surface of the suspended particles, and thereby removed along with these particles. However, should a need arise to further reduce the concentrations of these organic constituents, additional process units may be added to the skid-mounted treatment train. These may include dissolved air flotation and/or granulated activated carbon process units. The treated effluent would be required to meet specific contaminant concentration limits prior to discharge into the bay.

Actual materials that would be used for precipitation (alum, etc.) and the volumes required would be determined upon performance of a pilot scale test. This is appropriate for design of any treatment plant. The volume of water to be treated will be determined based on the dredging equipment to be used and the recovery rate of dredged sediment. The water treatment plant would be designed to keep pace with the dredging schedule, once it is determined. Current estimates indicate that under optimal conditions, dredging could progress at a rate of 435 cubic yards per day. If one assumes dredge spoils are 80 percent water, the plant would have to treat and discharge up to 75,000 gallons per day. Backup storage would have to be available to withhold as much pretreatment water that could be produced during a full day of dredging at optimal rate. This safeguard will assure that the treatment plant is not over-taxed at any time, and that dredging can be delayed if there is a delay in treatment production.

3.3.2.5 Disposal

All sediment will be tested for hazardous characteristics after dredging. Once the marine sediment has been tested for hazardous characteristics, approximately 80 percent is expected to be acceptable for disposal at a RCRA Subtitle D landfill following dewatering It is assumed that the remainder of the material (estimated to be 20 percent) would require treatment and/or disposal at a RCRA Subtitle C TSDF or landfill.

Assessment of this option follows:

- Effectiveness: Off-base disposal offers a full range of disposal and treatment/disposal options depending on the contaminant type and concentration. Disposal at a licensed RCRA Subtitle D/RCRA Subtitle C landfill or TSDF is an effective means of off-base disposal. Furthermore, these facilities may be capable of providing treatment of selected materials if required prior to disposal.

- Implementability: This option may be difficult to implement. RCRA Subtitle D landfills are available locally, but a single location may not be able to accept the volumes of materials removed from the site. RCRA Subtitle C TSDFs are available for disposing and/or treating dredged sediment but may require shipping out of state. Proper handling and transport of contaminated materials, complete

with bill of lading, would be required. Some stabilization of the materials may be required prior to transport to minimize the presence of free liquids.

- Cost: The capital costs are expected to be relatively high. No O&M costs are associated with this option.

Off-base disposal is retained for further consideration for dredged materials.

3.3.2.6 Treatment

Treatment is included as a potentially required component of the removal/treatment/disposal GRA. Contaminated marine sediment removed by dredging techniques may require treatment, following dewatering and prior to disposal. Treatment would ensure that all contaminated solids are of acceptable quality for disposal at the off-base facilities. Treatment may include stabilization or solidification to immobilize contaminants within the material, or use of bulking agents to remove excess water for transportation.

Appropriate off-base treatment options would be determined by the disposal facility accepting the material.

It is anticipated that once the marine sediment has been tested for hazardous characteristics, most of the dredged material may be disposed of in a RCRA subtitle D facility following dewatering.

On-Base Treatment

On-base treatment may be required for sediment contaminated with elevated concentrations of metals. Potential on-base treatment technologies include chemical/physical (stabilization/ solidification) options. Additional thermal, physical, chemical, and biological options were eliminated during preliminary screening.

Chemical/Physical Treatment (Solidification/Stabilization): Solidification/stabilization is a technique that mixes reactive materials with contaminated solids, semisolids, and sludge to immobilize the contaminants by forming a chemically stable matrix of limited permeability. Volume increases exceeding 20 percent can result. Solidification/stabilization agents may include cement, siliceous materials, lime, or proprietary agents. Selection of the most appropriate agent, the waste-to-additive ratio, mixing variables, and curing conditions all depend on the chemical and physical characteristics of the waste.

Solidification/stabilization techniques are most successful in treating wastes containing inorganics; however, some success has been experienced with oily sludge and solvents.

Assessment of this option follows:

- Effectiveness: Solidification/stabilization is a well-accepted technique to treat inorganic contaminants. Success in forming a chemically stable matrix depends on the selection of the stabilizing agents, the mix ratios of waste to agent, and proper mixing and curing. Its effectiveness in treating organics is inconclusive. Treatability studies would be required to confirm the effectiveness in treating organics, as well as in determining the optimum processing steps to reduce leaching of inorganic constituents from the solidified/stabilized medium. Addition of stabilizing agents is also used effectively to reduce the amount of free liquid present in sediment that may otherwise be of acceptable quality for disposal without additional treatment.

- Implementability: The implementation of the solidification/stabilization process may prove difficult for sediment or sediment slurries with high water content. Initial dewatering of these materials would be necessary to minimize the amount of stabilizing agent required. This preparatory step would, in turn, reduce the time required to stabilize the contaminants and minimize volume increases associated with bulking of the contaminated material. Treatability studies would be required to determine appropriate treatment processes.

- Cost: The capital costs are expected to be relatively low. Dredged and dewatered sediment requiring solidification/stabilization are expected to be treatable on-site for a minimal cost per cubic yard. No O&M costs are associated with this option.

Solidification/stabilization is a viable treatment option for inorganic contaminants and has been retained for further consideration.

Off-Base Treatment

Off-base treatment has been evaluated as a contingency in case onshore portions of the site are not available for treatment. The appropriate off-base treatment technologies will be determined by the disposal facility accepting the material.

Assessment of this option follows:

- Effectiveness: Treatment at a licensed RCRA Subtitle C/RCRA Subtitle D landfill or TSDF are effective means of rendering the contaminated material acceptable for off-base disposal. Treatment would reduce the toxicity and mobility of the contaminated media. The volume of the media would be increased (typically by up to 20 percent) by solidification/stabilization processes.

- Implementability: This option is implementable at a licensed off-base facility. Many facilities offer stabilization/solidification. Fewer facilities are available for treatment of organics. Proper handling and transport of contaminated materials, complete with bill of lading, would be required. Some stabilization of the materials may be required prior to transport to minimize the presence of free liquids.

- Cost: The capital costs are expected to be relatively low. Materials requiring solidification/ stabilization are expected to be treatable on-site for a minimal cost per cubic yard. No O&M costs are associated with this option.

Off-base treatment is retained for further consideration for the site area.

3.3.2.7 Aquatic Habitat Restoration

Aquatic habitat restoration is a required component of any remedial alternative that significantly damages or destroys the existing aquatic habitat. Dredging/excavation is expected to cause significant impacts to the aquatic habitat by destroying the existing aquatic habitat in the remediation area. Additionally, the aquatic habitat outside the remediation area may be damaged by construction activities associated with dredging.

This section evaluates aquatic restoration options for the ecological community at risk of damage from remedial alternatives: the eelgrass community in a portion of the subtidal area of the site. Restoration of damaged portions of these communities may be required following remedial action; however, all possible efforts will be made to avoid damage to the aquatic communities during remediation.

Eelgrass Communities

This section describes the eelgrass habitat and evaluates the measures that can be taken to restore damaged habitat.

Characteristics of the Habitat: Eelgrass (*Zostera marina L*) is one of approximately 50 species of marine vascular plants capable of vegetative and reproductive growth. It is found in coastal and estuarine waters in large meadows or small disjunct beds ranging in size from 1 yard across to acres in area. This species is a true flowering plant, with roots and rhizomes that inhabit sediments ranging from soft mud to coarse sand. The thin, green strap-like leaves range from 6 inches to over a yard long. It grows in water ranging from 1 to 8 meters deep and has been found to exist in a wide salinity range. Eelgrass is a sensitive species that grows where several physical, chemical, and biological parameters are in balance with the needs of the plant.

The availability of light controls the depth of eelgrass and is considered the most critical factor in maintaining healthy eelgrass beds (Kenworthy and Haunert, 1991). In Narragansett Bay, the most important factor contributing to the continuing decline of seagrass has most likely been light reduction caused by turbidity created by algal blooms and periodic disturbances such as dredging (TtNUS, 1999). The algal blooms are the result of increasing amounts of anthropogenic nitrogen since the 1870s (Nixon, 1993; Nixon, Granger, and Nowicki, 1995; Nixon, 1997). Natural factors such as wave and tidal action and shifting sediment have also contributed significantly to eelgrass bed instability.

Eelgrass may be present in the nearshore areas around the OFFTA; however, the extent of the eelgrass has not been fully characterized. Further characterization of the extent and viability of the eelgrass beds will be conducted during the blooming season in the summer of 2001.

Even if remedial actions such as dredging in the nearshore area may not directly affect the eelgrass beds, increased turbidity in the area caused by the remedial actions could impair light penetration and/or lead to siltation, which could damage the eelgrass beds.

Natural Restoration of the Eelgrass Habitat: Natural restoration is an option that could be considered to mitigate minor damage to eelgrass beds resulting from turbidity-related impacts such as decreased light availability or increased siltation. Natural restoration would be limited to the use of sediment resuspension/turbidity controls such as installing floating silt curtains during dredging or capping, implementing a turbidity monitoring program to ensure the effectiveness of the turbidity controls, and monitoring the restoration of the habitat following completion of the remedial action.

An assessment of the natural restoration of slightly damaged eelgrass communities follows:

- Effectiveness: The natural recovery potential for eelgrass indirectly affected by a remedial action in the nearshore area appears favorable. Light availability is not expected to be a significant factor in the long-term (i.e., the period following implementation of the sediment remediation alternative); however, uncontrolled sediment suspension caused by dredging during the remediation may decrease the available light for a short period. Effective dredging/excavation management and use of sediment resuspension/turbidity controls should minimize this problem. Under all circumstances, the sediment removal area would be enclosed by floating silt curtains to limit the dispersion of resuspended particulates. A turbidity monitoring program would be implemented to ensure the effectiveness of sediment containment procedures.

  Similarly, wave and current action in the area are not likely to be significantly altered by the sediment remedial action. Any minor changes in wave and current action are not expected to interfere with natural restoration of damaged eelgrass beds. Because the present stability of the eelgrass bed is unknown, it will be difficult to discern natural from anthropogenic stresses that might result from the remedial action. To address this concern, eelgrass bed monitoring would be conducted during remediation in conjunction with turbidity monitoring to provide some insight into whether operation-induced siltation is occurring.

- Implementability: Natural restoration of slightly impacted eelgrass beds is easily implemented. It would principally involve proper use of operational and sediment resuspension/turbidity controls during active remediation of the nearshore areas to limit damage and allow the area to quickly return to its original condition.

- Cost: The capital and O&M costs for natural restoration of slightly impacted eelgrass beds would be low. The costs for minimizing damage to the area would be included as part of the normal dredging costs. Additional costs would include turbidity monitoring and any monitoring associated with the restoration of the habitat.

Natural restoration is a viable option to address eelgrass beds slightly impacted by remedial actions in the nearshore area. It is retained for further consideration for alternatives that could result in slight damage to eelgrass beds.

Assisted Restoration of the Eelgrass Habitat: Assisted restoration is an option that could be considered to mitigate destruction of the eelgrass community caused by dredging within the limits of the eelgrass beds. Assisted restoration of eelgrass beds consists of providing the optimum habitat structure and transplanting eelgrass into the sediment structure. Seagrass transplanting methods can be grouped into three broad categories: (1) shoots with sediment intact, (2) seeds, and (3) shoots with bare roots. After initial transplanting, the success of the restoration would have to be monitored and additional transplanting would likely be necessary to replace grasses that did not survive.

An assessment of assisted restoration of severely damaged eelgrass communities follows:

- Effectiveness: The potential for accelerating the recovery of eelgrass impacted by a remedial action is evaluated below in light of the success of recent eelgrass restoration projects in Narragansett Bay.

  In 1995, the National Marine Fisheries Service (NMFS) conducted eelgrass restoration projects at 10 sites (Bristol Ferry North, Bristol Ferry South, Sakonnet River (2), Dutch Harbor, Dyer Island, Hog Island, Northern Jamestown, T-Dock, and West Prudence) chosen for their high clarity of water, sandy sediment, and protection from heavy wave action and strong tidal currents. By 1997, only three sites were found to still be supporting any plants (T-Dock, Prudence Island, and Dutch Harbor). The loss of sites has been attributed to strong winds that accompanied the passage of a hurricane in 1996, crab bioturbation, and excessive reduction in light transmission due to macroalgae; one site was probably set too shallow and one too deep.

  Further restoration efforts conducted by the University of Rhode Island (URI) in 1995 involved two separate eelgrass restoration projects: one involving eelgrass shoots with bare roots as the transplant media, and another using only eelgrass seeds. For each proposed transplant area, a careful evaluation of environmental variables was conducted, including collecting information on bathymetric data coupled with light extinction data, wave energy, sediment type (i.e., sandy bottom, presence/absence of existing eelgrass, and current human use). In addition, preference was given to areas known to have historically contained eelgrass beds vs. those areas that did not.

  Out of six sites selected for eelgrass shoot/root transplant by URI in 1995, only one site (Hope Island) has persisted to this date. Similarly, of the four sites where eelgrass seeding was conducted, only one site (Dutch Harbor) was successful. Limited success for both projects is

most likely a result of early planting (for seeding the project) and strong wave action. Both URI and NMFS found the higher density plots are more likely to succeed than are those with a lesser density.

In summary, eelgrass restoration projects underway in Narragansett Bay have targeted the most promising locations with respect to environmental conditions believed to favor growth. Despite extensive experimentation in transplantation methods, densities, and locations, very few sites have persisted more than a few years. Hence, it would appear that the potential for a successful assisted eelgrass restoration in the OFFTA area is low to negligible for eelgrass beds that might be destroyed by remedial activities.

- Implementability: Assisted restoration of eelgrass beds significantly damaged by remedial activities could be attempted by transplanting eelgrass shoot or seeds and optimizing the habitat structure to encourage eelgrass survival. However, successful restoration may not be possible. As described above, assisted restoration of eelgrass beds has not been widely successful, even under ideal conditions. It is unlikely the assisted restoration would be successful in the OFFTA area, which has less than ideal conditions.

- Cost: The costs of assisted restoration at this site or elsewhere would likely be high due to the need for multiple plantings and extensive monitoring. As noted, little success with assisted restoration of eelgrass in Narragansett Bay has been achieved to date.

Assisted restoration does not appear to be a viable option to enhance restoration of damaged eelgrass beds in the OFFTA area. However, if planned remedial actions would severely damage eelgrass beds and some form of mitigation is required, assisted mitigation could be reconsidered to restore the damaged bed or to restore a damaged eelgrass bed in another part of Narragansett Bay.

If assisted eelgrass restoration is considered, it should first be demonstrated that any eelgrass beds found offshore of OFFTA are viable with respect to cover, bed size, and shoot density, to the extent that these features characterize self-sustaining beds. If the eelgrass beds are characterized as viable and self-sustaining, attempts could be made to restore these beds or to restore a bed in another part of Narragansett Bay. Should this action be necessary, further restoration options would be evaluated employing habitat modifications that would structurally enhance eelgrass restoration, e.g., sand bottom and flatness. This effort would rely on the experience gained in other restoration projects noted above for optimal location and restoration procedures.

3.3.3 Representative Process Options for Sediment

EPA guidance for conducting FSs (EPA, 1988) recommends that one RPO be selected for each technology type to simplify the subsequent development and evaluation of alternatives without limiting flexibility during remedial design. RPOs are selected from the treatment techniques remaining after screening based on effectiveness, implementability, and cost. The RPOs selected provide a basis for developing performance specifications during preliminary design. Although specific process options are selected for alternative development and evaluation, these process options are intended to represent the broader range of process options within a general technology type. The specific process for implementation of the remedial action may not be selected until the remedial design phase.

Table 3-4 identifies the sediment RPO(s) chosen for each technology type. The RAOs specify that the goal of remediation is to restore the site for residential use without any restrictions. In order to meet this requirement, technologies involving containment and/or in situ technologies that require long-term monitoring are not considered, and, therefore, the selected RPOs primarily reflect removal, treatment, and disposal options. No action, dredging/excavation, disposal at an off-site landfill or TSDF, and solidification/stabilization have been selected as the RPOs.

The no action option consists of undertaking no remedial action at a particular site. Inclusion of the no action alternative is required under CERCLA guidance, and this alternative is used as a baseline consideration in the detailed evaluation or to address sites that do not require any active remediation. No technologies or process options are associated with this RPO.

Mechanical dredging is a viable removal option for nearshore areas and has therefore been retained for assembly into alternatives. Contaminated sediment removal activities may include both conventional earth-moving excavation techniques (behind a temporary cofferdam) and mechanical dredging using barge-mounted equipment for sediment inaccessible from the shoreline or haul road constructed into the water. This process option has been selected to represent the excavation/dredging technology for the removal/disposal and removal/treatment/disposal GRAs for the shoreline and nearshore areas.

Off-site disposal at a landfill or a TSDF was retained as an RPO for use either in conjunction with a remediation process that produces residuals that must be disposed of off base or for disposal of contaminated sediment. Use of a TSDF will be a very effective, long-term solution to contaminated soil disposal.

Solidification/stabilization is retained as the treatment RPO. If treatment is required, this RPO will effectively immobilize contaminants within the sediment.

4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES FOR SOIL

The purpose of this section is to develop and screen alternatives and to assemble an appropriate range of remedial options to achieve the site RAOs. Remedial technology process options retained for further consideration in Section 3.0 are combined to form remedial alternatives. Detailed evaluation of these alternatives is performed subsequently.

4.1 RATIONALE FOR DEVELOPMENT OF ALTERNATIVES

The alternatives are developed to comply with regulatory criteria applicable to the site conditions and the media of concern, as directed by the following regulations and guidance:

- *Navy/Marine Corps Installation Restoration Manual* (2000), which dictates that remedial alternatives be consistent with the procedures outlined in the NCP (40 CFR 300.430).

- National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR 300), which establishes the criteria for development and evaluation of remedial alternatives and further suggests consideration of applicable EPA directives and guidance.

- *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA, 1988).

These documents require that a range of alternatives be developed that eliminate, reduce, or control human and ecological risks The goal is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste. According to Section 121 of CERCLA, as amended by SARA, the statutory preference is for remedies that will result in a permanent and significant decrease in toxicity, mobility, or volume of contaminants and provide long-term protection. In addition, the NCP requires that certain expectations be considered in developing and screening remedial alternatives. These expectations are as follows:

- Treatment will address the principal threats posed by the site, wherever practical. Principal threats are considered to be liquids, areas contaminated with high concentrations of toxic compounds, and highly mobile materials.

- Engineering controls, such as containment, will be used for waste that poses a relatively low, long-term threat and for which treatment is impractical.

- A combination of methods will be used, as appropriate, to achieve protection of the environment In appropriate site situations, treatment of principal threats will be combined with engineering and institutional controls for dealing with residuals and relatively low, long-term threats.

- Institutional controls, such as deed restrictions, will supplement engineering controls for short- and long-term management to prevent or limit exposure to hazardous substances, pollutants, or contaminants.

- The use of innovative technologies will be considered when such use offers the potential for comparable or superior treatment performance or implementability, fewer or lesser adverse impacts, or lower costs for similar levels of performance than previously demonstrated technologies.

Environmental media will be returned to their beneficial uses, when practical, within a reasonable time frame. When restoration of a medium is not practical, actions are expected to prevent further migration and exposure to contaminated media and to evaluate further risk reduction measures

From the technologies that passed the screening, RPOs were selected to represent a typical remedial action in Section 3.0. Alternatives are developed by assembling RPOs. The *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA, 1988) identifies six steps for developing alternatives. The six steps as specified by EPA are described below.

1. Develop RAOs specifying the chemicals and media of interest, exposure pathways, and PRGs that permit a range of treatment and containment alternatives to be developed. The PRGs are developed on the basis of chemical-specific ARARs and, when available, other available information (e.g., reference doses [RfDs]) and site-specific risk-related factors.

2 Develop general response actions for each medium of interest defining containment, treatment, excavation, or other actions, singly or in combination, that may be taken to satisfy the RAOs for the site.

3. Identify volumes or areas of media to which GRAs might be applied, taking into account the requirements for protectiveness as identified in the RAOs and the chemical and physical characterization of the site.

4. Identify and screen the technologies applicable to each general response action to eliminate those that cannot be implemented at the site. Further define the GRAs to specify remedial

technology types (e.g., the GRA of treatment can be further defined to include chemical or biological technology types).

5. Identify and evaluate technological process options to select an RPO for each technology type to be retained for consideration. Although specific processes are selected for alternative development and evaluation, these processes are intended to represent the broader range of process options within a general technology type.

6. Assemble the selected RPOs into alternatives representing a range of treatment and containment combinations, as appropriate.

The purpose of providing a range of alternatives is to ensure all reasonable GRAs are represented and evaluated.

Table 3-2 listed the soil RPOs and the corresponding technology types. The soil remedial alternatives in this FS report are formulated from these RPOs and are presented in Table 4-1.

Based on current data, the remedial action for soil at OFFTA is to address approximately 49,500 cy of impacted surface and subsurface soil. Several PAHs, arsenic, beryllium, lead, and manganese exceeded RIDEM standards for surface soil. Subsurface soil contaminants exceeding RIDEM standards include several PAHs, antimony, arsenic, beryllium, lead, manganese, and petroleum hydrocarbons. The areal extent and depth of contamination are depicted on Figure 2-3. In order to address RIDEM requirements and be able to achieve residential cleanup standards with no land use restrictions, three alternatives were developed to address soil contamination at OFFTA. The alternatives are as follows:

Soil Alternative 1: No Action
Soil Alternative 2: Removal, Ex situ Treatment, and Backfill
Soil Alternative 3: Removal and Disposal

No alternatives using the Limited Action and Containment GRAs were assembled because they would not meet the RAO of allowing unrestricted residential use of the site.

4.2 DESCRIPTION OF ALTERNATIVES

The alternatives were developed to address soil and debris in the areas identified as posing potential risks to human health. As discussed previously, the volume requiring remediation consists of about 49,500 cy. The depth of contamination varies across the site.

Sections 4.2.1 through 4.2.3 describe the alternatives developed to address the site soil. Table 4-1 identifies the components of each alternative.

4.2.1 Soil Alternative 1: No Action

The no action alternative, as required under the NCP, would involve no remedial response activities and would provide no additional protection of human health or the environment. However, it would provide a baseline for comparison to other alternatives. Since contamination would remain and unrestricted future use of the area would be allowed, 5-year reviews of the no action decision would be required.

Under this alternative no remedial actions would be performed, no measures would be implemented to restrict access to the OFFTA site, and no actions would be taken to warn people of the hazards. Existing measures that provide some protectiveness include fencing and signs around the OFFTA that limit access to the site.

4.2.2 Soil Alternative 2: Removal, Ex situ Treatment, and Backfill

Alternative 2 would eliminate long-term management by addressing contaminated soil through excavation and treatment. This alternative would offer aggressive remediation through excavation and on-site treatment by LTTS and soil washing to reduce the contaminant concentrations to levels below PRGs. Elements of Alternative 2 would include:

- Pre-design investigation to determine the extent of excavation and types of disposal required
- Excavation of the mounds and segregation of soil and debris for temporary storage
- Excavation of site to remove debris and contaminated soil
- Segregation of debris and contaminated soil
- Temporary storage of contaminated and contaminant-free materials
- On-site treatment of contaminated soil with LTTS to remove organics
- On-site treatment of contaminated soil with soil washing to remove inorganics
- Confirmation sampling of treated soil
- Backfill with treated soil supplemented with clean fill material
- Disposal of debris and treatment residues
- Post-remediation groundwater monitoring
- Five-year review

LTTS uses direct or indirect heating to thermally desorb or volatilize organic contaminants present in soil. LTTS has been used extensively at various CERCLA sites, and the experience resulting from its use has

been positive. Soil washing involves treating soil with wash liquids that would separate the contaminants from the soil media; it would be used to remove metals from the soil. The combination of LTTS and soil washing would address all site contaminants, both organic and inorganic. Removal would involve the removal of surface and subsurface soil (up to 10 feet) using trackhoes. An estimated 49,500 cy of soil and debris would be excavated, with approximately 36,330 cy of that being soil to be treated. As part of pre-construction, the existing mounds at the OFFTA (10,900 cy) would be excavated and the debris disposed of in order to allow access to any contaminated soil beneath the mounds. It is assumed for the FS that the debris within the mounds and surrounding areas is suitable for disposal as solid waste; however, the materials would be tested prior to disposal to verify this. Treated soil would be used for backfilling excavated areas.

4.2.3 Soil Alternative 3: Removal and Disposal

Alternative 3 would eliminate long-term management by addressing contaminated soil through excavation and disposal. This alternative would offer aggressive remediation through excavation and transportation of contaminated soil to a TSDF or landfill. Elements of Alternative 3 would include:

- Pre-design investigation to determine the extent of excavation and types of disposal required
- Excavation of the mounds and segregation of soil and debris for temporary storage
- Excavation of site to remove debris and contaminated soil
- Segregation of debris and contaminated soil
- Temporary storage of contaminated and contaminant-free materials
- Disposal of debris and contaminant-free soil at a municipal landfill
- Disposal of contaminated soil at a TSDF
- Confirmation sampling of treated soil
- Backfill with clean fill material
- Post-remediation groundwater monitoring
- Five-year review

An estimated 49,500 cy of soil and debris would be excavated for disposal. It is assumed that as part of pre-construction, the existing mounds at the OFFTA (10,900 cy) would be excavated and the debris disposed of as solid waste in order to allow access to any contaminated soil beneath the mounds. The material in the mounds would be tested prior to disposal to determine the appropriate disposal facility.

Removal would involve the removal of surface and subsurface soil (up to 10 feet) using trackhoes. Excavated material would be loaded onto trucks and hauled off site to an approved disposal facility. The

effectiveness of the technique has been demonstrated in many full-scale operations. Backfilling with clean fill would be performed in conjunction with excavation.

TSDFs are controlled by regulations contained in, but not limited to, 40 CFR 264 and 265. LDRs would be followed at the TSDF. It is not practical to select a specified TSDF or transporter at this time; however, potential TSDFs are available in neighboring states. The TSDFs and transporters would be from an approved list of EPA- and/or state-registered vendors.

4.3 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

The remedial alternatives developed in Section 4.2 are described and analyzed in detail in this section. The detailed analysis of the alternatives provides information to facilitate selection of a specific remedy or combination of remedies. The detailed analysis of alternatives was developed in accordance with the NCP [40 CFR 200.430(e)] and the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988).

In conformance with the NCP, seven of the following nine criteria were used to evaluate each of the retained alternatives during the detailed analysis. The last two criteria, state and community acceptance, will be addressed following the receipt of state and public comments on the proposed plan.

- 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
- Cost
- State Acceptance
- Community Acceptance

Under the NCP, the selection of the remedy is based on the nine evaluation criteria, which are categorized into three groups:

- Threshold Criteria - Overall protection of human health and the environment and compliance with ARARs are threshold criteria that each alternative must meet in order to be eligible for selection.

- Primary Balancing Criteria - The five primary balancing criteria are long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost.

- Modifying Criteria - State and community acceptance are modifying criteria that will be considered in remedy selection.

Brief, general discussions of these evaluation criteria are presented in the following text. Detailed analyses of the alternatives using the evaluation criteria are presented in Section 4.4. A comparative analysis of the alternatives is presented in Section 4.5.

Overall Protection of Human Health and the Environment

This evaluation criterion provides a final check to assess whether each alternative provides adequate protection of human health and the environment. The overall assessment of protection draws on the assessments conducted under other evaluation criteria including long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. The evaluation focuses on whether a specific alternative achieves adequate protection and how risks are eliminated, reduced, or controlled.

Compliance with ARARs

ARARs are considered during the detailed evaluation of alternatives. Alternatives are assessed on whether they attain ARARs. When an ARAR cannot be met, the basis for justification of a waiver under CERCLA, or within the specific requirement, is presented.

The actual determination of which ARARs are requirements is determined by the Navy in consultation with EPA and RIDEM.

Long-Term Effectiveness and Permanence

Under this criterion, the alternatives are evaluated for long-term effectiveness, permanence, and the degree of risk remaining after the RAOs have been met. The following components are evaluated:

- Magnitude of residual risks - assesses the residual risk remaining from untreated wastes or treatment residuals at the conclusion of remedial actions, the remaining sources of risk, and the need for 5-year reviews.

- Adequacy and reliability of controls - assesses controls that are used to manage treatment residuals or remaining untreated wastes. This assessment includes addressing the likelihood of technologies to meet required efficiencies or specifications, type and degree of long-term management, long-term monitoring requirements, O&M functions to be performed, uncertainties associated with long-term O&M, potential need for replacement of technical components and associated magnitude of risks or threats, degree of confidence in controls to handle potential problems, and uncertainties associated with land disposal of untreated wastes and residuals.

Reduction of Toxicity, Mobility, or Volume Through Treatment

This criterion addresses the statutory preference for remedies that employ treatment as a principal element by assessing the relative performance of different treatment technologies for reducing the toxicity, mobility, or volume of the contaminated media. Specifically, the analysis should examine the magnitude, significance, and irreversibility of the estimated reductions.

The degree to which remedial alternatives employ treatment that reduces toxicity, mobility, or volume are assessed by considering the following factors:

- The treatment processes that the remedies employ, the media they would treat, and threats addressed.
- The approximate amount of hazardous materials that would be destroyed or treated.
- The degree of expected reduction in toxicity, mobility, or volume as a result of treatment.
- The degree to which the treatment is irreversible.
- The type and quantity of residuals that would remain following treatment, considering the persistence, toxicity, mobility, and bioaccumulation capacity of the contaminants of concern and impacted media.
- The ability of alternatives to satisfy the statutory preference for treatment as a principal element.

Short-Term Effectiveness

The assessment of short-term effectiveness during construction or implementation until the RAOs are met includes consideration of the following factors:

- Potential short-term impacts to the community during remedial actions and whether risks may be addressed or mitigated.

- Potential impacts to, and protection of, the workers during remedial actions.

- Potential adverse environmental impacts that result from construction and implementation of the alternative, and the reliability of mitigation measures.

- Time until RAOs are achieved.

Implementability

The ease or difficulty of implementing a remedial alternative is assessed by considering the following factors during the detailed analysis:

- Technical Feasibility:

  - Degree of difficulty or uncertainties associated with constructing and operating the alternative.

  - Technical difficulties associated with the technologies' reliability that could result in schedule delays.

  - Likelihood of additional remedial actions and anticipated ease or difficulty in implementation.

  - Ability to monitor the effectiveness of the remedy and risks of exposure if monitoring is insufficient to detect remedy failure.

- Administrative Feasibility:

  - The need to coordinate with other offices and agencies and obtain necessary approvals and permits.

- Availability of Services and Materials:

  - Availability of adequate capacity and location of treatment, storage, and disposal services, if required.

- Availability of necessary equipment and specialists.

- Availability of treatment technologies comprising the alternative, sufficient demonstration of the technologies, and availability of vendors.

- Availability of services and materials, and the potential for obtaining competitive bids.

Cost

A detailed cost analysis is performed for each alternative to assess the net present worth cost to implement the remedial actions. The cost analysis consists of the following:

- Estimation of capital (direct and indirect) and annual O&M costs.

- Development of costs with an accuracy in the range of +50 percent to -30 percent.

- Calculation of the present worth (capital and O&M costs) of the alternative by discounting to a base year or current year using a discount rate of 7 percent

State Acceptance

RIDEM will be providing input to the FS process on an ongoing basis and would continue to do so throughout the public comment period. Assessment of the state concerns may not be completed until comments on the RI Report, FS Report, and proposed plan are received. As a result, this Draft FS does not include any additional discussion about this criterion for any of the alternatives analyzed. State concerns may be discussed, to the extent possible, in the proposed plan to be issued for public comment. The state's comments would be fully addressed in the record of decision (ROD). The state concerns that would be assessed include the following:

(1) The state's position and key concerns related to the preferred alternative and other alternatives and

(2) State comments on ARARs or the proposed use of waivers.

Community Acceptance

This criterion refers to the community's comments on the remedial alternatives under consideration. The community is broadly defined to include all interested parties. Community concerns would be addressed after the public comment period, which follows the release of an administrative record that includes the RI Report, FS Report, and proposed plan along with any other documents that were used by the EPA to develop the proposed remedy. As a result, this FS does not include any additional discussion about this criterion for any of the alternatives analyzed.

4.4 INDIVIDUAL ANALYSES OF SOIL ALTERNATIVES

Three remedial alternatives, including the No Action Alternative, were developed to address the contaminated soil at OFFTA. Detailed evaluations of each alternative are presented in this section and summarized in Table 4-2. Detailed cost estimates, including both capital and O&M costs, as well as assumptions for each alternative are presented in Appendix D.

4.4.1 Soil Alternative 1: No Action

Consideration of a no action alternative is required under the NCP. At a minimum, it provides a baseline against which other alternatives may be compared. No containment, removal, or treatment of soil contaminant would be conducted. The alternative would provide no mechanism to minimize potential risks to receptors except for the existing fencing and signs, which would not be maintained. The only activities to be conducted under Alternative 1 would be review of site conditions and risks every 5 years

An analysis of this alternative with respect to the evaluation criteria is as follows:

Overall Protection of Human Health and the Environment: The no action alternative would not provide long-term protection of human health and the environment and would not facilitate site re-use. Alternative 1 would not achieve RAOs for the protection of human health or the environment, and several PAH and inorganic contaminants would still exist at the OFFTA site at concentrations exceeding PRG levels. Contaminants in the soil would continue to pose unacceptable risks to human health in the long-term through dermal contact, incidental ingestion, and possibly through fugitive dust inhalation, under potential future use of the site. Under the future land-use scenario, a resident exposed to existing contamination in subsurface soil would have unacceptable risk. The fencing and signs currently at the site would not be maintained and could become ineffective.

The PAHs and inorganic contaminants remaining in the soil would also have a continued potential to leach into the groundwater. Because contaminants would remain at the site, 5-year reviews would be conducted, as required by CERCLA, to assess changing conditions and potential risks. Once the 5-year review results have been evaluated, and if contaminant migration is deemed to pose human health or environmental risks, then additional response actions may be warranted.

Compliance with ARARs: Tables 4-3, 4-4, and 4-5 summarize chemical-, location-, and action-specific ARARs and TBCs, respectively, for Alternative 1. This alternative fails to meet ARARs because it does not address soil exceeding PRGs that have been derived from state and federal regulations. Since no action is to be taken under this alternative, there are no state or federal location-specific or action-specific ARARs or TBCs.

Long-Term Effectiveness and Permanence: Since no remedial actions would occur under Alternative 1, the unacceptable future threats to human health and the environment would remain. Potential contaminant migration pathways would not be addressed, and PAHs and metal contaminants remaining at the site would continue to pose threats to human health through various exposure pathways. Estimated excess carcinogenic risk of approximately 2.5×10^{-5} for surface soil and 4.0×10^{-5} for subsurface soil would remain during future residential use of the site under this alternative.

Contaminants in the subsurface would also continue to potentially leach into the groundwater underlying the site and migrate off site into Coasters Harbor.

Because of the risk associated with leaving contaminated soil on site, 5-year reviews would be required. These 5-year reviews would assess whether threats or risks are increasing or abating with time and any changes in the conditions at the site.

Under the no action alternative, no additional controls would be used to manage the contaminants at the site. Therefore, the evaluation of the adequacy and reliability of new controls is not applicable.

Reduction of Toxicity, Mobility, or Volume Through Treatment: The no action alternative would not reduce the toxicity, mobility, or volume of contamination through treatment, since no treatment is used to address the contaminated soil. As a result, no hazardous substances would be treated or destroyed, and contaminated soil would remain in place.

Alternative 1 would not satisfy the statutory preference for treatment to reduce risks posed by contaminated soil.

Short-Term Effectiveness: Since no response actions other than long-term monitoring would occur, implementation of the no action alternative would not pose additional short-term risks to the local community, base personnel, or the environment. Workers conducting long-term monitoring would be protected from contaminant-related risks by PPE and proper site safety procedures. Potential risks from soil contamination would remain unabated. None of the RAOs would be achieved.

Implementability: This alternative would require no implementation other than completion of the 5-year reviews. This activity would not require any permits, but it may require a minimal amount of coordination between regulatory agencies. Implementation of the no action alternative would not limit future implementation of additional remedial actions at the site, if deemed necessary.

Cost: A detailed estimate of capital, O&M, and present-worth costs for Alternative 1 is provided in Appendix D and is summarized below. Present-worth costs were developed for a 30-year period at a 7 percent discount rate.

Cost Description	Estimated Cost
Capital Costs	$0
O&M/Long-Term Monitoring	$0
5-Year Reviews	$22,000/5 years
Present Worth	$46,000

4.4.2 Soil Alternative 2: Removal, Ex situ Treatment, and Backfill

Alternative 2 features the excavation of surface and subsurface soil exceeding PRG levels and on-site treatment of the soil using LTTS and soil washing. LTTS would remove organic contamination from soil through thermal treatment, and soil washing would address the metals. Off-gas controls would be necessary to capture organic constituents removed during thermal treatment. Treated soil would be used as backfill. Excavation would involve the removal of soil using a trackhoe or front-end loader, and excavated material would be loaded onto trucks and hauled to a centralized location on the site for treatment. The excavation would be performed in stages, where a limited area would be excavated, the soil hauled to the treatment area, and the excavation backfilled. This process would proceed from one side of the site to the other. Runoff and erosion controls would be maintained around the active excavation area.

All surface and subsurface soil exceeding PRGs in the vadose zone would be excavated. The three soil mounds at the site built of soil/construction debris require excavation and removal in order to reach

contaminated soil beneath the mounds. The debris within the mounds is assumed to be acceptable for disposal as solid waste.

A Pre-Design Investigation (PDI) would be performed to gather information needed to complete the final remedial design. The PDI would include sampling to better define the extent of contamination and the percent of debris expected in the excavation. The PDI would also finalize the staging methods for performing the excavation and would define the post-excavation sampling plan.

Contaminated soil would be treated in an on-site treatment system consisting of LTTS and soil washing steps. LTTS uses direct or indirect heating to thermally desorb or volatilize organic contaminants present in solids or soil. The temperatures used are contaminant- and matrix-specific with a range of approximately 200 to 1,000°F. Typically, contaminated soil is processed through an externally fired pug mill or rotary drum system equipped with heat transfer surfaces that are heated by circulating hot oil, gases, or steam. An induced air flow conveys the desorbed organics through a secondary treatment system, such as a carbon adsorption unit, combustion afterburner, or condenser unit. The air stream is then discharged through a stack, and any water that is driven off is sent through carbon adsorption units. Residuals other than gas are soil, ash, and spent carbon.

Soil washing involves removal of contaminants by washing in an aqueous-based system. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove heavy metals. Soil washing removes contaminants sorbed onto soil particles from soil by either dissolving or suspending them in the wash solution (which is later treated by conventional water treatment methods, such as in a POTW). In the washing process, the soil is screened and then scrubbed to break up soil aggregates and liberate fines. The surfaces of the coarse particles are "washed" by abrasive action and by desorption of contaminants upon contact with the washing solution.

As the contaminants would be removed to concentrations below PRGs, long-term monitoring or 5-year reviews would not be required. However, four new monitoring wells would be installed (the existing wells would be destroyed during excavation) and sampled after remediation for trend comparison with pre-remediation concentrations. The four 2-inch polyvinyl chloride (PVC) wells would be installed near existing monitoring wells MW-4, MW-101, and MW-2, all of which had elevated levels of arsenic in the groundwater, and MW-10 to provide a well on the eastern portion of the site. Three sampling rounds would be collected at 6-month intervals and analyzed for SVOCs, metals, gasoline range organics, and diesel range organics (Method 8015B).

An analysis of this alternative with respect to the evaluation criteria is as follows:

Overall Protection of Human Health and the Environment: Alternative 2 would provide high overall protection of human health and the environment because all contaminated soil exceeding PRGs would be excavated and treated. The alternative provides protection against potential long-term direct exposures (dermal contact, incidental ingestion, and inhalation) to humans. The potential to leach would be minimized, and any potential impact to groundwater due to leaching would be negligible. Excavated soil would be treated to remove contaminants, and the treated soil would be used as backfill.

There would be increased short-term risks to on-site workers from potential exposures to contaminated soil during implementation because of the magnitude of excavation and treatment involved. These risks would be minimized through the use of engineering controls and proper PPE.

Once the contaminated materials have been removed and the area backfilled with treated soil, no long-term management measures would be required. There would be no restrictions that would limit future activities at the property.

Compliance with ARARs: Tables 4-6, 4-7, and 4-8 summarize chemical-, location-, and action-specific ARARs and TBCs, respectively, for Alternative 2. This alternative would comply with chemical-specific ARARs because organic and inorganic contaminants would be reduced to acceptable concentrations in the treated soil. Alternative 2 would comply with the RIDEM requirements for both direct contact and the leachability criteria.

Implementation of Alternative 2 would meet state and federal location-specific ARARs by conducting the activities in accordance with applicable and relevant and appropriate floodplain, wetland, coastal resource management, endangered species, fish and wildlife protection, and historic preservation regulations and by coordinating with appropriate agencies to find ways to minimize adverse effects to fish, wildlife, endangered species, and historic sites.

Action-specific ARARs would be met by designing and implementing the alternative in accordance with Clean Air Act (CAA) requirements. Disposal of waste liquids from the soil washing operation would be done in accordance with applicable local, state, and federal regulations.

Long-Term Effectiveness and Permanence: Excavating and treating the soil would provide long-term effectiveness and permanence. The LTTS process would reduce organic concentrations to meet PRGs, and soil washing would remove inorganic concentrations to meet PRGs. This alternative would not require long-term management because contaminants above PRGs would be removed from the soil.

LTTS would be effective at removing the organic COCs from the contaminated soil. The removal efficiency would be dependent on the temperature employed, the volatility (boiling point) of the chemical, and the soil matrix. As temperature increases, removal efficiency also increases. The off-gas treatment system would then capture or destroy the contaminants. Inorganics would be removed by the soil washing treatment, and the desired removal would be achievable by adjusting the pH of the wash solution. The effectiveness of the alternative can be monitored through sampling and analysis of the excavation boundaries and the treated soil.

As the contaminants above PRGs would be removed from the soil, no long-term management is expected. Groundwater monitoring would not be required because there would be no remaining potential to leach.

Reduction of Toxicity, Mobility, or Volume through Treatment: Alternative 2 would reduce the toxicity, mobility, and volume of organic and inorganic contaminants through removal and treatment of contaminated soil. The degree of toxicity and volume reductions would depend on the soil matrix and the treatment system parameters. A small amount of LTTS vapor treatment system and soil washing system residual material (spent carbon and liquid waste) may require treatment or off-site disposal

Short-Term Effectiveness

The short-term risk to workers, base personnel, and the public during implementation of Alternative 2 would be controllable and would primarily result from the excavation and handling of the contaminated soil during the treatment processes PPE, at a level commensurate with the contaminants involved, would be required during excavation and treatment operations. The risk to the environment from fugitive emissions and erosion would be greatest during excavation activities and would diminish with time during the treatment processes. Air monitoring conducted during construction activities would indicate the need for any additional measures to address the short-term risks. The time required to reach the remedial action objectives is estimated at 6 to 8 months.

Implementability: Alternative 2 is implementable because soil excavation using a trackhoe is a standard construction practice. LTTS and soil washing are also implementable. LTTS would be reliable in meeting PRGs; however, the reliability of soil washing would be moderate, and soils may require more than one pass through the equipment to meet PRGs. Numerous vendors are available to design, construct, and operate the components of this alternative. Future remedial actions, if required, at OFFTA would be easily implementable through additional excavation and treatment.

Permit requirements to treat organics may need to be met for LTTS technology. Disposal permit requirements may need to be met to dispose of liquid waste from the soil washing system and spent carbon from the LTTS system. A permit from RIDEM for air emissions may also be required. Federal, state, and local permits may be required for the construction and operation of the treatment systems. Any required permits are expected to be obtainable.

O&M activities for this alternative would be relatively intensive but only during the period of remediation when the treatment equipment is operating. Qualified O&M personnel would be required to maintain the components of this alternative to assure reliability. The LTTS and soil washing units would require monitoring, adjustments, and periodic maintenance. The maintenance schedule would be as recommended by the equipment manufacturer and existing legal requirements or as dictated by desired flow rates and system adjustments.

Cost: A detailed estimate of capital, O&M, and present-worth costs for Alternative 2 is provided in Appendix D and is summarized below. Present-worth costs were developed for a 30-year period at a 7 percent discount rate.

Cost Description	Estimated Cost
Capital Costs	$10,919,000
O&M/Long-Term Monitoring	$30,000 (year 1) $15,000 (year 2)
5-Year Reviews	$22,000/5 years
Present Worth	$10,975,000

4.4.3 Soil Alternative 3: Removal and Disposal

Alternative 3 would eliminate long-term management by removing the contaminated soil exceeding PRGs from the site. This alternative would offer aggressive remediation through excavation and transportation of contaminated soil to a TSDF or appropriate, permitted disposal facility.

Excavation would involve the removal of soil and debris using a trackhoe or front-end loader, and excavated material would be loaded onto trucks and hauled to an appropriate disposal facility. Backfilling would involve placement of clean fill in the excavated areas followed by contouring to the desired grade. The excavation would be performed in stages, where a limited area would be excavated, direct-loaded into trucks, and the excavation backfilled. This process would proceed from one side of the site to the other. Runoff and erosion controls would be maintained around the active excavation area. The three soil mounds at the site built of soil/construction debris require excavation and removal in order

to reach contaminated soil beneath the mounds. The debris within the mounds is assumed to be non-contaminated and therefore would be disposed of as solid waste.

Soil and debris would be tested prior to disposal to determine the appropriate disposal facility. Much of the material can be disposed of in a RCRA Subtitle D landfill, such as a municipal landfill. The remaining material that is considered hazardous would go to a RCRA Subtitle C TSDF. TSDFs are controlled by regulations contained in, but not limited to, 40 CFR 264 and 265. It is not practical to select a specified TSDF or transporter at this time; however, potential TSDFs are available in neighboring states (e.g , Model City, New York). Excavated material would be piled into several piles, and uncontaminated debris (e.g., from the mounds) and contaminated (but non-hazardous) soil would be transported to a landfill. The hazardous soil, assumed to be approximately 10 percent of the total soil volume, would be transported to a TSDF. The landfills, TSDFs, and transporters would be selected during the remedial design phase of the remediation program from an EPA- and RIDEM-approved list of vendors.

A PDI would be performed to gather information needed to complete the final remedial design. The PDI would including sampling to better define the extent of contamination and the percent of debris expected in the excavation. The PDI would also finalize the staging methods for performing the excavation and would define the post-excavation sampling plan.

As the contaminants would be removed to concentrations below PRGs, long-term monitoring or 5-year reviews would not be required. However, four new monitoring wells would be installed (the existing wells would be destroyed during excavation) and sampled after remediation for trend comparison with pre-remediation concentrations. The four 2-inch PVC wells would be installed near existing monitoring wells MW-4, MW-101, and MW-2, all of which had elevated levels of arsenic in the groundwater, and MW-10 to provide a well on the eastern portion of the site. Three sampling rounds would be collected at 6-month intervals and analyzed for SVOCs, metals, gasoline range organics, and diesel range organics (Method 8015B).

An analysis of this alternative with respect to the evaluation criteria is as follows:

Overall Protection of Human Health and the Environment: Alternative 3 would provide high overall protection of human health and the environment because all contaminated soil exceeding PRGs would be excavated and removed from the site. The alternative provides protection against potential long-term direct exposures (dermal contact, incidental ingestion, and inhalation) to humans. The potential to leach would be minimized, and any potential impact to groundwater due to leaching would be negligible

Excavated soil would be disposed of at a TSDF or appropriate disposal facility, and clean soil would be used as backfill.

There would be increased short-term risks to on-site workers from potential exposures to contaminated soil during implementation because of the magnitude of excavation involved. These risks would be minimized through the use of engineering controls and proper PPE.

Once the contaminated materials have been removed and the area backfilled with clean soil, no long-term management measures would be required. There would be no restrictions that would limit future activities at the property.

Compliance with ARARs: Tables 4-9, 4-10, and 4-11 summarize chemical-, location-, and action-specific ARARs and TBCs, respectively, for Alternative 3. This alternative would comply with chemical-specific ARARs because organic and inorganic contaminants above PRGs would be removed from the site. Alternative 3 would comply with the RIDEM requirements for both direct contact and the leachability criteria.

Implementation of Alternative 3 would meet state and federal location-specific ARARs by conducting the activities in accordance with applicable and relevant and appropriate floodplain, wetland, coastal resource management, endangered species, fish and wildlife protection, and historic preservation regulations and by coordinating with appropriate agencies to find ways to minimize adverse effects to fish, wildlife, endangered species, and historic sites.

Action-specific ARARs would be met by monitoring and use of controls to minimize emissions during soil excavation and by disposing of excavated materials at a TSDF or appropriate, permitted facility.

Long-Term Effectiveness and Permanence: Excavating and disposing of the contaminated soil would provide long-term effectiveness at the site. Although removal of contaminated soil provides a permanent solution at the site, the contaminated soil may need to be effectively treated at the TSDF to provide permanent destruction or immobilization of contaminants. Only a small fraction of soil is expected to need treatment at the TSDF. The effectiveness of the remedial action would be monitored through sampling and analysis of excavation boundaries. This alternative would reduce the residual risk at the site and would not require long-term management or monitoring.

Reduction of Toxicity, Mobility, or Volume through Treatment: Alternative 3 would only reduce mobility of organic and inorganic contaminants through removal. Because no on-site treatment is planned, toxicity and volume would not be reduced unless treatment is performed at the TSDF. Only a small fraction of soil is expected to need treatment at the TSDF. No residuals would be produced at the base.

Short-Term Effectiveness: The short-term risk to workers, base personnel, and the public during implementation of Alternative 3 would be minimal and controllable and would primarily result from excavation activities. PPE, at a level commensurate with the contaminants involved, would be required during excavation. The risk to the environment would be greatest during excavation as a result of fugitive emissions. Air monitoring conducted during construction activities would indicate the need for any additional measures to address the short-term risks. The time required to reach the RAOs is estimated at 4 to 6 months.

Implementability: Alternative 3 would be readily implementable, reliable, and available. Numerous vendors are available to provide earthmoving and transfer equipment and disposal services. Future remedial actions, if required, would be easily implementable at OFFTA through additional excavation activities.

Federal, state, and local permits may be required for the implementation of the alternative and are expected to be obtainable.

O&M requirements for this alternative are considered average and would consist of maintaining the earthmoving equipment during the excavation phase of the alternative. The maintenance schedule would be as recommended by the equipment manufacturer.

Cost: A detailed estimate of capital, O&M, and present-worth costs for Alternative 3 is provided in Appendix D and is summarized below. Present-worth costs were developed for a 30-year period at a 7 percent discount rate.

Cost Description	Estimated Cost
Capital Costs	$7,700,000
O&M/Long-Term Monitoring	$30,000 (year 1) $15,000 (year 2)
5-Year Reviews	$22,000/5 years
Present Worth	$7,757,000

4.5 COMPARATIVE ANALYSIS OF SOIL ALTERNATIVES

The soil remedial alternatives were individually assessed using the CERCLA criteria (EPA, 1988) in Section 4.4. This section contains a comparative analysis evaluating the relative merits of the soil alternatives in relation to each of the criteria. The purpose of the comparison is to provide a means of qualitatively ranking various alternatives to reveal the strengths and weaknesses of each. This comparative analysis focuses on the key differences between the alternatives and attempts to highlight

critical issues of concern to the decision maker selecting the preferred remedial action. This analysis focuses on differences between alternatives with respect to the primary balancing criteria.

The main objectives for the preferred remedial action are to be protective of human health and the environment and to comply with ARARs, which are considered threshold criteria. For an alternative to be considered as final, these two threshold criteria must be met. The no action alternative has been removed from further analysis because the alternative does not meet the two threshold criteria. This alternative is shown in the summary table for comparison purposes but is not discussed in the text. The following five criteria are the balancing criteria: (1) long-term effectiveness and permanence; (2) reduction of toxicity, mobility, or volume through treatment, (3) short-term effectiveness; (4) implementability; and (5) cost. The balancing criteria require the most discussion in this section because the major differences between alternatives frequently relate to one or more of these five criteria. Final comments addressing regulatory acceptance and community acceptance will be included in the ROD.

The comparative analysis for soil alternatives evaluates the relative performance of the alternatives in relation to each specific evaluation criterion and to the specific conditions representative of OFFTA, which contains widespread surface and subsurface contamination across the site. This approach is in contrast to that of the preceding detailed analyses in which each alternative was analyzed independently, without consideration of the others. A summary of the comparative analysis and costs for the soil alternatives is presented in Table 4-12.

Two alternatives are compared in this section: Alternative 2, which includes soil excavation, treatment of organic contamination by LTTS, removal of inorganic contamination by soil washing, and backfilling with clean processed soil; and Alternative 3, which includes soil excavation, disposal at a TSDF or an appropriate landfill, and backfilling with clean soil. Alternative 1 is not included in the comparison because it consists of no action.

Overall Protection of Human Health and the Environment: Alternatives 2 and 3 would both provide a high level of overall protection because of the source-removal action. Both alternatives would address the potential exposure pathways to protect human health and environment and would eliminate sources of contamination by removal. Neither alternative would require long-term monitoring because there would be no contaminants exceeding PRGs remaining on site after the alternatives are implemented. Both alternatives would provide high levels of protection over time because they both would involve excavation of contaminated soil; however, the exposure risk would be somewhat greater for Alternative 2 because of the on-site treatment and potential for fugitive air emissions. Additionally, residual contaminants below PRGs may remain in the treated backfilled soil under Alternative 2.

Compliance with Applicable or Relevant and Appropriate Requirements: The treatment steps in Alternative 2 would meet chemical-specific ARARs, and the excavation and removal of soil to a disposal facility in Alternative 3 would meet chemical-specific ARARs.

Implementation of either alternative would meet state and federal location-specific ARARs by conducting the activities in accordance with applicable and relevant and appropriate floodplain, wetland, coastal resource management, endangered species, fish and wildlife protection, and historic preservation regulations and by coordinating with appropriate agencies to find ways to minimize adverse effects to fish, wildlife, endangered species, and historic sites.

The selected remedy must comply with the ARARs presented in Tables 2-1 through 2-3 that are specific to the alternative. Both Alternatives 2 and 3 would meet all identified ARARs.

Long-Term Effectiveness and Permanence: Both alternatives would provide long-term effectiveness and permanence because the contaminated material would be excavated for treatment or disposal. There would be some risk that a portion of the contaminated material exceeding PRGs would not be excavated during the implementation of the alternatives, but proper monitoring should reduce or eliminate this risk. The residual risk for both alternatives would be negligible. Alternative 3 would not generate any treatment residuals, whereas Alternative 2 would require some effort in residual management for the short term. Lack of proper monitoring in Alternative 2 could also result in release of residuals into the atmosphere. Both alternatives are considered reliable.

Neither alternative would require 5-year reviews to monitor the effectiveness of the remediation because there would be no contaminants exceeding PRGs left at the site. Alternative 2 would require adequate controls and reliable methods for residual management, while Alternative 3 would not require such controls because no residuals would be generated on site.

Reduction of Toxicity, Mobility, or Volume Through Treatment: Both alternatives would remove approximately 49,500 cy of contaminated soil and debris from OFFTA. Alternative 2 would be considered permanent, and Alternative 3 would be permanent for the site, but permanent destruction or immobilization of contaminants would depend on the amount and type of treatment considered at the TSDF. Only a minimal volume of soil is expected to require treatment prior to disposal at a TSDF. Alternative 3 would reduce mobility, while Alternative 2 would reduce contaminant toxicity, mobility, and volume. Alternative 3 would generate no residuals whereas Alternative 2 would generate a small quantity of spent activated carbon and spent wash liquids. These residuals would be disposed of following applicable local, state, and federal regulations. The treatment in Alternative 2 would meet the statutory preference for treatment.

Short-Term Effectiveness: Alternatives 2 and 3 would both involve excavation, which would increase the exposure risk to the workers, community, and environment. Further, Alternative 2 would involve on-site treatment adding additional exposure risks. Short-term risks for both alternatives should be effectively managed through use of proper health and safety practices and engineering controls during excavation. Alternatives 2 and 3 would each reach remedial objectives in about 6 months.

Implementability: Alternative 2 would be less implementable than Alternative 3 because of the complexity of the treatment. The excavation portion of these alternatives would involve common technology, and well-maintained equipment would be very reliable. Future actions would be easy to undertake. The LTTS step in Alternative 2 would be reliable; however, improper functioning of the equipment might leave some of the contaminated soil untreated or partially treated. The reliability of soil washing would be moderate. Pilot tests and optimization of operating conditions would be required for Alternative 2 before the alternative could be implemented. Monitoring requirements for Alternative 3 would be limited to determining the extent of the excavation, with a failure of the monitoring system potentially allowing some contaminated material to remain in place. The LTTS and soil washing technologies in Alternative 2 would be reliable, and the monitoring requirements would include off-gas monitoring, wash solution concentrations, and sampling of treated soil as well as determining the extent of the excavation. Failure in the monitoring system, however, could allow uncontrolled air emissions and backfilling with untreated or partially treated soil. Contractors, equipment, operators, and disposal facilities are readily available for both alternatives. The large soil volumes involved would necessitate intensified management and O&M. An adequate number of contractors with equipment and experience are available for implementing both alternatives. TSDFs and disposal facilities are available for the disposal of soil in Alternative 3. Both alternatives may require federal, state, and base permits for construction, air emissions, and transportation off site. The permits are readily obtainable.

Cost: Capital, O&M, present worth costs for the three soil alternatives are summarized as follows:

Costs	Alternative 1 No Action	Alternative 2 Removal, Ex situ Treatment, and Backfill	Alternative 3 Removal and Disposal
Capital	$0	$10,919,000	$7,700,000
O&M/Long-Term Monitoring	$0	$30,000 (year 1) $15,000 (year 2)	$30,000 (year 1) $15,000 (year 2)
5-Year Reviews	$22,000/5 year	$22,000/5 years	$22,000/5 years
PRESENT WORTH	$46,000	$10,975,000	$7,757,000

Alternative 3 would provide lower cost of present worth compared to Alternative 2. The higher costs are associated with the treatment steps involved in Alternative 2. Table 4-12 provides the capital, O&M, and total present worth project costs for each alternative.

5.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES FOR MARINE SEDIMENT

Development and screening of alternatives is conducted to assemble an appropriate range of remedial options to achieve the site RAOs for sediment. Remedial technologies retained for further consideration in Section 3.0 are combined to form remedial alternatives. Detailed evaluation of these alternatives is performed subsequently.

The alternatives are developed to comply with regulatory criteria applicable to the site conditions and the media of concern, as directed by the regulations and guidance presented in Section 2.0.

The remedial alternatives developed for the marine sediment in the shoreline and nearshore areas of the OFFTA site are summarized in Table 5-1. The alternatives are developed to apply to marine sediment located within the shoreline (intertidal zone) as well as nearshore marine sediment (sediment below the low-tide line). Affected sediment at these locations is addressed as a whole and is referred to as marine sediment. Figure 2-4 depicts the contaminated areas of marine sediment zones. COCs impacting the marine sediment include various PAHs and arsenic. Descriptions of each of these alternatives are provided in the following section.

5.1 RATIONALE FOR DEVELOPMENT OF ALTERNATIVES

In selecting remedial options, GRAs and process options chosen to be representative of the various technology types (see Section 3.0) are combined to form remedial alternatives to allow for future remedy selection. The alternatives are developed to address a range of risk reduction measures, future land use restrictions, and exposure scenarios. Alternatives are also developed that achieve compliance with ARARs and PRGs. Under limited circumstances, waivers may be required if ARARs cannot be satisfied.

The remedial alternatives developed to address marine sediment contamination consist of combinations of no action, institutional controls, long-term monitoring, removal, and disposal. The purpose of each remedial alternative is to prevent migration of and control contact with the contaminated media. A range of remedial alternatives from no action to complete removal and disposal of impacted media is considered for detailed evaluation.

The sediment contaminant concentrations are sufficiently low that the sediment would likely be acceptable for disposal in a solid waste (RCRA Subtitle D) landfill without treatment. However, to accommodate the possibility that highly contaminated sediment may be encountered during remedial action, TSDF disposal is considered.

Four remedial alternatives have been developed for addressing contamination in marine sediment at OFFTA.

Sediment Alternative 1:	No Action
Sediment Alternative 2:	Limited Action (Access Restrictions/Long-Term Monitoring)
Sediment Alternative 3:	Limited Dredging and Disposal
Sediment Alternative 4:	Dredging and Disposal

5.2 DESCRIPTION OF ALTERNATIVES

The alternatives were developed to address sediment in the areas identified as posing potential risks to humans (through wading and ingestion of contaminated shellfish) and ecological receptors. As discussed previously, the areas requiring remediation consist of all areas of Stations 3 through 6 and about 17,000 square feet of Station 7. The depth interval of contamination above PRGs is limited to the upper 2 vertical feet of sediment, based on core samples collected at stations 5, 5E, and 6. Therefore, contaminated sediment volume estimates were made using a depth of 2 feet. The nearshore elevated-risk areas exceeding recommended PRGs are shown on Figure 2-4. The HHRA and marine ERA evaluations identified the marine sediment in the nearshore as posing risks to both human health and the environment because of concentrations of PAHs and arsenic.

5.2.1 Sediment Alternative 1: No Action

The no action alternative, as required under the NCP, would involve no remedial response activities and would provide no additional protection of human health or the environment. However, it would provide a baseline for comparison to other alternatives. Since contamination would remain and unrestricted future use of the nearshore environment would be allowed, 5-year reviews of the no action decision would be required.

Under this alternative no remedial actions would be performed, no measures would be implemented to restrict access to the marine environment adjacent to OFFTA, and no actions would be taken to warn people of the hazards associated with wading in the area. However, measures currently in place would continue to provide limited protection of human health. Existing measures that provide some protectiveness include a no swimming policy for the NAVSTA Newport shorelines and fencing around the OFFTA that limits access to the shoreline.

5.2.2 Sediment Alternative 2: Limited Action

This limited action alternative would involve no direct remedial response activities for contaminated sediment along the shoreline and in the bay at OFFTA. It would provide no removal or treatment of impacted material. Therefore, it would provide no protection of the environment or ecological receptors. However, it would provide some additional protection of human health by employing access restrictions to augment the protection measures currently in place (fencing and access restrictions) and a long-term monitoring program to allow evaluation of changing conditions at the site. Because contamination would remain, 5-year reviews of the alternative would be required to evaluate the risks to human health and the environment posed by the site in the future.

Access restrictions (shoreline fencing, buoys, and signs) would discourage public access and recreational use of the shoreline and state-owned land in the intertidal zone, thereby increasing the effectiveness of the existing use restrictions and potentially reducing risks to human health. The existing shoreline fencing would be extended to restrict access to all of Stations 3 and 7. A perimeter buoy system would be placed at 100-foot intervals approximately 10 to 20 feet seaward of the mean low water line, in order to identify areas restricted for recreational use. Warning signs would be posted on the fencing and buoys to warn people of the potential hazards associated with the use of the area. Buoys could also include such features as internal radar reflecting material and reflective markings. Buoy anchoring would likely consist of a triangular placement of ballast to minimize drift and to provide a consistent demarcation of the impacted area. Additional signs would be strategically placed along the shoreline. The fencing, signs, and buoys would be inspected quarterly. Repair/replacement would be on an as-needed basis.

The long-term monitoring program would assess the quality of the marine environment over a 30-year period to evaluate changes in human health and ecological risk. The long-term monitoring program would include sediment chemistry and toxicity. Monitoring would involve measuring parameters that were previously found to contribute to human health or ecological risk. For costing purposes, it is assumed that samples would be collected from eight locations (four for human health risk and four for ecological risk) in the nearshore sediment at areas selected to correspond to sample stations tested in the previous investigations. The analyses would include sediment chemistry (PAHs and arsenic), porewater chemistry (arsenic), and sediment toxicity to amphipod and arabacia.

Given the nature of sediment contamination and the slow changes in sediment quality anticipated, a single sampling event per year was assumed to be sufficient to monitor long-term sediment quality trends. For the purposes of costing, it was assumed that annual monitoring would be conducted for the first 5 years and then, assuming that the sediment quality did not change significantly, the long-term sampling frequency would be reduced from annually to every 5 years. The final long-term monitoring plan, which would specify all the

details of the monitoring program, including analytical methods, sampling locations, and sampling frequency, would be developed in coordination with EPA and RIDEM.

The results of the monitoring would be compiled and an evaluation of the findings and associated risks would be conducted every 5 years, as required by CERCLA. The results of these 5-year reviews would be used to identify any changes in the contaminant concentrations and to determine the need to implement future response actions at the site or change the required frequency of long-term monitoring events.

5.2.3 Sediment Alternative 3: Limited Dredging and Disposal

This alternative was developed to reduce the on-site toxicity, mobility, and volume of contaminated marine sediment through removal and disposal while providing protection to eelgrass beds. Sediment within and adjacent to the eelgrass beds would remain intact while the rest of the impacted sediment exceeding PRGs would be removed using a combination of appropriate excavation and dredging techniques. Sediment associated with eelgrass beds is assumed to account for approximately 25% of the portions of Stations Areas 3, 4, and 5 beyond the low-tide line, with an estimated volume of about 800 cy. In order to monitor the risk from the remaining sediment, long-term monitoring would be implemented. These tasks would be similar to those outlined in Section 5.2.2.

Removal would involve more than 92 percent of contaminated sediment at the site with an estimated volume of about 8,870 cy. (The remaining 8 percent is the 800 cy associated with the eelgrass beds.) After excavation and dredging activities are complete, the areas would be backfilled with clean materials similar to the existing substrate. The sediment removal area is shown on Figure 5-1. Elements of Alternative 3 would include:

- Pre-design investigation
- Installation of engineering controls to minimize erosion and sediment migration during construction
- Removal and disposal of debris along the affected areas
- Installation of a bay haul road along the shoreline to facilitate excavation/dredging
- Excavation/dredging of about 8,870 cy of contaminated sediment from areas with no eelgrass beds
- Sediment dewatering
- Treatment of dewatering fluids and discharge to bay
- Disposal of sediment at TSDF
- Backfill with natural fill
- Access restrictions to the areas with eelgrass beds
- Protection of eelgrass beds in Stations 3,4, and 5
- Long-term O&M of access restrictions
- Long-term monitoring of eelgrass beds and shellfish
- Five-year reviews

A PDI would be performed to gather information needed to complete the final remedial design. The PDI would include a series of shallow-core samples to confirm the nature and extent of contamination and determine the treatment requirements for fluids to be generated during dredging and dewatering. Approximately 15 borings would be advanced to confirm the extent of sediment contamination and define the area for sediment removal. Borings would also be used to gather geotechnical information needed to select the dredging methods best suited for the materials present. The PDI would also include a detailed evaluation regarding any treatment requirement for the sediment prior to proper disposal.

Construction debris along the bank and shoreline would be removed and disposed of as solid waste during the implementation of the alternative. This construction debris consists of granite blocks, concrete slabs, bricks, and asphalt placed along the shoreline to retain the bank and reduce erosion. Any material found buried into the bank would be addressed with the onshore soil alternatives. After removal of the debris and implementation of the excavation portion of the alternative, a stone revetment would be placed along the bank.

Engineering controls would be installed around the perimeter of the area to be excavated/dredged to minimize sediment migration. A bay haul road seaward of the low-tide line would be installed for access to the areas past the low-tide line to facilitate excavation/dredging. The road would be constructed along the shoreline as shown on Figure 5-1. The location of the haul road would be finalized after the PDI and by optimizing it to provide necessary access to the nearshore excavation areas. A typical cross-section of the road is shown on Figure 5-2. Contaminated sediment and debris would be excavated from the path of the road, and Rhode Island Department of Transportation (RIDOT) specified R-6 stone would be installed over the dredged portion to construct the road. Construction of the bay haul road would be performed in sections by starting from the shore, excavating an area of contaminated sediment, backfilling, and then placing the stone for the road. The next section would be started from the end of the previous section. The haul road surface would typically be 1 foot above the mean high tide level and approximately 20 feet wide.

Impacted sediment would be excavated and segregated, if required; however, the need for segregation is not anticipated based on the type of contaminants detected in the nearshore marine sediment. Land-based excavation would be performed in most of the areas using conventional earth-moving equipment such as track-mounted excavators, front-end loaders, bulldozers, and dump trucks. A trackhoe with a long-reach arm should be able to access most of the areas from the bay haul road. The shoreline sediment that can be reached from the shore would be excavated after the completion of the bay haul road. The looped haul road would then act as a barrier to the area inside the loop, minimizing turbidity in Coasters Harbor during excavation of this portion of the sediment. Dewatering pumps could be used to allow this portion of the excavation to proceed in relatively dry conditions. (Water pumped from the work area would be treated as necessary to meet applicable discharge standards.) The remaining areas (if any) would be dredged using

barge-mounted mechanical dredging equipment such as clamshell dredges, orange-peel dredges, dipper-dredges, or excavators. It is not anticipated that barge-mounted dredging would be necessary.

All excavated/dredged sediment would be staged and processed at a centralized location. Dredged materials would be dewatered before being transported for final processing and staging. Water generated from sediment dewatering would be treated to meet applicable standards and then be discharged to the bay. An estimated 8,870 cy of contaminated sediment would be excavated as part of Alternative 3. Excavated/dredged sediment would be screened to remove debris and stones over approximately 6 inches in diameter. The screened material would be segregated as follows:

- For the purposes of this FS, it was assumed that approximately 20 percent of the dredged material (1,800 cy) would be over 6 inches in diameter and would be suitable for reuse after decontamination by methods permitted under relevant hazardous waste standards. These large rocks and boulders would be decontaminated to remove any contaminated sediment and then be staged for reuse as backfill.

- Screened material less than or equal to 6 inches in diameter (7,100 cy or 80 percent of the excavated material) would be staged separately for disposal. All trash and debris such as steel and concrete would be included with this portion of the excavated material, regardless of size. Any large debris to be sent off site for recycling or disposal would first be decontaminated to remove any contaminated sediment. Water generated from rock and debris decontamination would be treated to meet applicable standards and then be discharged to the bay.

Evaluation of the existing analytical data indicates that sediment contaminant levels are low enough that the material would not require any stabilization for disposal at a TSDF or would likely meet requirements for disposal in a RCRA Subtitle D landfill without treatment. However, if the sediment requires stabilization prior to transportation to the TSDF, lime stabilization would be carried out.

Following dredging operations, excavated areas would be backfilled with a mix of clean fill materials selected and placed to assist in the natural restoration of the aquatic community that would be destroyed by dredging. The proposed dredging and backfilling would remove and replace approximately 2.75 acres of existing rocky intertidal and subtidal aquatic habitat, temporarily destroying the aquatic community in the area. The proposed backfill would promote the natural restoration of the affected aquatic community by providing an optimal habitat structure to support a diverse and stable aquatic community. Natural recolonization of the area would occur as waterborne algae spores and animal larvae are swept into the area by tidal currents and wave action. The long-term O&M program would include regular inspection of

the backfilled areas to assess the condition of the habitat. It is anticipated that the ecological community would be reestablished within 1 to 4 years.

The backfill substrate would be placed to provide a stable and non-uniform habitat structure to promote community growth and diversity. The fill substrate would consist of graded sand, gravel, and stone sized similar to the current materials in the nearshore sediment that are not impacted. Implementation of this alternative would not impact eelgrass beds located in offshore station areas 3, 4, and 5. Efforts would be taken during dredging to minimize turbidity that could result in damage to the eelgrass beds. Slight damage to eelgrass beds would be mitigated by natural restoration, which would be monitored during long-term monitoring.

For the FS, it was assumed that long-term monitoring would include sediment and biota chemistry as well as amphipod and arabacia toxicity during the first 5 years after the remedial action is completed. Monitoring requirements would be similar to the previous alternative as described in Section 5.2.2.

5.2.4 Sediment Alternative 4: Dredging and Disposal

This alternative was developed to provide a remedial action that reduces or eliminates the on-site toxicity, mobility, and volume of contaminated marine sediment through removal and disposal. Sediment would be removed from the nearshore area using appropriate excavation and dredging techniques. Removal would be conducted over the nearshore marine sediment area shown in Figure 5-3. These areas include those presented in Section 5.2.3 and potential eelgrass beds in Station Areas 3, 4, and 5. Elements of Alternative 4 include:

- Pre-design investigation
- Installation of engineering controls to minimize erosion and sediment migration during construction
- Removal and disposal of debris along the affected areas
- Installation of a bay haul road along the shoreline to facilitate excavation and dredging
- Excavation/dredging of about 9,670 cy of contaminated sediment
- Sediment dewatering
- Treatment of dewatering fluids and discharge to bay
- Disposal of sediment at TSDF
- Backfill with natural fill
- Assisted restoration of aquatic community
- Natural restoration of eelgrass beds (0.25 acre)
- Long-term monitoring (years 1, 2, and 5 only)
- Five-year review

The approach for removal and disposal of contaminated sediment would be similar to the Limited Dredging alternative presented in Section 5.2.3. The primary differences are that the quantity of contaminated sediment removed as part of Alternative 4 would be slightly larger, and contaminated sediment present in the eelgrass

bed areas would also be excavated. After excavation and dredging activities are complete, the areas would be backfilled with clean materials similar to the existing substrate, and eelgrass beds would be restored.

Details of excavation/dredging would be similar to those presented in Section 5.2.3. A PDI would be performed to gather information needed to complete the final remedial design. Approximately 15 borings would be advanced to confirm the extent of sediment contamination and define the area for sediment removal. Borings would also be used to gather geotechnical information needed to select the excavation/dredging methods best suited for the materials present. The PDI would also include a detailed evaluation regarding any treatment requirement for the sediment prior to proper disposal.

Construction debris along the bank and shoreline would be removed and disposed of as solid waste during the implementation of the alternative. This construction debris consists of granite blocks, concrete slabs, bricks, and asphalt placed along the shoreline to retain the bank and reduce erosion. Any material found buried into the bank would be addressed with the onshore soil alternatives. After removal of the debris and implementation of the excavation portion of the alternative, a stone revetment would be placed along the bank.

Engineering controls would be installed around the perimeter of the area to be excavated/dredged to minimize sediment migration. A bay haul road along the shoreline would be installed for access to the areas past the low-tide line to facilitate excavation/dredging. In order to assure complete removal of contaminated sediment, excavation would be carried out to a depth of 2 feet.

Contaminated sediment would be excavated and segregated, if required; however, the need for segregation is not anticipated based on the type of contaminants detected in the nearshore marine sediment. Land-based excavation would be performed in most of the areas using conventional earth-moving equipment such as track-mounted excavators, front-end loaders, bulldozers, and dump trucks. A trackhoe with a long-reach arm should be able to access most of the areas from the bay haul road. The road construction would be similar to the Limited Dredging alternative presented in Section 5.2.3. The shoreline sediment that can be reached from the shore would be excavated after the completion of the bay haul road. The looped haul road would then act as a barrier to the area inside the loop, minimizing turbidity in Coasters Harbor during excavation of this portion of the sediment. Dewatering pumps could be used to allow this portion of the excavation to proceed in relatively dry conditions. (Water pumped from the work area would be treated as necessary to meet applicable discharge standards.) The remaining areas (if any) would be dredged using barge-mounted mechanical dredging equipment such as clamshell dredges, orange-peel dredges, dipper-dredges, or excavators. It is not anticipated that barge-mounted dredging would be necessary.

All excavated/dredged sediment would be staged and processed at a centralized location. Dredged materials would be dewatered before being transported for final processing and staging. Water generated from sediment dewatering would be treated to meet applicable standards and then be discharged to the bay.

An estimated 9,670 cy of contaminated sediment would be excavated as part of Alternative 4. Excavated/dredged sediment would be screened to remove debris and stones over approximately 6 inches in diameter. The screened material would be segregated as follows:

- For the purposes of this FS, it was assumed that approximately 20 percent of the dredged material (1,930 cy) would be over 6 inches in diameter and would be suitable for reuse after decontamination by methods permitted under relevant hazardous waste standards. These large rocks and boulders would be decontaminated to remove any contaminated sediment and staged for reuse as backfill.

- Screened material less than or equal to 6 inches in diameter (7,740 cy or 80 percent of the excavated material) would be staged separately for disposal. All trash and debris such as steel and concrete would be included with this portion of the excavated material, regardless of size. Any large debris to be sent off site for recycling or disposal would first be decontaminated to remove any contaminated sediment. Water generated from rock and debris decontamination would be treated to meet applicable standards and then discharged to the bay.

Evaluation of the existing analytical data indicates that sediment contaminant levels are low enough that the material would not require any stabilization prior to TSDF disposal or would likely meet requirements for disposal in a RCRA Subtitle D landfill without treatment. If stabilization is required, sediment would be stabilized with lime prior to disposal in a TSDF.

Following dredging operations, excavated areas would be backfilled with a mix of clean fill materials selected and placed to assist in the natural restoration of the aquatic community that would be destroyed by dredging. The proposed dredging and backfilling would remove and replace approximately 3 acres of existing rocky intertidal and subtidal aquatic habitat, temporarily destroying the aquatic community in the area. The proposed backfill would promote the natural restoration of the affected aquatic community by providing an optimal habitat structure to support a diverse and stable aquatic community. Natural recolonization of the area would occur as waterborne algae spores and animal larvae are swept into the area by tidal currents and wave action. The long-term O&M program would include regular inspection of the backfilled areas to assess the condition of the habitat. It is anticipated that the ecological community would be reestablished within 1 to 4 years.

The backfill substrate would be placed to provide a stable and non-uniform habitat structure to promote community growth and diversity. The fill substrate would consist of graded sand, gravel, and stone sized similar to the current materials in the nearshore sediment that are not impacted. Implementation of this alternative would also impact eelgrass beds assumed to be present in offshore station areas 3, 4, and 5. New eelgrass beds (0.25 acre) would have to be developed.

For the FS, it was assumed that long-term monitoring would include sediment and biota chemistry as well as amphipod and arabacia toxicity during the first 5 years after the remedial action is completed.

5.3 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

The detailed analysis of alternatives provides relevant information to support the future selection of a remedial action. Each alternative is more fully developed and further evaluated according to a prescribed set of criteria. The evaluation results are used to compare alternatives and identify key tradeoffs between the options, as well as to provide a basis for regulatory agency and public review of potential remediation alternatives for the site.

5.4 CRITERIA FOR DETAILED ANALYSIS

In accordance with the NCP and CERCLA guidance, the detailed analysis of alternatives was conducted in accordance with nine evaluation criteria. These criteria are divided into three groups: threshold criteria related to statutory requirements; balancing criteria that are technical in nature; and modifying criteria that are formally assessed following a public review and comment period. The criteria used to support the detailed analysis are presented in Section 4.0. The aspects of each criterion with respect to shoreline and nearshore marine sediment are presented as following:

Overall Protection of Human Health and the Environment: The primary concern, and one of the statutory requirements in remedy selection, is the overall protection of human health and the environment. The evaluation of protection is based on the ability of the remedy to eliminate, reduce, or control current and potential future exposure risks to human and ecological receptors through each applicable exposure pathway. This protection may be in the form of treatment, engineering controls, and/or institutional controls. The overall assessment of protection draws on assessments conducted under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. Furthermore, evaluation of protection considers short-term risks or cross-media impacts posed by implementation of a remedy.

This criterion will be used to evaluate the effectiveness of each alternative in eliminating, reducing, or controlling human health and environmental risks at the nearshore (includes shoreline) sediment. The

effectiveness issues related to alternatives for the marine sediment will be based on human health risks (wading in shoreline sediment) and environmental risks to marine biota.

Compliance with ARARs: Compliance with ARARs is one of the statutory requirements for selection of a remedy. This evaluation criterion is used to determine whether each alternative will meet all of its respective ARARs or whether justification exists for one of the six ARAR waivers allowed under CERCLA. Chemical-, location-, and action-specific ARARs are reviewed as they apply to each alternative. Alternatives are refined, as necessary, to ensure compliance with these requirements.

This criterion will be used to evaluate each alternative in complying with chemical- and location-specific federal and state ARARs and TBCs for protection of human health and the environment. Alternatives requiring sediment removal coupled with subsequent disposal or treatment activities will also be evaluated for compliance with action-specific ARARs related to sediment handling, sediment treatment and/or disposal, as well as treatment and discharge of water generated from sediment dewatering activities.

Long-Term Effectiveness and Permanence: Alternatives are assessed in terms of their long-term effectiveness and degree of permanence in offering protection of human health and the environment following implementation. The evaluation focuses on the extent and effectiveness of controls required to manage risks remaining on the site following completion of the remedial action. The analysis considers the magnitude of risks to human and ecological receptors from residuals (untreated waste or treatment by-products) remaining on site at the completion of remedial activities, the adequacy of engineering and/or institutional controls to manage residuals, the reliability of the controls to provide continued protection from residuals, and potential needs to maintain and/or replace technical components of an alternative.

This criterion will be used to evaluate each alternative for its ability to manage risks remaining on site following implementation. The no action, limited action, and limited dredging alternatives will be evaluated based on future risks associated with leaving contaminated sediment on site. Both dredging alternatives will be evaluated in relation to the management of residuals formed as a result of sediment excavation/dredging operations, dewatering activities, and disposal. Evaluation of alternatives will further address potential risks associated with residuals following sediment treatment.

Reduction of Toxicity, Mobility, or Volume through Treatment: Alternatives are evaluated to address the statutory preference for remedies that employ treatment as a principal element to reduce toxicity, mobility, or volume of hazardous substances. The evaluation focuses on the following factors:

- Treatment processes employed by the remedy, as well as the materials they will treat.

- Amount of hazardous materials to be destroyed or treated.
- Degree of expected reduction in toxicity, mobility, or volume, including how the principal threats will be addressed.
- Degree to which the treatment will be irreversible.
- Type and quantity of treatment residuals that remain following treatment.
- Whether the alternative satisfies the statutory preference for treatment as a principal element.

This criterion will be used to evaluate the effectiveness of alternatives for their ability to reduce mobility and/or their effectiveness in reducing risks through natural attenuation processes or removal with off-site disposal.

Short-Term Effectiveness: The short-term effectiveness criterion assesses potential effects to human health and the environment during the construction and implementation phase of a remedy until remedial response objectives are met. The analysis includes considering protection of both the community and on-site workers during remedial activities, environmental impacts that may result from construction or implementation activities, the reliability of measures to be taken to prevent or reduce potential impacts, and an estimation of time required to meet remedial response objectives.

This criterion will be used to evaluate each alternative for its ability to protect human health and the environment during implementation, as well as during any associated long-term monitoring activities. While the no action alternatives require no implementation activities, limited action alternatives will be evaluated for the protection they offer during implementation of institutional controls, access restrictions, and long-term monitoring. Evaluation of the remaining alternatives will address sediment removal and dewatering activities. The time required for each alternative to reach the sediment cleanup goals will also be assessed.

Implementability: Implementability considerations include the technical and administrative feasibility of implementing an alternative, as well as the availability of goods and services on which the viability of the alternative depends. These considerations often affect the timeliness of undertaking an alternative.

Technical feasibility issues include:

- Ability to construct and operate an alternative as a whole
- Likelihood of a technology to meet specified process efficiencies and performance goals

- Ease of undertaking any required future remedial actions
- Ability to monitor the effectiveness of the remedy

Administrative feasibility deals with the activities needed and time required to coordinate with various federal, state, and local agencies in obtaining any necessary approvals and permits for off-site activities.

Issues related to the availability of goods and services include:

- Accessibility of adequate capacity and location of needed treatment, storage, and disposal services.
- Ease in obtaining necessary equipment and specialists, and provisions to ensure any additional resources.
- Timing and availability of technologies under consideration.
- Availability of services and materials, plus the potential for obtaining competitive bids.

These issues will be reviewed to evaluate the implementability of each remedial alternative. Issues will also be evaluated for both the ease of implementation and associated time frame required to coordinate subcontractors, activities, and required regulatory approvals.

Cost: This criterion encompasses all capital outlays, as well as O&M costs incurred over the lifetime of the remedial action. The detailed analysis of costs associated with each alternative will be based on accurate cost estimates and a net present worth cost analysis for a 30-year performance period.

State Acceptance: State acceptance, an ongoing concern throughout the remedial process, reflects the statutory requirement to provide for substantial and meaningful state involvement. State acceptance must be considered during remedy selection.

This criterion will not be evaluated until RIDEM has reviewed and provided comments on the FS report. Therefore, this criterion will not be included in the detailed analysis.

Community Acceptance: Community acceptance refers to the issues and concerns of "all interested parties," as they relate to each of the alternatives under consideration. Community acceptance must be considered during remedy selection.

This criterion will not be evaluated until the Restoration Advisory Board (RAB) has reviewed and provided comments on the FS report and the public has been invited to ask questions and share their concerns during the public comment period. Therefore, this criterion will not be included in the detailed analysis.

5.5 INDIVIDUAL ANALYSES OF MARINE SEDIMENT ALTERNATIVES

Four remedial alternatives were developed for nearshore (including shoreline) sediment to address risks to human health (wading and direct contact) and the environment associated with contaminants in the sediment. Sections 5.2.1 through 5.2.4 contain brief descriptions of each alternative and describe the individual analyses of these alternatives. A summary of the analyses is presented in Table 5-2.

5.5.1 Sediment Alternative 1: No Action

Consideration of a no action alternative is required under the NCP. At a minimum, it provides a baseline for comparison with other alternatives. This alternative would involve no remedial response activities with respect to impacted nearshore sediment at the site. No containment, removal, or treatment of contaminated sediment would be conducted, and no erosion control actions would be implemented to prevent potential migration of contaminated sediment into Narragansett Bay and connecting waterways. The alternative would provide no mechanism to reduce potential risks to human health or the environment. Because contaminated sediment would remain on site and unlimited use of the nearshore area would be allowed, a 5-year review of site conditions and risks would be required under the NCP.

An analysis of this alternative with respect to the evaluation criteria is as follows:

Overall Protection of Human Health and the Environment: This alternative would not achieve the RAOs for protection of human health and the environment identified in Section 2.0. It would offer no additional protection of human health and the environment because it would not address potential risks through the elimination, reduction, or control of exposures to impacted sediment. Contaminated sediment would not be contained or removed, and no access restrictions would be installed to discourage future access to the area for recreational use. Potential risks to human health and the environment at levels estimated in the RI (TtNUS, 2001) would remain at the site. Therefore, 5-year reviews would be conducted, as required by CERCLA, to assess changing site conditions and potential risks. Results of the reviews would be used to determine the need to implement future remedial actions at the site.

Compliance with ARARs: Tables 5-3, 5-4, and 5-5 summarize chemical-, location-, and action-specific ARARs and TBCs, respectively, for Alternative 1. This alternative fails to meet chemical-specific ARARs because it does not address sediment exceeding PRGs that were derived from federal and state water quality standards. Several non-promulgated criteria (TBCs) were used in assessing human health risks and developing sediment PRGs. Since no action is to be taken under this alternative, there are no state or federal location-specific or action-specific ARARs or TBCs.

Long-Term Effectiveness and Permanence: Existing restrictions on access would continue to provide some long-term protection of human health for the foreseeable future, as long as the controls remain in effect and are implemented effectively. The no action alternative would offer no additional long-term effectiveness or permanence in addressing sediment contamination at the site. The existing risks to human health and the environment would remain, and no controls would be provided to manage future exposures to sediment contaminants. Potential contaminant migration pathways would not be addressed, and contaminated sediment could migrate to adjacent marine environments. Because of the risk associated with leaving contaminated sediment on site, 5-year reviews would be required.

Reduction of Toxicity, Mobility, or Volume through Treatment: This alternative would not include any sediment treatment processes and would not involve removal of contaminated sediment. Therefore, the alternative would offer no reduction in toxicity, mobility, or volume of contamination through treatment.

Short-Term Effectiveness: Since no remedial activities are associated with implementation of this alternative, no short-term effects would occur. No increase or reduction in short-term risks would be offered to the local community, base personnel, or the environment. RAOs for protection of human health and the environment would not be achieved by this alternative.

Implementability: This alternative would require no implementation other than completion of the 5-year reviews. This activity would not require any permits, but it may require a minimal amount of coordination between regulatory agencies. Implementation of the no action alternative would not limit future implementation of additional remedial actions at the site, if deemed necessary.

Cost: A detailed estimate of capital, O&M, and present-worth costs for Alternative 1 is provided in Appendix D and is summarized below. Present-worth costs were developed for a 30-year period at a 7 percent discount rate.

Cost Description	Estimated Cost
Capital Costs	$0
O&M/Long-Term Monitoring	$0
5-Year Reviews	$22,000/5 years
Present Worth	$46,000

5.5.2 Sediment Alternative 2: Limited Action

Alternative 2 is a limited action option that would provide no direct remedial response activities. No containment, removal, and/or treatment of contaminated marine sediment would be conducted, and no erosion

control actions would prevent potential migration of contaminated sediment into Narragansett Bay and connecting waterways. This alternative would, however, limit potential risks to human health through the placement of shoreline fencing, signs, and a perimeter buoy system. A long-term monitoring program and 5-year reviews would be conducted to evaluate risks to human health and the environment posed by the site. For the purposes of costing, it was assumed that annual monitoring would be conducted for the first 5 years, and then the sampling frequency would be reduced from annually to every 5 years. The actual monitoring frequency would be determined by the Navy and regulatory agencies based on the monitoring results and 5-year reviews.

An analysis of this alternative with respect to the evaluation criteria is as follows:

Overall Protection of Human Health and the Environment. This alternative would provide a limited degree of protection of human health by discouraging access to, and use of, the impacted nearshore areas. Through the placement of fencing, signs, and a perimeter buoy system, this alternative would increase public awareness of the hazards associated with the contaminated sediment in the area, thereby discouraging shoreline use. The effectiveness of the access restrictions would depend on individual compliance with the restrictions and Navy and state enforcement of these restrictions on Navy and state-owned property, respectively.

This alternative would provide no protection against potential disruption and/or migration of contaminated sediment due to wave or storm action, and it would not reduce risks to ecological receptors. Potential risks to marine biota would remain.

Implementation of the long-term monitoring program would not provide protection of either human health or the environment, although, through annual monitoring, it would document changes in sediment quality that may affect future exposure risks. Because contaminants would remain at the site, 5-year reviews would be conducted to assess changing site conditions and potential risks. Results of the reviews would be used to determine the need to implement future remedial actions at the site or change the required frequency of long-term monitoring events.

This alternative would partially meet RAOs for protection human health by limiting human exposure to the contaminated nearshore sediment. This alternative would not meet the RAOs for the protection of the environment.

Compliance with ARARs: Tables 5-6, 5-7, and 5-8 summarize chemical-, location-, and action-specific ARARs and TBCs, respectively, for Alternative 2. This alternative fails to meet chemical-specific ARARs because it does not adequately address sediment exceeding PRGs that were derived from federal and state water

quality standards. Several non-promulgated criteria (TBCs) were used in assessing human health risks and developing sediment PRGs.

Federal and state location-specific ARARs for this alternative include wetland and floodplain regulations, as well as coastal resource management, endangered species, fish and wildlife protection, and historic preservation regulations. Alternative 2 does not satisfy federal ARARs for the protection of wetlands and floodplains because the action to be taken does not address the risk to the wetland and floodplain environment posed by the contamination. Additionally, state hazardous waste standards for facilities within a floodplain are not satisfied. Any actions taken under this alternative (installation of fencing and buoys, and monitoring) that would affect the resources protected by these regulations would be conducted in accordance with the substantive requirements of the regulations.

Long-Term Effectiveness and Permanence: This alternative would rely on physical barriers, warning signs, and use restrictions to limit access to the impacted sediment and thereby reduce human risk associated with direct contact. Although the shoreline fencing and a perimeter buoy system would help to minimize access, they may not be totally effective in prohibiting access to the area of concern. Regular maintenance and periodic replacement of the fencing and buoys by the Navy would be necessary to ensure their long-term effectiveness in deterring access and warning the public of the potential hazards. Restrictions on recreational use of the shoreline would require long-term enforcement by the state and the Navy to ensure their protectiveness.

The limited action alternative would provide no long-term protection of ecological receptors or the environment. Ecological receptors would continue to be exposed to contaminants in sediment and porewater, potential contaminant migration pathways would not be addressed, and contaminated sediment could migrate to adjacent marine environments. Since contaminated sediment would remain on site above levels allowing for unlimited use and unrestricted exposure, annual monitoring and 5-year reviews of this alternative would be required to evaluate the effectiveness of the alternative.

Reduction in Toxicity, Mobility, or Volume through Treatment: This alternative would not include any sediment treatment processes. Therefore, the limited action alternative would offer no reduction in contaminant toxicity, mobility, or volume through treatment.

Short-Term Effectiveness: A slight increase in short-term risks could potentially result from the implementation of this alternative. Installation of the shoreline fencing and signs could result in minimal suspension and migration of contaminated sediment around the boundaries of the designated nearshore area. However, common engineering controls (the use of silt fences, silt curtains, and/or other features) would serve to minimize any potential short-term impacts to the marine environment. Potential exposures of on-site workers to contaminated sediment during installation activities would be limited through the use of PPE. There would

also be potential short-term impacts to workers associated with annual monitoring activities. These would be addressed through proper use of PPE and by using proper handling, storage, and disposal procedures for potentially contaminated sediment samples.

On-site installation activities are estimated to require less than 1 month. Each annual monitoring activity would require less than 1 week. RAOs associated with preventing risks to human health would be partially addressed when installation of fencing, signs, and buoys is complete, but RAOs for protection of the environment would not be achieved.

Implementability: Implementation of this alternative would involve installing shoreline fencing, signs, and a perimeter buoy system and completing a long-term monitoring program and 5-year reviews.

The purchase and deployment of buoys and installation of shoreline fencing and signs would be easily implemented given the availability of qualified contractors, marine supplies, and boats within the Newport area. Consistent enforcement of the shoreline access restrictions as well as long-term maintenance of the fencing and buoy system by the Navy would be required. Because the buoys and a portion of the fence would be installed on state-owned land below the high tide line, coordination with the State of Rhode Island would be required for placing fencing and buoys and enforcing access restrictions prohibiting recreational use of the shoreline.

The establishment of a long-term monitoring program to assess sediment quality would be easily implemented, given the availability of consulting/environmental firms and laboratories qualified to conduct such activities. These activities may require some coordination with regulatory agencies.

Implementation of the limited action alternative would not impede execution of future remedial actions at the site, if deemed necessary.

Cost: A detailed estimate of capital, O&M, and present-worth costs for Alternative 2 is provided in Appendix D and is summarized below. Present-worth costs were developed for a 30-year period at a 7 percent discount rate.

Cost Description	Estimated Cost
Capital Costs	$10,000
O&M/Long-Term Monitoring	$50,000/year (years 1-5 and 5-year intervals) $9,000/year (other years)
5-Year Reviews	$22,000/5 years
Present Worth	$394,000

5.5.3 Sediment Alternative 3: Limited Dredging and Disposal

Alternative 3 involves dredging/excavating contaminated marine sediment at all locations except those areas with eelgrass beds. Sediment associated with eelgrass beds would be monitored on a long-term basis until natural attenuation mechanisms reduce COC concentrations to meet PRG levels. The monitoring aspects would be similar to those presented for Alternative 2. Excavated sediment would be disposed of at a TSDF. This alternative would limit potential risks to human health and the environment through implementation of monitoring and limited removal and disposal of contaminated sediment.

Contaminated sediment and debris removed as part of this remedial action would be screened and segregated in a dedicated staging area. All trash and debris such as steel and concrete would be sent for recycling or disposal. Any large debris to be sent off site for recycling or disposal would first be decontaminated in accordance with relevant hazardous waste standards. Long-term monitoring would be conducted for the sediment in the eelgrass beds.

An analysis of this alternative with respect to the evaluation criteria is as follows:

Overall Protection of Human Health and the Environment: Alternative 3 would achieve RAOs for protection of human health and the environment to some extent by removing and properly disposing of a fraction of the contaminated sediment and monitoring the remaining contaminated sediment. This alternative also protects the eelgrass beds. The removal of approximately 8,870 cy, or nearly 92 percent of the contaminated sediment exceeding PRGs, would decrease the volume and the lateral extent of contaminants remaining in the area, thereby providing additional protection to human health and the environment.

Implementation of this alternative would result in some increased short-term risks, including the destruction of existing biota within the impacted area and suspension of contaminated sediment. However, these impacts would be at least partially mitigated through proper implementation of turbidity control measures and selection of appropriate backfill materials. Dredging would temporarily destroy the aquatic community in the filled area below the high tide line. The proposed fill design would assist natural restoration of these communities by providing a habitat structure that would promote colonization of the species indigenous to the area. Natural recolonization of the area would occur as waterborne algae spores and animal larvae are swept into the area by tidal currents and wave action. It is anticipated that the aquatic community destroyed by the remedial action would be reestablished within 1 to 4 years. In addition, habitats adjacent to the site may be affected by turbidity. These habitats would have to be monitored to determine the need for mitigation measures.

Damage to the eelgrass beds is expected to be slight (principally due to increased turbidity caused by resuspension of sediment during dredging in and around the beds) Because the sediment in the nearshore

area is relatively coarse and operations in the area adjacent to the eelgrass beds would be conducted over a relatively short duration, standard turbidity control measures such as silt curtains are expected to effectively control turbidity and minimize damage to the eelgrass beds. Additional investigation would be needed during the PDI to define the limits of the eelgrass beds and determine effective ways of eliminating excavation/dredging in the close proximity.

There would also be increased short-term risks to on-site workers from potential exposures to contaminated sediment during excavation, dredging, and handling activities. There may also be some risks associated with disposal of the dredged materials. These risks would be minimized through the use of PPE and proper safety procedures.

Implementation of the long-term monitoring program would allow assessment of changes in sediment quality. Five-year reviews would be conducted to assess site conditions and potential risks. Results would be used to determine whether additional remedial actions are needed at the site

Compliance with ARARs: Tables 5-9, 5-10, and 5-11 summarize chemical-, location-, and action-specific ARARs and TBCs, respectively, for Alternative 3. This alternative would not comply with federal and state chemical-specific ARARs (water quality standards) used to derive sediment PRGs at all locations because about 8 percent of the total contaminated sediment would be still in place. ARARs require that the alternative chosen be the least damaging practicable alternative. To satisfy the Clean Water Act (CWA) Section 404 requirements, damaged aquatic habitats would have to be restored.

Implementation of Alternative 3 would meet all other state and federal location-specific ARARs by conducting the activities in accordance with applicable and relevant and appropriate floodplain, wetland, coastal resource management, endangered species, fish and wildlife protection, and historic preservation regulations and by coordinating with appropriate agencies to find ways to minimize adverse effects to fish, wildlife, endangered species, and historic sites.

Alternative 3 would be conducted in accordance with all identified state and federal action-specific ARARs. The action-specific ARARs identified for this alternative include RCRA requirements for identifying, listing, and disposing of hazardous wastes; CWA requirements for discharges to surface water; and CAA requirements for emissions monitoring of dewatering processes.

Long-Term Effectiveness and Permanence: Alternative 3 would partially eliminate the risks to potential human health and aquatic receptors posed by exposure to contaminated marine sediment and porewater. Risk would still exist from contaminated sediment left around the eelgrass areas.

The long-term monitoring program (which would include annual sediment and biota monitoring) would be conducted to ensure that natural attenuation is decreasing the contaminated sediment concentrations. Since contaminated sediment would remain on site above levels allowing for unlimited use and unrestricted exposure, monitoring and 5-year reviews would be required to evaluate the protectiveness of the remedy.

Reduction in Toxicity, Mobility, or Volume through Treatment: Alternative 3 would not include treatment; therefore, it would provide no reduction in the toxicity, mobility, or volume of contaminants through treatment. However, this alternative would reduce the mobility through limited removal activities.

Short-Term Effectiveness. Implementation of Alternative 3 would result in increases in short-term risks to human and ecological receptors due to disruption and handling of contaminated sediment during site preparation and sediment removal. Potential exposures of on-site workers to contaminated sediment during excavation, dredging, and handling activities would be minimized through the use of PPE and proper safety procedures.

Resuspension of contaminated sediment would occur during the dredging operations. Migration and resettling of suspended sediment may harm marine biota and enlarge the area impacted by site contaminants. Engineering controls, such as silt curtains, would minimize potential environmental impacts associated with contaminant migration; however, adverse effects may not be completely eliminated. Additional data regarding sediment grain size and dredging techniques are needed to predict the degree of effectiveness of sedimentation controls.

Dredging would remove the resident plants and shellfish and temporarily disrupt the aquatic habitat in the dredged areas below the high tide line. Because approximately 92 percent of the resident plants and shellfish would be removed, the area would not function as a feeding area for some aquatic organisms, birds, and mammals, and it would not serve product export functions such as provision of nutrients for other systems. The lost functions and values of the habitat would not be completely replaced until the aquatic community was fully reestablished. Placement of fill materials similar to the existing sand/gravel/rock substrate of the area would provide a foundation for reestablishment of the aquatic community, serving as a habitat for plants and animals to root and breed. Natural recolonization of the area would occur as waterborne algae spores and animal larvae were continually swept into the area by tidal currents and wave action.

The rehabitation of the area may take several years to complete. However, observations in a nearby site, McAllister Point Landfill, indicate that natural rehabitation of the aquatic community in the area occurs at a fairly rapid pace (in about 2 years) (TtNUS, 1999). Based on these observations and recovery reported for similar habitats it is anticipated that the aquatic community destroyed by the remedial action would be reestablished within 1 to 4 years. In addition, habitats adjacent to the site may be temporarily affected by

turbidity produced during dredging/excavation activities. These habitats would have to be monitored to determine the need for mitigation measures.

Damage to the eelgrass beds is expected to be slight because excavation would be carried out away from the beds. Standard turbidity control measures such as silt curtains are expected to effectively control turbidity and minimize damage to the eelgrass beds. Additional investigation would be needed during the PDI to define the limits of the eelgrass beds and determine whether they would be impacted by excavation in the close proximity.

Implementability: Implementation of Alternative 3 would require significant efforts, both administratively and technically. The complexity of implementation is a function of the location of the area to be dredged. Most of the areas would be able to be accessed by a long arm trackhoe.

Implementation of this alternative would require qualified contractors with personnel trained in hazardous waste site operations, who are qualified to handle contaminated sediment dredging, grading, and erosion control operations in an aqueous environment and who are capable of completing construction in a timely and effective manner. Wave action, the influence of local currents and tides, and weather conditions could result in scheduling delays related to site accessibility.

Implementation of this alternative would require coordination with regulatory agencies regarding marine dredging and filling operations; water treatment and discharge from sediment dewatering activities into the bay; materials handling/off-base disposal issues; and potential effects on fisheries, endangered species, and the aquatic habitat Agreements with regulatory agencies would have to be reached regarding mitigation for altering aquatic habitats and establishing the periods for dredging/excavation and filling activities in the bay. Obtaining agreements with regulatory agencies is not expected to pose a problem. The State of Rhode Island generally requires dredging projects to be conducted between November 1 and January 15 to protect sensitive species. The Navy will investigate the use of aquatic habitats on site by sensitive species to determine potential impacts from dredging during different times of the year.

If it is determined that material would be suitable for disposal in RCRA Subtitle D solid waste facilities, multiple facilities, including local landfills such as Central Landfill in Johnston, Rhode Island, would likely be able to accept the material. Otherwise, disposal would take place at a permitted TSDF.

Performing long-term monitoring to assess sediment quality would be easily implementable, given the availability of consulting/environmental firms and laboratories qualified to conduct such activities. These activities may require coordination with regulatory agencies.

Implementation of the removal and disposal alternative would not limit future implementation of additional remedial actions at the site.

Cost: A detailed estimate of capital, O&M, and present-worth costs for Alternative 3 is provided in Appendix D and is summarized below. Present-worth costs were developed for a 30-year period at a 7 percent discount rate. The results of the detailed cost estimate are presented below.

Cost Description	Estimated Cost
Capital Costs	$3,554,000
O&M/Long-Term Monitoring	$61,000/year (years 1-5 and 5-year intervals) $0/year (other years)
5-Year Reviews	$22,000/5 years
Present Worth	$3,937,000

5.5.4 Sediment Alternative 4: Dredging and Disposal

Alternative 4 includes removal of all contaminated sediment exceeding PRGs including in areas with eelgrass beds, dewatering the removed materials, treating and discharging dewatering fluids to the bay, disposing of the solids in the appropriately permitted off-base TSDF, and refilling the dredged area back to the original grade. These actions would eliminate potential risks to human health and the environment by removing contaminated sediment from the nearshore area and disposing of it in appropriately secured facilities.

Evaluation of the existing analytical data indicates that most of the sediment has contaminant levels low enough that it likely does not require disposal as a hazardous waste. Removed material would be tested to determine whether it should be disposed of in a TSDF or a RCRA Subtitle D solid waste facility.

Long-term operation and maintenance would not be required because virtually all contaminants exceeding the PRGs would be removed from the shoreline and nearshore areas. An inspection of the area to verify aquatic habitat recovery would be included in the long-term monitoring program.

An analysis of this alternative with respect to the evaluation criteria is as follows:

Overall Protection of Human Health and the Environment: Alternative 4 would achieve RAOs for protection of human health and the environment by removing and appropriately disposing of contaminated sediment, thereby preventing potential exposure to and migration of impacted sediment. Removal activities would eliminate potential risks to human health and prevent risks to aquatic receptors posed by exposure to contaminated marine sediment.

Because all sediment with contaminant concentrations exceeding the recommended PRGs would be removed from the shoreline and nearshore areas, long-term protection and permanence of the alternative would ultimately depend on the treatment at the TSDF.

Implementation of this alternative would result in some increased short-term risks, including the temporary destruction of the existing aquatic community within the removal area and suspension of contaminated sediment, which could impact the aquatic community in the surrounding area. These impacts may be partially mitigated through proper implementation of turbidity control measures and selection of appropriate backfill materials. Sediment removal and backfilling would temporarily destroy the aquatic community in the area below the high tide line. The proposed backfill material would assist natural restoration of these communities by providing habitat structure that would promote colonization by the species indigenous to the area. Natural recolonization of the area would occur as waterborne algae spores and animal larvae are swept into the area by tidal currents and wave action. Based on the studies at similar sites, it is anticipated that the aquatic community destroyed by the remedial action would be reestablished within 1 to 4 years. In addition, habitats adjacent to the site may be temporarily affected by turbidity produced during dredging/excavation activities. These habitats would have to be monitored to determine the need for mitigation measures.

Removal activities would impact eelgrass beds located in Station Areas 3, 4, and 5. Additional investigation would be needed during the PDI to define the limits of the eelgrass beds, and if it is concluded that the eelgrass beds would suffer significant damage, it may be necessary to consider assisted restoration.

There would also be increased short-term risks to on-site workers from potential exposures to contaminated sediment during excavation, dredging, and handling activities. These risks would be minimized through the use of PPE and proper safety procedures.

Implementation of the long-term monitoring program would allow assessment of the restoration of the aquatic habitat and any changes in sediment quality, and a 5-year review would allow assessment of site conditions and potential risks. The results of monitoring and 5-year reviews would be used to determine whether additional remedial actions are needed at the site and whether long-term monitoring and 5-year reviews may be discontinued.

Compliance with ARARs: Tables 5-12, 5-13, and 5-14 summarize chemical-, location-, and action-specific ARARs and TBCs, respectively, for Alternative 4. This alternative would comply with federal and state chemical-specific ARARs (water quality standards) used to derive sediment PRGs because sediment exceeding the PRGs derived from these standards would be removed by dredging/excavation.

Implementation of Alternative 4 would meet all state and federal location-specific ARARs by conducting the activities in accordance with floodplain and wetland regulations, as well as coastal resource management, endangered species, fish and wildlife protection, and historic preservation regulations and by coordinating with appropriate agencies to find ways to identify and minimize adverse effects to fish, wildlife, endangered species, and historic sites.

Alternative 4 would be conducted in accordance with all identified state and federal action-specific ARARs. The action-specific ARARs identified for this alternative include RCRA requirements for identifying, listing, and disposing of hazardous wastes; CWA requirements for discharging to surface water; and CAA requirements for monitoring emissions of dewatering processes.

Long-Term Effectiveness and Permanence: Alternative 4 would eliminate the potential human health risks and risks to aquatic receptors posed by exposure to contaminated marine sediment and porewater. The risk reduction offered by this alternative would be accomplished through removing the contaminated sediment from the shoreline and nearshore areas, thereby permanently eliminating the risks posed by these materials. Disposal, or treatment and disposal, of contaminated sediment would eliminate the need for long-term management of untreated sediment within the nearshore area. The long-term effectiveness of this alternative would depend on the long-term management and integrity of the disposal facilities.

Reduction in Toxicity, Mobility, or Volume Through Treatment: Alternative 4 would not use treatment to reduce the toxicity, mobility, or volume at the site so very little overall reduction in contaminant toxicity, mobility, or volume would be offered. However, this alternative would reduce the mobility of impacted sediment through removal A reduction in overall contaminant mobility in the environment would also be expected through placing the contaminated sediment and debris in the approved TSDF.

Short-Term Effectiveness: Implementation of Alternative 4 would result in increased short-term risks to human and ecological receptors due to the disruption of the contaminated sediment during remedial activities. Potential exposures of on-site workers to impacted sediment during excavating, dredging, and handling activities would be minimized through the use of PPE and proper workplace safety practices. Ecological risks are not as easily mitigated.

Resuspension of contaminated sediment would occur during the excavation/dredging operations. Migration and resettling of suspended sediment may harm marine biota and enlarge the area impacted by site contaminants. Engineering controls, such as silt curtains, would minimize potential environmental impacts associated with contaminant migration; however, adverse effects may not be completely eliminated. Additional data regarding sediment grain size and dredging techniques are needed to predict the degree of effectiveness of sedimentation controls.

Dredging would remove the resident plants and shellfish and temporarily disrupt the aquatic habitat in the dredged and filled areas below the high tide line. Some of the habitat functions and values would be temporarily lost as a result of the remedial actions. The remediation area would temporarily cease to function as a feeding area for some aquatic organisms, birds, or mammals, and it would not serve product export functions such as provision of nutrients for other systems. The lost functions and values of the habitat would not be completely replaced until the aquatic community was fully reestablished. Placement of fill materials similar to the existing sand/gravel/rock substrate of the area would provide a foundation for reestablishment of the aquatic community, serving as a habitat for plants and animals to root and breed. Natural recolonization of the area would occur as waterborne algae spores and animal larvae were continually swept into the area by tidal currents and wave action.

The rehabitation of the area may take several years to complete. However, observations from similar sites indicate that natural rehabitation of the aquatic community occurs at a fairly rapid pace (TtNUS, 1999). Based on these observations and recovery reported for similar habitats, it is anticipated that the aquatic community would be reestablished within 1 to 4 years.

Sediment removal activities would also temporarily impact eelgrass beds and the aquatic community located outside the remediation area. It may be necessary to consider assisted restoration. Monitoring of adjacent areas would be conducted to determine the need for any mitigation measures.

Implementability: Implementation of Alternative 4 would require significant efforts, both administratively and technically. The complexity of implementation is a function of the location of the area to be dredged and backfilled and the depth and nature of the materials to be removed Most of dredging/excavation would be implemented by land-based equipment using trackhoe with long reach arm. Access for conventional equipment would be through a temporary bay haul road constructed in the intertidal zone.

Implementation of this alternative would require qualified contractors with personnel trained in hazardous waste site operations, who are qualified to handle contaminated sediment dredging, grading, and erosion control operations in an aqueous environment and who are capable of completing construction in a timely and effective manner. Wave action, the influence of local currents and tides, and weather conditions could result in scheduling delays related to site accessibility.

Implementation of the sediment dewatering and water treatment operations may also increase the complexity of implementing this alternative. The nature and grain size distribution of the sediment could greatly impact the success of the proposed gravity separation process.

Implementation of this alternative would require coordinating with regulatory agencies regarding marine dredging and filling operations; water treatment and discharge from sediment dewatering activities into the bay; materials handling/off-base disposal issues; and potential effects on fisheries, endangered species, and the aquatic habitat. Agreements with regulatory agencies would have to be reached regarding mitigation for altering aquatic habitats and establishing the periods for dredging and filling activities in the bay. Obtaining agreements with regulatory agencies is not expected to pose a problem. The State of Rhode Island generally requires dredging projects to be conducted between November 1 and January 15 to protect sensitive species. The Navy will investigate the use of aquatic habitats on site by sensitive species to determine potential impacts from dredging during different times of the year.

If it is determined that the excavated material would be suitable for disposal in RCRA Subtitle D solid waste facilities, multiple facilities, including local landfills such as Central Landfill in Johnston, Rhode Island, would likely be able to accept the material. Otherwise, disposal would take place at a permitted TSDF.

Performing long-term monitoring to assess sediment quality would be easily implementable, given the availability of consulting/environmental firms and laboratories qualified to conduct such activities. These activities may require coordination with regulatory agencies.

Implementation of the removal and disposal alternative would not limit future implementation of additional remedial actions at the site.

Cost: A detailed estimate of capital, O&M, and present-worth costs for Alternative 4 is provided in Appendix D and is summarized below. Present-worth costs were developed for a 30-year period at a 7 percent discount rate.

Cost Description	Estimated Cost
Capital Costs	$4,134,000
O&M/Long-Term Monitoring	$61,000/year (years 1, 2, and 5) $0/year (other years)
5-Year Reviews	$22,000/5 years
Present Worth	$4,302,000

5.6 Comparative Analysis of Sediment Alternatives

A comparative analysis is conducted to evaluate the significant differences between alternatives based on the threshold and balancing criteria. This analysis is provided below and summarized in Table 5-15.

Overall Protection of Human Health and the Environment: Because no actions would be taken under Alternative 1, this alternative would provide no additional protection of human health or the environment. Existing risks would remain to human health and to marine biota from contact with sediment contaminants. In addition, no mechanism would be in place to prevent erosion and subsequent migration of the contaminants into Narragansett Bay and connecting waterways.

Alternative 2 would provide limited protection of human health through implementation of access restrictions to discourage use of the site for recreation, while providing no protection to the marine receptors. In addition, no erosion control measures would be provided to prevent contaminant migration.

Alternative 3 would provide higher overall protection compared to Alternatives 1 and 2 mainly due to dredging/excavating 8,870 cy of contaminated sediment and disposing in a secured landfill. This would result in a smaller area and volume of contaminated sediment remaining in the area. Limited excavation in Alternative 3 would protect eelgrass beds. Alternative 4 would provide greater overall protection to human health and the environment; however, the eelgrass beds would be impacted. The implementation of Alternatives 3 and 4 would temporarily destroy the aquatic community within the impacted area below the high tide line and potentially result in short-term impacts to the environment due to increases in suspension of contaminated sediment in the water column during site preparation.

Alternative 4 would provide greater overall protection of human health and the environment than that provided by Alternative 3 because all contaminants exceeding PRGs would be permanently removed from the bay. Risks to human health and the environment associated with contaminated sediment would be permanently reduced to acceptable levels through sediment removal. The major difference between the overall protection provided by the two action alternatives is that Alternative 4 would permanently remove all the contaminated sediment from the environment, ensuring that the remedial action would be effective over time and eliminating the need for long-term O&M. The short-term impacts to the aquatic environment would be somewhat greater for Alternative 4 than Alternative 3 because of the additional dredging required. Habitat restoration would likely occur in the same time frame for these two alternatives. Overall protection from future exposures to the removed material would depend on the maintenance of the selected disposal facility and the effectiveness of the treatment process, if required.

RAOs would not be achieved under Alternative 1. RAOs associated with preventing risks to human health would be partially addressed by installing fencing, signs, and buoys under Alternative 2, but RAOs for protection of the environment would not be achieved. Alternative 3 would achieve success for protecting human health and partial success in protecting the environment. Alternative 4 would achieve RAOs for the protection of human health and the environment.

Compliance with ARARs: Alternatives 1 and 2 would fail to meet chemical-specific ARARs (water quality standards) used to derive sediment PRGs because they do not adequately address sediment exceeding PRGs.

Alternative 3 would comply with federal and state chemical-specific ARARs used to derive sediment PRGs only if natural attenuation decreases the concentrations of the COCs in the sediment in the areas of eelgrass beds.

Alternative 4 would comply with federal and state chemical-specific ARARs used to derive sediment PRGs because all sediment exceeding the PRGs derived from these standards would be removed by dredging/excavation. For all four alternatives, several non-promulgated criteria (TBCs) were used in assessing human health risks and developing sediment PRGs.

There are no location-specific or action-specific ARARs for Alternative 1. Alternative 2 does not satisfy federal location-specific ARARs for the protection of wetlands and floodplains.

Alternatives 3 and 4 would meet all state and federal location-specific ARARs and all state and federal action-specific ARARs by conducting the activities in accordance with the identified requirements. To satisfy the CWA Section 404 requirements, damaged aquatic habitats would have to be restored; no permanent losses would be anticipated. Alternative 3 would protect eelgrass beds; however, it requires long-term monitoring of contaminated sediment associated with the beds. Alternative 4 would excavate all areas of contamination including those associated with eelgrass beds and restore the eelgrass beds after remediation is complete.

Long-Term Effectiveness and Permanence: Alternative 1 would provide no additional long-term effectiveness and permanence in addressing sediment contamination at the site. Risks to environmental receptors would not be reduced. This no action alternative, along with the limited action (Alternative 2) and limited dredging (Alternative 3) alternatives, would require 5-year reviews since the contaminated sediment would remain on site.

Alternative 2 would provide limited effectiveness in minimizing human health risks by discouraging/deterring site access due to the placement of physical barriers and use restrictions. However, it would not be effective in preventing human health risks without proper enforcement of the existing use and access restrictions. Properly enforced, Alternative 2 would be effective in limiting human health exposure pathways, but it would not be effective in limiting any potentially adverse environmental impacts or potential migration of contamination.

Alternative 3 would provide a higher level of long-term effectiveness than would Alternative 2. By removing most of the contaminated sediment, future risks to human health and the ecological receptors would be

minimized. Since limited removal of contaminated sediment in this alternative would decrease the area and volume of contaminated sediment remaining, long-term risks would be lower than for Alternative 2, which removes no contaminated sediment.

Alternative 4 would be the most effective alternative in eliminating long-term risks to human health and the environment by removing the contaminated media from the marine environment. Provided that all sediment with contaminant concentrations above the PRGs is removed from the area, this alternative would not require long-term monitoring and 5-year reviews.

Reduction in Toxicity, Mobility, or Volume through Treatment: Alternatives 1 and 2 would not provide any reduction of toxicity, mobility, or volume through treatment. Alternatives 3 and 4 would reduce the toxicity and mobility through any treatment at the TSDF. If the excavated sediment requires stabilization, the overall volume of contaminated sediment would not be reduced and may actually be increased by treatment under Alternatives 3 and 4 due to bulking associated with stabilization treatment. Alternative 4 would reduce the toxicity, mobility, and volume of contaminants present at the site through their removal. Alternative 3 would achieve the same, but slightly less sediment would be removed.

Short-Term Effectiveness: The no action alternative would offer no change in short-term risks. For Alternative 2, a minimal increase in short-term risks would result because of disturbances to subsurface conditions during fencing and buoy system installation and long-term monitoring activities. Installation of buoys and fencing is expected to require less than 1 month; however, regular maintenance will likely be required to maintain the fencing and buoy system within the intertidal zone. Use of PPE would protect on-site workers from potential exposures during sampling. Following implementation (1 month), RAOs associated with minimizing human health risks would be partially achieved, but issues related to environmental impacts would not be addressed.

Alternative 3 would potentially result in increases in short-term risks due to disruption and suspension of contaminated sediment during site preparation and limited sediment removal activities, estimated to require 2 months. However, measures to minimize and/or contain sediment suspension would reduce short-term risks to the marine environment by limiting discharge to offshore waters, and the use of PPE would protect on-site workers from potential exposures. Intertidal and subtidal aquatic habitat functions and values would be temporarily lost during sediment removal. The lost functions and values would not be completely replaced until the aquatic community in the area is fully reestablished through natural recolonization (an estimated 1 to 4 years), assisted by the placement of appropriate substrate. Following implementation (2 years), RAOs associated with minimizing risks to human health would be achieved. RAOs associated with protecting the environment would be achieved after disturbed habitats were restored.

Implementation of Alternative 4 would result in short-term human and environmental risks from excavation/dredging and handling operations. Proper use of PPE would minimize human risks from direct contact with contaminated media. Engineering controls would minimize, but may not eliminate, environmental impacts caused by sediment resuspension during removal of contaminated sediment and debris. Intertidal and subtidal aquatic habitat functions and values would be temporarily lost during dredging and filling and would not be completely replaced until the aquatic community in the area is fully re-established through natural recolonization (an estimated 1 to 4 years), assisted by placement of appropriate substrate. The eelgrass beds would need to be reestablished. Following implementation (2 years), RAOs associated with minimizing risks to human health would be achieved. RAOs associated with protecting the environment would be achieved after disturbed habitats were restored.

Implementability: The no action alternative is the most readily implementable; it would require no construction activities. Implementation would include completing the 5-year reviews only. Furthermore, implementation would not limit the ease of undertaking future remedial actions at the site, if deemed necessary.

Limited actions associated with Alternative 2 would also be readily implemented. Technical feasibility issues would be minimal, since they would only include sampling activities for long-term monitoring and limited construction activities for installation of fencing and placement of buoys. Administrative feasibility would require some initial coordination/agreement with the owner of the intertidal zone, the State of Rhode Island, to establish access restrictions. Perhaps, however, the most cumbersome component in implementing this alternative is providing continual enforcement of the access and use restrictions on state-owned land and the continued maintenance of the fencing and buoy system, which would be required to ensure protection of human health. Implementation would not limit conducting future remedial actions at the site, if deemed necessary.

Implementation of Alternatives 3 and 4 would be more difficult due to removal of contaminated sediment. Site preparation and dredging would be affected by access limitations. Alternatives 3 and 4 would also result in temporary loss of aquatic habitat that would require restoration. Natural restoration would be implemented by placement of appropriate substrate and restoration to the original grade.

Implementation of Alternatives 2, 3, and 4 would all require similar coordination with regulatory agencies regarding marine dredging/filling operations; potential effects on fisheries, endangered species, and the aquatic habitat; and marine dredging (Alternatives 3 and 4 only). Agreements would have to be reached with regulatory agencies regarding mitigation for altering aquatic habitats, restoring eelgrass beds (for Alternative 4 only), and establishing the periods for dredging and filling activities in the bay.

Cost: Capital, O&M, present worth costs for the four shoreline and nearshore alternatives are summarized as follows:

Beach

Costs	Alternative 1 No Action	Alternative 2 Limited Action Restrict access	Alternative 3 Limited Dredging and Disposal	Alternative 4 Dredging and Disposal
Capital	$0	$10,000	$3,554,000	$4,134,000
O&M/Long-Term Monitoring	$0	$50,000/year (years 1-5 and 5-year intervals) $9,000/year (other years)	$61,000/year (years 1-5 and 5-year intervals) $0/year (other years)	$61,000/yr (years 1, 2, and 5) $0/year (other years)
5-Year Reviews	$22,000/5 years	$22,000/5 years	$22,000/5 years	$22,000/5 years
PRESENT WORTH	$46,000	$394,000	$3,937,000	$4,302,000

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TABLES

TABLE 1-1
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR SOIL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Media	Scenario/Receptor	RME or CTE	Media >1E-04 or HI>1	Total Cancer Risks	Total Noncancer Risks
On-Site Surface soils	Current/Future Child Recreational User	RME	NO	2.44E-06	0.0658
	Current/Future Youth Recreational User	RME	NO	2.02E-06	0.0221
	Current/Future Adult Recreational User	RME	NO	9.32E-07	0.00487
	Current/Future Lifetime Recreational User	RME	NO	5.40E-06	
	Future Child Resident	RME	NO	1.61E-05	0.299
	Future Adult Resident	RME	NO	8.75E-06	0.0411
	Future Lifetime Resident	RME	NO	2.48E-05	
On-Site Subsurface soils	Future Child Resident	RME	NO	2.57E-05	0.661
	Future Adult Resident	RME	NO	1.41E-05	0.0865
	Future Lifetime Resident	RME	NO	3.98E-05	
	Future Adult Excavation Worker	RME	NO	1.38E-06	0.232

Notes:

RME- Reasonable Maximum Exposure
CTE- Central Tendency Exposure

TABLE 1-2
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR SEDIMENT
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Media	Scenario/Receptor	RME or CTE	Media >1E-04 or HI>1	Total Cancer Risks	Total Noncanc r Risks
Shoreline Sediment	Future Child Resident	RME	NO	1.17E-05	0.164
	Future Adult Resident	RME	NO	1.05E-05	0.0235
	Future Lifetime Resident	RME	NO	2.22E-05	
	Current/Future Child (Age 1-4) Shoreline Visitor	RME	NO	4.43E-07	0.00949
	Current/Future Youth (Age 5-12) Shoreline Visitor	RME	NO	6.79E-07	0.00569
	Current/Future Youth (Age 1-12) Shoreline Visitor	RME	NO	1.12E-06	
Lobster	Future Adult Subsistence Fisherman	RME CTE	YES	1.41E-03 5.28E-04	27.2 27.2
	Future Child Recreational User	RME	YES	2.94E-05	2.27
	Future Adult Recreational User	RME	YES	8.45E-05	1.63
	Future Lifetime Recreational User	RME CTE	YES	1.14E-04 4.15E-05	
Clams	Future Adult Subsistence Fisherman	RME CTE	YES	1.72E-03 6.45E-04	33.1 27.7
	Future Child Recreational User	RME CTE	YES	3.59E-05 1.20E-05	2.78 2.31
	Future Adult Recreational User	RME CTE	YES	1.03E-04 3.87E-05	2 1.66
	Future Lifetime Recreational User	RME CTE	YES	1.39E-04 5.07E-05	
Blue Mussels	Future Adult Subsistence Fisherman	RME CTE	YES	4.36E-04 1.64E-04	24.5 21.9
	Future Child Recreational User	RME	YES	9.11E-06	2.05
	Future Adult Recreational User	RME	YES	2.62E-05	1.47
	Future Lifetime Recreational User	RME	NO	3.53E-05	

Notes:

RME- Reasonable Maximum Exposure
CTE- Central Tendency Exposure

TABLE 2-1
POTENTIAL CHEMICAL-SPECIFIC ARARs and TBCs
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION
Federal Regulatory Requirements	EPA Region IX Risk-Based Concentrations (Oct 1997)	To Be Considered	Risk Based Concentrations (RBCs) are human-health-based allowable exposure guidance levels developed for carcinogenic and non-carcinogenic compounds, using reference doses and carcinogenic potency slopes obtained from EPA's Integrated Risk Information System (IRIS) database, EPA's Health Effects Assessment Summary Tables (HEAST), and standard exposure scenarios. RBCs are chemical concentrations corresponding to a fixed level of risk in various media.	RBCs from Region III are used in the RI and future data will be compared with Region IX for human health risk evaluation to identify and select contaminants of potential concern.
	EPA Human Health Assessment Cancer Slope Factors (CSFs)	To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants	Will be used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media
	Clean Water Act, Section 304 40 USC 1314; 40 CFR 122 44	Relevant and Appropriate	Establish Ambient Water Quality Criteria (AWQC). Guidelines established for the protection of human health and/or the aquatic organisms	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria Sediments exceeding PRGs must be adequately addressed to meet these standards.
	OSWER Directive 9200 4-26, Approaches for Addressing Dioxins in Soil at CERCLA and RCRA Sites (Apr. 13, 1998)	To Be Considered	This Directive provides guidance in establishing cleanup levels for dioxins A 1 µg/kg (ppb) concentration of dioxins (as 2,3,7,8-TCDD TE) has been established for surficial soils involving residential exposure scenarios A cleanup range of 5 to 20 µg/kg of dioxin (as 2,3,7,8-TCDD TE) has been established for commercial and industrial exposure scenarios	This OSWER policy aids in the establishment of dioxin PRGs for soil and sediment to be used in the remedial action.

TABLE 2-1 (cont'd)
POTENTIAL CHEMICAL-SPECIFIC ARARs and TBCs
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION
Federal Regulatory Requirements (Cont'd)	Land Disposal Restrictions (40 CFR 268)	Applicable	This regulation establishes treatment standards (concentration levels or methods of treatment) which wastes must meet in order to be eligible for land disposal.	Contaminated soil, sediment, and debris must be treated to attain applicable treatment standards prior to placement in a landfill or other land disposal facility outside the are of contamination where placement occurs.
State Regulatory Requirements	State of Rhode Island Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases (Short Title Remediation Regulations), DEM-DSR-01-93, as amended August 1996	Applicable	The Remediation Regulations ensure consistency and certainty in the process of establishing clean up objectives for soil and groundwater	The Remediation Regulations are used in the establishment of PRGs for soil and sediment to be used in the remedial action
	Water Pollution Control RIGL 46-12 *et seq* ; ENVM 112-88.97-1	Relevant and Appropriate	Establishes water use classification and water quality criteria for waters of the state Also establishes acute and chronic water quality criteria for the protection of aquatic life	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria Sediments exceeding PRGs must be adequately addressed to meet these standards
	State of Rhode Island Rules and Regulations for Hazardous Waste Management, DEM-DAHM-WMB-01-92, as amended April 1992	Applicable	These regulations are intended to minimize environmental hazards associated with the generation, transportation, treatment, storage, and disposal of hazardous wastes.	The Hazardous Waste Management Regulations aid in the establishment of PRGs for soil and sediment to be used in the remedial action.
	State of Rhode Island Oil Contaminated Soil Policy, Division of Air and Hazardous Materials September 1991	Applicable	This policy statement applies to soil that has been contaminated with petroleum products but does not meet the definition of a hazardous waste. Material contaminated with virgin petroleum products may be processed in state, but material contaminated with unknown or waste petroleum products must be disposed of out of state	Soil contaminated with petroleum products may be removed from the site and would be subject to this policy statement

TABLE 2-2
POTENTIAL LOCATION-SPECIFIC ARARs AND TBCs
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION
Federal Regulatory Requirements	Floodplain Management (Executive Order 11988-40 CFR 6 302(b) and Statement of procedures on Floodplain Management and Wetlands Protection (40 CFR 6, App. A)	Applicable	Federal agencies are required to avoid impacts associated with the occupancy and modification of a floodplain and avoid support of floodplain development wherever there is a practicable alternative	The expected impacts of each alternative will be evaluated, in terms of the intent of this provision, and considered during the preferred alternative selection process Adverse impacts may be mitigated where feasible or necessary
	Rivers and Harbors Act (33 U.S C. Section 403), Section 10	Applicable	These regulations set forth criteria from the Army Corps of Engineers (ACOE) for placing dams/structures in navigable waters of the United States.	If an alternative involves a cap in Narragansett Bay, the substantive requirements of these regulations will be met Alternatives may involve dredging or excavation of marine sediments Filling or dredging activity will only occur where there is no other practicable alternative and any adverse impacts will be mitigated
	Clean Water Act - Section 404(b)(1) Guidelines for specification of disposal sites for dredged or fill material (40 CFR Part 230)	Applicable	These guidelines outline requirements for the discharge of dredged or fill materials into surface waters	
	Fish and Wildlife Coordination Act (16 U.S C 661), Fish and Wildlife protection (40 CFR Section 6.302(g))	Applicable	This regulation requires that any federal agency proposing to modify a body of water must consult with the U S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service, and other related state agencies. That federal agency must consult with the appropriate government entity and also take action to prevent, mitigate, or compensate for project-related losses of fish and wildlife resources.	Alternatives may modify potential fish and wildlife habitats. All appropriate state and federal agencies, such as the USFWS, will be consulted to ensure that losses of these resources will be prevented, mitigated, or compensated.

TABLE 2-2 (cont'd)
POTENTIAL LOCATION-SPECIFIC ARARs
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION
Federal Regulatory Requirements (Cont'd)	Executive Order 11990 RE· Protection of Wetlands 40 CFR Part 6, Appendix A	Applicable	This Order requires Federal agencies to take action to avoid adversely impacting wetlands wherever possible, to minimize wetlands destruction and to preserve the values of wetlands, and to prescribe procedures to implement the policies and procedures of this Executive Order.	Restoration and preservation of the wetlands may be altered by the removal action Actions will be conducted so that the wetlands' natural and beneficial values can be realized. Implementation of the Order will be considered and incorporated into any plan or action, wherever feasible
	Endangered Species Act 16 USC 1531 *et seq* , 50 CFR Part 200, 50 CFR Part 402	Applicable	If a location contains a federal endangered or threatened species or its critical habitat, and an action may impact the species or its habitat, the U.S Fish & Wildlife Service or the National Marine Fisheries Service must be consulted	The federally endangered loggerhead turtle (*Caretta caretta*) and federally threatened Kemp's ridley turtle (*Lepidochelys k mpii*) occur in the waters of Narragansett Bay Appropriate agencies will be consulted to find ways to minimize adverse effects to the listed species and its habitat
	National Historic Preservation Act 16 USC 470 *et seq* , 26 CFR Part 800	Applicable	Requires action to take into account effects on properties included on or eligible for the National Register of Historic Places and minimizes harm to National Historic Landmarks	Historic vessels may be sunken in the area Remedial actions may involve actions that might cause potential harm to historic sites Such actions would be prevented.
	Coastal Zone Management Act (16 USC Section 1451 et seq)	Applicable	This act regulates activities affecting the coastal zone including lands thereunder and adjacent shoreline	For remedial actions in a coastal zone, requires determination that all activities are consistent to the maximum extent practicable with the State Coastal Zone Management Plan

TABLE 2-2 (cont'd)
POTENTIAL LOCATION-SPECIFIC ARARs
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION
State Regulatory Requirements	Coastal Resources Management RIGL 46-23-1 *et seq.*	Applicable	Sets standards for management and protection of coastal resources.	The entire site is located in a coastal resource management area, therefore, applicable coastal resource management requirements need to be addressed.
	Endangered Species Act, RIGL 20-37-1 *et seq.*	Applicable	Regulates activities affecting state-listed endangered or threatened species or their critical habitat	The state listed loggerhead turtle (*Caretta caretta*) and Kemp's ridley turtle (*Lepidochelys kempii*) occur in the waters of Narragansett Bay. Appropriate agencies will be consulted to find ways to minimize adverse effects to the listed species and its habitat
	Rhode Island Coastal Resources Management Law (RIGL, Title 46, Chapter 23) and Regulations	Applicable	This law creates the Coastal Resources Management Council and authorizes promulgation of regulations for management and protection of coastal resources.	All actions will be consistent, to the extent practicable, with the Coastal Zone Management Plan.

TABLE 2-3
POTENTIAL ACTION-SPECIFIC ARARs AND TBCs
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION
Federal Regulatory Requirements	Clean Water Act, Section 402, EPA administered permit programs: the NPDES (40 CFR Part 122), criteria and standards for the NPDES (40 CFR Part 125), Water quality standards (40 CFR Part 131)	Applicable	Contains discharge limitations, monitoring requirements, and best management practices Substantive requirements under NPDES are written such that state and federal ambient water quality criteria (AWQC) are met Permits are required for off-site discharges	Alternatives may involve substantial activities in Narragansett Bay, including dewatering sediment activities that may disturb sediments. These regulations will be complied with to the extent practicable.
	Clean Air Act (CAA), National Emission Standards for Hazardous Air Pollutants (NESHAPS 42 USC 7411, 7412, 40 CFR Part 61	Applicable	NESHAPS are a set of emission standards for specific chemicals, including naphthalene, arsenic, cadmium, chromium, lead, mercury, nickel, PCBs, DDE, and hexachlorobenzene. Certain activities are regulated including site remediation.	Alternatives may involve excavation and treatment of soil and sediment. Monitoring of air emissions will be used to assess compliance with these standards if threshold levels are reached. Operation and maintenance activities will be carried out in a manner that will minimize potential air releases.
State Regulatory Requirements	Hazardous Waste Management Act (RI General Laws 23-19.1-6, 23-19.1-7, and 23-19 1-10); Section 5, Generators	Applicable	These regulations apply to all generators of hazardous waste They include requirements for identification, storage, shipment and labeling of waste	Alternatives may involve the generation of hazardous waste via excavation Excavation and related activities will comply with this regulation
	Waters and Navigation (RI Gen. Laws 46-12 and 46-13.1), Health and Safety (RI Gen Laws 23-19.1, 23-19.14); Remediation Regulations DEM-DSR-01-93 Section 8.01, A to D	Relevant and Appropriate	This section regulates impacted media at contaminated sites	This section will be used as a performance measurement during post-removal sampling If such sampling indicates an unacceptable human health risk, further action will be required and an additional decision document may be issued.
	Water Pollution (RI General Laws 46-12), Environmental Management (RI General Laws 42-17 1, Water Quality Regulations (R.I. Code R. 112-88 97-1), Rule #18	Applicable	Regulations designed to protect state surface water resources. Establishes water use classification and water quality criteria for waters of the state.	Alternatives will include provisions for the protection of Narragansett Bay where construction activities occur in these waters.

TABLE 2-3 (cont'd)
POTENTIAL ACTION-SPECIFIC ARARs
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

AUTHORITY	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION
State Regulatory Requirements (Cont'd)	Clean Air Act - Emissions Detrimental to Persons or Property RIGL 23-23 *et seq.*; CRIR 12-31-07	Relevant and Appropriate	Prohibits emissions of contaminants which may be injurious to humans, plant or animal life or cause damage to property or which reasonably interferes with the enjoyment of life and property	Alternatives may involve removal, processing, and temporary storage of debris, soil, and sediments involving the release of contaminants.
	Clean Air Act - Air Toxics RIGL 23-23 *et seq.*, CRIR 12-31-22	Applicable	Prohibits the emission of specified contaminants at rates which would result in ground level concentrations greater than acceptable ambient levels or acceptable ambient levels as set in the regulations	Alternatives may involve removal, processing, and temporary storage of debris, soil, and sediments involving the release of contaminants.
	Clean Air Act - Fugitive Dust Control RIGL 23-23 *et seq.*; CRIR 12-31-05	Applicable	Requires that reasonable precaution be taken to prevent particulate matter from becoming airborne.	Alternatives with removal, processing, and temporary storage of debris, soil, and sediments might generate fugitive dust Controls would be implemented to prevent material from becoming airborne.
	Clean Air Act - Air Pollution Control RIGL 23-23 *et seq.*, CRIR 12-31-09	Applicable	Establishes guidelines for the construction, installation, or operation of potential air emission units. Establishes permissible emission rates for some contaminants.	Alternatives may involve processing of debris, soil, and sediment, and treatment of dewatering liquid, releasing contaminants and in such instances this regulation will be complied with
	RI Air Pollution Control Regulation #5, Fugitive Dust	Applicable	Regulations designed to control releases of airborne particulate in the State of Rhode Island, including those caused by earth moving activities.	Alternatives may include earth-moving activities and land clearing where there is a possibility of fugitive dust and in such instances this regulation will be complied with

TABLE 2-4
RISK-BASED COPC SELECTION FOR SURFACE SOIL
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Parameter	Units	Det. Freq.	Maximum Detected	Risk-Based Conc. (cancer)	Risk-Based Conc. (noncancer)	COPC Requiring Further Consideration?
SURFACE SOILS - SEMIVOLATILE ORGANIC COMPOUNDS RESULTS						
4-Chloro-3-Methylphenol	ug/kg	3 / 71	140 J			No
Benzo(a)anthracene	ug/kg	43 / 71	9100	910		Yes
Benzo(a)pyrene	ug/kg	42 / 71	7100	91		Yes
Benzo(b)fluoranthene	ug/kg	52 / 71	9700	910		Yes
Benzo(k)fluoranthene	ug/kg	15 / 71	3500 J	9100		No
Carbazole	ug/kg	9 / 65	930 J	33000		No
Chrysene	ug/kg	46 / 71	8100	91000		No
Dibenzo(a,h)anthracene	ug/kg	11 / 71	610	91		Yes
Indeno(1,2,3-cd)pyrene	ug/kg	30 / 71	4100	910		Yes
SURFACE SOILS - PESTICIDES/PCBs RESULTS						
Aroclor-1254	ug/kg	2 / 39	530	320	1800	Yes
SURFACE SOILS - METALS RESULTS						
Arsenic	mg/kg	76 / 76	10.4	0.60	35	Yes
Chromium	mg/kg	76 / 76	37.9	150	380	No
Lead	mg/kg	75 / 76	2970		400	Yes
Manganese	mg/kg	76 / 76	750		9100	No
Nickel	mg/kg	66 / 76	221		2500	No
SURFACE SOILS - DIOXINS/FURANS RESULTS						
Total 2,3,7,8-TCDD Equivalents	ug/kg	7 / 7	0.0164	0.006		Yes

[1]Chemical selected as COPC requiring further action if the maximum detected concentration exceeds either the cancer or noncancer risk-based concentration.
Data qualifiers:
J = estimated

TABLE 2-5
RISK-BASED COPC SELECTION FOR SUBSURFACE SOIL
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Parameter	Units	Det. Freq.	Maximum Detected	Risk-Based Conc. (cancer)	Risk-Based Conc. (noncancer)	COPC Requiring Further Consideration?
SUBSURFACE SOILS - SEMIVOLATILE ORGANIC COMPOUNDS RESULTS						
4,6-Dinitro-2-Methylphenol	ug/kg	1 / 32	320 J			No
Benzo(a)anthracene	ug/kg	35 / 43	3400	910		Yes
Benzo(a)pyrene	ug/kg	32 / 42	4000	91		Yes
Benzo(b)fluoranthene	ug/kg	34 / 42	2800	910		Yes
Benzo(k)fluoranthene	ug/kg	22 / 43	2500 J	9100		No
Carbazole	ug/kg	1 / 21	170 J	33000		No
Chrysene	ug/kg	37 / 43	3200 J	91000		No
Dibenzo(a,h)anthracene	ug/kg	19 / 37	820 J	91		Yes
Indeno(1,2,3-cd)pyrene	ug/kg	29 / 39	2300 J	910		Yes
SUBSURFACE SOILS - PESTICIDES/PCBs RESULTS						
delta-BHC	ug/kg	1 / 33	2.4 J			No
Dieldrin	ug/kg	2 / 33	44 J	62	6300	No
SUBSURFACE SOILS - METALS RESULTS						
Antimony	mg/kg	9 / 39	39.2 J		51	No
Arsenic	mg/kg	50 / 50	74.4 J	0.60	36	Yes
Chromium	mg/kg	50 / 50	61.9	150	380	No
Lead	mg/kg	49 / 49	7820 J		400	Yes
Manganese	mg/kg	50 / 50	1110 J		9100	No
Mercury	mg/kg	26 / 37	2.2 J		13	No
Vanadium	mg/kg	47 / 50	57		880	No
Zinc	mg/kg	47 / 50	4240		38000	No

[1]Chemical selected as COPC requiring further action if the maximum detected concentration exceeds either the cancer or noncancer risk-based concentration.
Data qualifiers:
J = estimated

TABLE 2-6
RIDEM-BASED COPC SELECTION FOR SURFACE SOIL
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Parameter	Units	Det. Freq.	Maximum Detected	RIDEM Direct Exposure Residential	RIDEM GB Leachability	COPC Requiring Further Consideration?[1]
SURFACE SOILS - VOLATILE ORGANIC COMPOUNDS RESULTS						
1,1,1-Trichloroethane	ug/kg	1 / 67	2 J	540000	160000	No
1,2-Dichloroethene (total)	ug/kg	1 / 67	17	630000	60000	No
2-Butanone	ug/kg	15 / 67	13	10000000		No
2-Hexanone	ug/kg	1 / 67	32			No
Acetone	ug/kg	23 / 67	320 J	7800000		No
Bromomethane	ug/kg	2 / 67	1 J	800		No
Carbon Disulfide	ug/kg	1 / 67	2 J	120000		No
Chloromethane	ug/kg	3 / 67	1 J	490		No
Methylene Chloride	ug/kg	37 / 67	4 J	45000		No
Tetrachloroethene	ug/kg	3 / 67	16	12000	4200	No
Toluene	ug/kg	5 / 67	4 J	190000	54000	No
Trichloroethene	ug/kg	1 / 67	1 J	13000	20000	No
Vinyl Chloride	ug/kg	1 / 67	3 J	20		No
Xylenes (total)	ug/kg	6 / 67	3 J	110000		No
SURFACE SOILS - SEMIVOLATILE ORGANIC COMPOUNDS RESULTS						
2-Methylnaphthalene	ug/kg	9 / 71	660	123000		No
4-Chloro-3-Methylphenol	ug/kg	3 / 71	140 J			No
9H-Carbazole	ug/kg	7 / 33	690	32000		No
Acenaphthene	ug/kg	12 / 71	940	43000		No
Acenaphthylene	ug/kg	6 / 71	140 J	23000		No
Anthracene	ug/kg	21 / 71	3800	35000		No
Benzo(a)anthracene	ug/kg	43 / 71	9100	900		Yes
Benzo(a)pyrene	ug/kg	42 / 71	7100	400		Yes
Benzo(b)fluoranthene	ug/kg	52 / 71	9700	900		Yes
Benzo(g,h,i)perylene	ug/kg	29 / 71	4300	800		Yes
Benzo(k)fluoranthene	ug/kg	15 / 71	3500 J	900		Yes
bis(2-ethylhexyl)Phthalate	ug/kg	15 / 71	3200 J	46000		No
Carbazole	ug/kg	9 / 65	930 J	32000		No

TABLE 2-6 (cont'd)
RIDEM-BASED COPC SELECTION FOR SURFACE SOIL
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Parameter	Units	Det. Freq.	Maximum Detected	RIDEM Direct Exposure Residential	RIDEM GB Leachability	COPC Requiring Further Consideration?[1]
SURFACE SOILS - SEMIVOLATILE ORGANIC COMPOUNDS (continued)						
Chrysene	ug/kg	46 / 71	8100	400		Yes
di-N-Butylphthalate	ug/kg	17 / 71	170 J	7800000		No
di-N-Octylphthalate	ug/kg	1 / 71	54 J	1600000		No
Dibenzo(a,h)anthracene	ug/kg	11 / 71	610	400		Yes
Dibenzofuran	ug/kg	8 / 71	650	164000		No
Fluoranthene	ug/kg	56 / 71	15000	20000		No
Fluorene	ug/kg	13 / 71	1200	28000		No
Hexachlorobenzene	ug/kg	2 / 71	210 J	400		No
Indeno(1,2,3-cd)pyrene	ug/kg	30 / 71	4100	900		Yes
N-Nitroso-Diphenylamine	ug/kg	1 / 71	150 J	94000		No
Naphthalene	ug/kg	7 / 71	740	54000		No
Pentachlorophenol	ug/kg	1 / 71	350	5300		No
Phenanthrene	ug/kg	45 / 71	9700	40000		No
Phenol	ug/kg	1 / 71	60 J	6000000		No
Pyrene	ug/kg	59 / 71	12000	13000		No
SURFACE SOILS - PESTICIDES/PCBs RESULTS						
4,4'-DDD	ug/kg	21 / 39	17	2700		No
4,4'-DDE	ug/kg	36 / 39	42	1900		No
4,4'-DDT	ug/kg	36 / 39	74	1900		No
Aldrin	ug/kg	3 / 39	1.5 J	38		No
alpha-BHC	ug/kg	4 / 39	1.7 J	100		No
alpha-Chlordane	ug/kg	14 / 39	14	500		No
Aroclor-1254	ug/kg	2 / 39	530	10000	10000	No
beta-BHC	ug/kg	3 / 39	0.99 J	340		No
Dieldrin	ug/kg	17 / 39	11 J	40		No
Endosulfan I	ug/kg	7 / 39	9.4	2300		No
Endosulfan II	ug/kg	18 / 39	25	2300		No

TABLE 2-6 (cont'd)
RIDEM-BASED COPC SELECTION FOR SURFACE SOIL
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Parameter	Units	Det. Freq.	Maximum Detected	RIDEM Direct Exposure Residential	RIDEM GB Leachability	COPC Requiring Further Consideration?[1]
SURFACE SOILS - PESTICIDES/PCBs (continued)						
Endosulfan Sulfate	ug/kg	11 / 39	33			No
Endrin	ug/kg	27 / 39	74	5000		No
Endrin Aldehyde	ug/kg	18 / 33	25 NJ			No
Endrin Ketone	ug/kg	1 / 39	2.9 J			No
gamma-BHC	ug/kg	9 / 39	2.4	490		No
gamma-Chlordane	ug/kg	13 / 39	7.8	500		No
Heptachlor	ug/kg	3 / 39	0.74 J	140		No
Heptachlor Epoxide	ug/kg	24 / 39	8.1	70		No
Methoxychlor	ug/kg	8 / 39	10 J	7800		No
SURFACE SOILS - METALS RESULTS						
Antimony	mg/kg	10 / 76	9.1 J	10		No
Arsenic	mg/kg	76 / 76	10.4	1.7		Yes
Barium	mg/kg	72 / 76	282	5500		No
Beryllium	mg/kg	60 / 76	0.6	0.4		Yes
Cadmium	mg/kg	3 / 76	0.94	39		No
Chromium	mg/kg	76 / 76	37.9	390		No
Lead	mg/kg	75 / 76	2970	150		Yes
Manganese	mg/kg	76 / 76	750	390		Yes
Mercury	mg/kg	32 / 76	0.61	23		No
Nickel	mg/kg	66 / 76	221	1000		No
Selenium	mg/kg	8 / 76	0.66 J	390		No
Silver	mg/kg	22 / 76	26.5 J	200		No
Vanadium	mg/kg	76 / 76	41.2	550		No
Zinc	mg/kg	75 / 76	1910 J	6000		No
SURFACE SOILS - DIOXINS/FURANS RESULTS						
Total 2,3,7,8-TCDD Equivalents	ug/kg	7 / 7	0.016388			Yes

[1]Chemical selected as COPC requiring further action if the maximum detected concentration exceeds either the cancer or noncancer risk-based concentration.
Data qualifiers:
J = estimated
NJ = presumtively present at an estimated level

TABLE 2-7
RIDEM-BASED COPC SELECTION FOR SUBSURFACE SOIL
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Parameter	Units	Det. Freq.	Maximum Detected	RIDEM Direct Exposure Residential	RIDEM GB Leachability	COPC Requiring Further Consideration?[1]
SUBSURFACE SOILS - VOLATILE ORGANIC COMPOUNDS RESULTS						
2-Butanone	ug/kg	3 / 37	1100 J	10000000		No
Carbon Disulfide	ug/kg	3 / 38	11	120000		No
Chloroethane	ug/kg	1 / 35	1 J			No
Ethylbenzene	ug/kg	3 / 37	630 J	71000	62000	No
Methylene Chloride	ug/kg	6 / 53	1800	45000		No
Toluene	ug/kg	10 / 39	67	190000	54000	No
Total VOCs	ug/kg	3 / 3	3			No
Xylenes (total)	ug/kg	5 / 37	1200	110000		No
SUBSURFACE SOILS - SEMIVOLATILE ORGANIC COMPOUNDS RESULTS						
2-Methylnaphthalene	ug/kg	13 / 35	11000	123000		No
4,6-Dinitro-2-Methylphenol	ug/kg	1 / 32	320 J			No
9H-Carbazole	ug/kg	6 / 12	220 J	32000		No
Acenaphthene	ug/kg	14 / 37	4900	43000		No
Acenaphthylene	ug/kg	10 / 33	640	23000		No
Anthracene	ug/kg	32 / 43	4800	35000		No
Benzo(a)anthracene	ug/kg	35 / 43	3400	900		Yes
Benzo(a)pyrene	ug/kg	32 / 42	4000	400		Yes
Benzo(b)fluoranthene	ug/kg	34 / 42	2800	900		Yes
Benzo(g,h,i)perylene	ug/kg	22 / 39	1900 J	800		Yes
Benzo(k)fluoranthene	ug/kg	22 / 43	2500 J	900		Yes
Benzoic Acid	ug/kg	1 / 2	48 J	340000		No
bis(2-ethylhexyl)Phthalate	ug/kg	3 / 44	110 J	46000		No
Butylbenzylphthalate	ug/kg	1 / 33	120 J	330000		No
Carbazole	ug/kg	1 / 21	170 J	32000		No
Chrysene	ug/kg	37 / 43	3200 J	400		Yes
di-N-Butylphthalate	ug/kg	3 / 40	1400 *	7800000		No
Dibenzo(a,h)anthracene	ug/kg	19 / 37	820 J	400		Yes
Dibenzofuran	ug/kg	11 / 34	4000	160000		No

TABLE 2-7 (cont'd)
RIDEM-BASED COPC SELECTION FOR SUBSURFACE SOIL
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Parameter	Units	Det. Freq.	Maximum Detected	RIDEM Direct Exposure Residential	RIDEM GB Leachability	COPC Requiring Further Consideration?[1]
SUBSURFACE SOILS - SEMIVOLATILE ORGANIC COMPOUNDS (continued)						
Fluoranthene	ug/kg	43 / 47	16000	20000		No
Fluorene	ug/kg	17 / 36	3400	28000		No
Hexachlorobenzene	ug/kg	1 / 33	370 J	400		No
Indeno(1,2,3-cd)pyrene	ug/kg	29 / 39	2300 J	900		Yes
Naphthalene	ug/kg	10 / 34	4000	54000		No
Phenanthrene	ug/kg	43 / 47	14000	40000		No
Phenol	ug/kg	3 / 22	490	6000000		No
Pyrene	ug/kg	45 / 49	5300	13000		No
Total BNAs	ug/kg	8 / 8	20890			No
Total Carcinogenic PAHs	ug/kg	4 / 4	3950			No
Total PAHs	ug/kg	16 / 16	21100			
SUBSURFACE SOILS - PESTICIDES/PCBs RESULTS						
4,4'-DDD	ug/kg	5 / 33	89 J	2700		No
4,4'-DDE	ug/kg	8 / 33	67 J	1900		No
4,4'-DDT	ug/kg	11 / 33	370	1900		No
alpha-BHC	ug/kg	4 / 33	2.5 J	100		No
alpha-Chlordane	ug/kg	2 / 33	10 NJ	500		No
Aroclor-1254	ug/kg	2 / 33	190 J	10000	10000	No
Aroclor-1260	ug/kg	1 / 33	39 J	10000	10000	No
delta-BHC	ug/kg	1 / 33	2.4 J			No
Dieldrin	ug/kg	2 / 33	44 J	40		Yes
Endosulfan I	ug/kg	3 / 33	5.4 J	2300		No
Endosulfan II	ug/kg	12 / 33	13 J	2300		No
Endosulfan Sulfate	ug/kg	3 / 33	17 J			No
Endrin	ug/kg	6 / 33	120 J	5000		No
Endrin Aldehyde	ug/kg	3 / 33	16 J			No
gamma-BHC	ug/kg	3 / 33	3.1 NJ	490		No

TABLE 2-7 (c nt'd)
RIDEM-BASED COPC SELECTION FOR SUBSURFACE SOIL
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Parameter	Units	Det. Freq.	Maximum Detected	RIDEM Direct Exposure Residential	RIDEM GB Leachability	COPC Requiring Further Consideration?[1]
SUBSURFACE SOILS - PESTICIDES/PCBs (continued)						
gamma-Chlordane	ug/kg	3 / 33	2.5 J	500		No
Heptachlor	ug/kg	1 / 33	1.4 J	140		No
Heptachlor Epoxide	ug/kg	10 / 33	43	70		No
Methoxychlor	ug/kg	1 / 33	4 NJ	7800		No
SUBSURFACE SOILS - TOTAL PETROLEUM HYDROCARBONS RESULTS						
TPH	mg/kg	11 / 14	21000 J	500	2500	Yes
SUBSURFACE SOILS - METALS RESULTS						
Antimony	mg/kg	9 / 39	39.2 J	10		Yes
Arsenic	mg/kg	50 / 50	74.4 J	1.7		Yes
Barium	mg/kg	50 / 50	220	5500		No
Beryllium	mg/kg	23 / 39	0.48 B1	0.4		Yes
Cadmium	mg/kg	11 / 38	8.1	39		No
Chromium	mg/kg	50 / 50	61.9	390		No
Lead	mg/kg	49 / 49	7820 J	150		Yes
Manganese	mg/kg	50 / 50	1110 J	390		Yes
Mercury	mg/kg	26 / 37	2.2 J	23		No
Nickel	mg/kg	50 / 50	64.1	1000		No
Selenium	mg/kg	18 / 40	1.7 B1	390		No
Vanadium	mg/kg	47 / 50	57	550		No
Zinc	mg/kg	47 / 50	4240	6000		No

[1]Chemical selected as COPC requiring further action if the maximum detected concentration exceeds either the cancer or noncancer risk-based concentration.
Data qualifiers:
J = estimated
NJ = presumptively present at an estimated level
B = greater than Instrument Detection Level (IDL) but less that Contract Required Detection Limit (CRL)
* = qualifier changed as a result of data validation

TABLE 2-8
SELECTION OF SOIL COPCs REQUIRING FURTHER CONSIDERATION
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Parameter	Selected by Risk-Based Process	Selected by RIDEM-Based Process
SEMIVOLATILE ORGANIC COMPOUNDS		
Benzo(a)anthracene	X	X
Benzo(a)pyrene	X	X
Benzo(b)fluoranthene	X	X
Benzo(g,h,i)perylene		X
Benzo(k)fluoranthene		X
Chrysene		X
Dibenzo(a,h)anthracene	X	X
Indeno(1,2,3-cd)pyrene	X	X
PESTICIDES/PCBs		
Aroclor-1254	X	
Dieldrin		X
TOTAL PETROLEUM HYDROCARBONS		
TPH		X
METALS		
Antimony		X
Arsenic	X	X
Beryllium		X
Lead	X	X
Manganese		X
DIOXINS/FURANS		
Total 2,3,7,8-TCDD Equivalents	X	X

TABLE 2-9
SOIL PRELIMINARY REMEDIATION GOALS
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Parameter	Units	Risk-Based PRG	RIDEM Residential Direct Exposure Criteria	RIDEM GB Leachability Criteria	ARAR/TBC	Background Concentration	Selected Soil PRG	Basis for Selection
SEMIVOLATILE ORGANIC COMPOUNDS								
Benzo(a)anthracene	ug/kg	910	900				900	RIDEM
Benzo(a)pyrene	ug/kg	91	400 (a)				400	RIDEM
Benzo(b)fluoranthene	ug/kg	910	900				900	RIDEM
Benzo(g,h,i)perylene	ug/kg	(b)	800				800	RIDEM
Benzo(k)fluoranthene	ug/kg	(b)	900				900	RIDEM
Chrysene	ug/kg	(b)	400				400	RIDEM
Dibenzo(a,h)anthracene	ug/kg	91	400 (a)				400	RIDEM
Indeno(1,2,3-cd)pyrene	ug/kg	910	900				900	RIDEM
PESTICIDES/PCBs								
Aroclor-1254	ug/kg	320	10000		1000		1000	ARAR
Dieldrin	ug/kg	(b)	40				40	RIDEM
TOTAL PETROLEUM HYDROCARBONS								
TPH	mg/kg		500	2500			500	RIDEM
METALS								
Antimony	mg/kg	(b)	10			0.42	10	RIDEM
Arsenic	mg/kg	0.60	1.7			6.2(c)	6.2	Background
Beryllium	mg/kg	(b)	0.4			0.439	0.4 (d)	RIDEM
Lead	mg/kg	400	150		400	15.4	150	RIDEM
Manganese	mg/kg	(b)	390			372	390	RIDEM
DIOXINS/FURANS								
Total 2,3,7,8-TCDD Equivalents	ug/kg	0.0060	0.0043		1		1	ARAR

(a) Based on quantitation limits. Because the quantitation limit is 400 ug/kg for these chemicals, the lower risk-based value is not chosen.
(b) No value presented -- not a COPC based on Risk-Based COPC Selection method
(c) Calculat d by RIDEM, see Section 2.2.2.2
(d) RIDEM Direct Exposure concentration is below background level. However, to be conservative, th RIDEM concentration was selected.

TABLE 2-10
SELECTION OF SOIL COCs
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Parameter	Units	Soil PRG	Maximum Detected	Selected as COC?
SEMIVOLATILE ORGANIC COMPOUNDS				
Benzo(a)anthracene	ug/kg	900	9100	Yes
Benzo(a)pyrene	ug/kg	400	7100	Yes
Benzo(b)fluoranthene	ug/kg	900	9700	Yes
Benzo(g,h,i)perylene	ug/kg	800	4300	Yes
Benzo(k)fluoranthene	ug/kg	900	3500 J	Yes
Chrysene	ug/kg	400	8100	Yes
Dibenzo(a,h)anthracene	ug/kg	400	820 J	Yes
Indeno(1,2,3-cd)pyrene	ug/kg	900	4100	Yes
PESTICIDES/PCBs				
Aroclor-1254	ug/kg	1000	530	No
Dieldrin	ug/kg	40	44 J	Yes
TOTAL PETROLEUM HYDROCARBONS				
TPH	mg/kg	500	21000 J	Yes
METALS				
Antimony	mg/kg	10	39.2 J	Yes
Arsenic	mg/kg	6.2	74.4 J	Yes
Beryllium	mg/kg	0.4	0.48 B1	Yes
Lead	mg/kg	150	7820 J	Yes
Manganese	mg/kg	390	1110 J	Yes
DIOXINS/FURANS				
Total 2,3,7,8-TCDD Equivalents	ug/kg	1	0.016388	No

Data qualifiers:
J = estimated
B = greater than IDL but less than CRDL

TABLE 2-11
SURFACE SOIL CONCENTRATIONS EXCEEDING PRGs
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Location	Sample Depth (ft) top	bottom	Parameter	Concentratio	qual	units	Soil PRG
B-8	0	1	Arsenic	6.3	J	mg/kg	6.2
B-9	0	1	Beryllium	0.43		mg/kg	0.4
B-11	0	1	Arsenic	6.6	J	mg/kg	6.2
B-11	0	1	Manganese	439	J	mg/kg	390
B-12	0	1	Arsenic	6.6	J	mg/kg	6.2
B-12	0	1	Benzo(a)pyrene	2800		ug/kg	400
B-12	0	1	Benzo(g,h,i)perylene	980		ug/kg	800
B-12	0	1	Dibenz(a,h)anthracene	610		ug/kg	400
B-12	0	1	Indeno(1,2,3-cd)pyrene	1200		ug/kg	900
B-12	0	1	Manganese	439	J	mg/kg	390
B-13	0	1	Arsenic	10	J	mg/kg	6.2
B-14	0	1	Arsenic	8.5		mg/kg	6.2
B-15	0	1	Arsenic	7		mg/kg	6.2
B-15	0	1	Benzo(a)anthracene	2400		ug/kg	900
B-15	0	1	Benzo(a)pyrene	2600		ug/kg	400
B-15	0	1	Benzo(b)fluoranthene	3900		ug/kg	900
B-15	0	1	Benzo(g,h,i)perylene	1300	J	ug/kg	800
B-15	0	1	Chrysene	2400		ug/kg	400
B-15	0	1	Indeno(1,2,3-cd)pyrene	1100	J	ug/kg	900
B-15	0	1	Manganese	506	J	mg/kg	390
B-16	0	1	Arsenic	7.3		mg/kg	6.2
B-16	0	1	Benzo(a)pyrene	410		ug/kg	400
B-16	0	1	Chrysene	450		ug/kg	400
B-16	0	1	Manganese	554		mg/kg	390
B-17	0	1	Manganese	404	J	mg/kg	390
MW-7	0	1	Beryllium	0.46		mg/kg	0.4
MW-8	0	1	Chrysene	450		ug/kg	400
MW-9	0	1	Benzo(a)pyrene	890		ug/kg	400
MW-9	0	1	Benzo(b)fluoranthene	1600		ug/kg	900
MW-9	0	1	Beryllium	0.43		mg/kg	0.4
MW-9	0	1	Chrysene	750		ug/kg	400
MW-9	0	1	Manganese	451		mg/kg	390
MW-10	0	1	Arsenic	7		mg/kg	6.2
MW-10	0	1	Lead	372		mg/kg	150
MW-10	0	1	Manganese	697	J	mg/kg	390
MW-11	0	1	Lead	2970		mg/kg	150
SS1	0	0.5	Arsenic	6.2		mg/kg	6.2
SS1	0	0.5	Beryllium	0.47		mg/kg	0.4
SS3	0	0.5	Beryllium	0.41		mg/kg	0.4
SS5	0	0.5	Beryllium	0.48		mg/kg	0.4

TABLE 2-11 (continued)
SURFACE SOIL CONCENTRATIONS EXCEEDING PRGs
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Location	Sample Depth (ft)		Parameter	Concentratio	qual	units	Soil PRG
	top	bottom					
SS6	0	0.5	Arsenic	8.9		mg/kg	6.2
SS6	0	0.5	Benzo(a)anthracene	3300		ug/kg	900
SS6	0	0.5	Benzo(a)pyrene	2700		ug/kg	400
SS6	0	0.5	Benzo(b)fluoranthene	2800		ug/kg	900
SS6	0	0.5	Benzo(k)fluoranthene	3100		ug/kg	900
SS6	0	0.5	Chrysene	2800		ug/kg	400
SS6	0	0.5	Manganese	750		mg/kg	390
SS-10	0	0.5	Beryllium	0.43		mg/kg	0.4
SS-11	0	0.5	Beryllium	0.5		mg/kg	0.4
SS-12	0	1	Beryllium	0.44		mg/kg	0.4
SS-13	0	1	Beryllium	0.46		mg/kg	0.4
SS-14	0	1	Arsenic	6.3	J	mg/kg	6.2
SS-15	0	1	Arsenic	6.3	J	mg/kg	6.2
SS-19	0	1	Arsenic	6.7	J	mg/kg	6.2
SS-19	0	1	Beryllium	0.41		mg/kg	0.4
SS-20	0	1	Arsenic	7.4	J	mg/kg	6.2
SS-20	0	1	Benzo(a)anthracene	1200		ug/kg	900
SS-20	0	1	Benzo(a)pyrene	960		ug/kg	400
SS-20	0	1	Benzo(b)fluoranthene	1800		ug/kg	900
SS-20	0	1	Chrysene	1100		ug/kg	400
SS-23	0	1	Arsenic	8.5	J	mg/kg	6.2
SS-28	0	1	Arsenic	6.2	J	mg/kg	6.2
SS-301	0	1	Manganese	478	J	mg/kg	390
SS-302	0	1	Arsenic	7.3	J	mg/kg	6.2
SS-304	0	1	Arsenic	6.4		mg/kg	6.2
SS-304	0	1	Benzo(a)pyrene	430	J	ug/kg	400
SS-305	0	1	Arsenic	7.8		mg/kg	6.2
SS-305	0	1	Beryllium	0.6		mg/kg	0.4
SS-306	0	1	Arsenic	7.6	J	mg/kg	6.2
SS-307	0	1	Arsenic	8.1	J	mg/kg	6.2
SS-308	0	1	Arsenic	9.1		mg/kg	6.2
SS-309	0	1	Arsenic	6.5	J	mg/kg	6.2
SS-310	0	1	Arsenic	9	J	mg/kg	6.2
SS-311	0	1	Arsenic	8	J	mg/kg	6.2

TABLE 2-11 (continued)
SURFACE SOIL CONCENTRATIONS EXCEEDING PRGs
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Location	Sample Depth (ft)		Parameter	Concentratio	qual	units	Soil PRG
	top	bottom					
SS-312	0	1	Arsenic	6.2		mg/kg	6.2
SS-312	0	1	Benzo(a)anthracene	1400	J	ug/kg	900
SS-312	0	1	Benzo(a)pyrene	1300	J	ug/kg	400
SS-312	0	1	Benzo(b)fluoranthene	1700	J	ug/kg	900
SS-312	0	1	Benzo(g,h,i)perylene	840	J	ug/kg	800
SS-312	0	1	Beryllium	0.43		mg/kg	0.4
SS-312	0	1	Chrysene	1400	J	ug/kg	400
SS-312	0	1	Manganese	490		mg/kg	390
SS-313	0	1	Benzo(a)pyrene	790	J	ug/kg	400
SS-313	0	1	Benzo(b)fluoranthene	1100	J	ug/kg	900
SS-313	0	1	Benzo(g,h,i)perylene	1000	J	ug/kg	800
SS-313	0	1	Chrysene	930	J	ug/kg	400
SS-313	0	1	Manganese	688		mg/kg	390
SS-314	0	1	Benzo(a)anthracene	9100		ug/kg	900
SS-314	0	1	Benzo(a)pyrene	7100		ug/kg	400
SS-314	0	1	Benzo(b)fluoranthene	9700		ug/kg	900
SS-314	0	1	Benzo(g,h,i)perylene	4300		ug/kg	800
SS-314	0	1	Benzo(k)fluoranthene	3500	J	ug/kg	900
SS-314	0	1	Chrysene	8100		ug/kg	400
SS-314	0	1	Indeno(1,2,3-cd)pyrene	4100		ug/kg	900
SS-315	0	1	Arsenic	6.9		mg/kg	6.2
SS-315	0	1	Benzo(a)anthracene	1100	J	ug/kg	900
SS-315	0	1	Benzo(a)pyrene	920	J	ug/kg	400
SS-315	0	1	Benzo(b)fluoranthene	1000	J	ug/kg	900
SS-315	0	1	Chrysene	910	J	ug/kg	400
SS-316	0	1	Beryllium	0.51		mg/kg	0.4
SS-320	0	1	Beryllium	0.41		mg/kg	0.4
SS-321	0	1	Beryllium	0.46		mg/kg	0.4
SS-323	0	1	Beryllium	0.42		mg/kg	0.4
SS-324	0	1	Arsenic	6.7	J	mg/kg	6.2
SS-325	0	1	Arsenic	10.4		mg/kg	6.2
SS-326	0	1	Arsenic	10.1		mg/kg	6.2
SS-326	0	1	Beryllium	0.47		mg/kg	0.4

TABLE 2-11 (continued)
SURFACE SOIL CONCENTRATIONS EXCEEDING PRGs
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Location	Sample Depth (ft)		Parameter	Concentratio	qual	units	Soil PRG
	top	bottom					
SS-327	0	1	Arsenic	7.7	J	mg/kg	6.2
SS-327	0	1	Benzo(a)anthracene	2500		ug/kg	900
SS-327	0	1	Benzo(a)pyrene	1900		ug/kg	400
SS-327	0	1	Benzo(b)fluoranthene	2400		ug/kg	900
SS-327	0	1	Benzo(g,h,i)perylene	1200	J	ug/kg	800
SS-327	0	1	Benzo(k)fluoranthene	930	J	ug/kg	900
SS-327	0	1	Chrysene	2300		ug/kg	400
SS-327	0	1	Indeno(1,2,3-cd)pyrene	1100	J	ug/kg	900
SS-328	0	1	Arsenic	10.3		mg/kg	6.2
SS-329	0	1	Arsenic	7.2		mg/kg	6.2
SS-330	0	1	Arsenic	8.7	J	mg/kg	6.2
SS-331	0	1	Arsenic	6.8	J	mg/kg	6.2
SS-332	0	1	Arsenic	7.9		mg/kg	6.2

Data qualifiers:
J = estimated

TABLE 2-12
SUBSURFACE SOIL CONCENTRATIONS EXCEEDING PRGs
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Location	Sample Depth (ft)		Parameter	Concentration	qual	units	Soil PRG
	top	bottom					
B-1	6	8	Arsenic	9.6	J*	mg/kg	6.2
B-1	6	8	Lead	529		mg/kg	150
B-2	2	4	Manganese	492	J*	mg/kg	390
B-2	6	8	Arsenic	8.6		mg/kg	6.2
B-2	6	8	Manganese	584	J*	mg/kg	390
B-2	8	10	Manganese	646	J*	mg/kg	390
B-3	6	8	Benzo(a)pyrene	660		ug/kg	400
B-3	6	8	Chrysene	770		ug/kg	400
B-5	4	6	Manganese	960	J*	mg/kg	390
B-7	4	6	Benzo(a)anthracene	1300	J	ug/kg	900
B-7	4	6	Benzo(a)pyrene	1000	J	ug/kg	400
B-7	4	6	Benzo(b)fluoranthene	1300	J	ug/kg	900
B-7	4	6	Chrysene	1000	J	ug/kg	400
B-7	6	8	Benzo(a)pyrene	490		ug/kg	400
B-7	6	8	Chrysene	540		ug/kg	400
B-8	8	10	Arsenic	6.4	J	mg/kg	6.2
B-8	8	10	Benzo(a)anthracene	2200		ug/kg	900
B-8	8	10	Benzo(a)pyrene	1700		ug/kg	400
B-8	8	10	Benzo(b)fluoranthene	2800		ug/kg	900
B-8	8	10	Chrysene	2100		ug/kg	400
B-8	8	10	Lead	189		mg/kg	150
B-8	8	10	Manganese	540	J	mg/kg	390
B-11	4	6	Arsenic	10	J	mg/kg	6.2
B-11	4	6	Lead	314		mg/kg	150
B-11	4	6	Manganese	627	J	mg/kg	390
B-12	2	4	Manganese	551	J	mg/kg	390
B-13	4	6	Arsenic	6.3	J	mg/kg	6.2
B-14	15	17	Arsenic	9.2		mg/kg	6.2
B-14	15	17	Chrysene	460	J	ug/kg	400
B-14	15	17	Lead	252		mg/kg	150

TABLE 2-12 (continued)
SUBSURFACE SOIL CONCENTRATIONS EXCEEDING PRGs
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Location	Sample Depth (ft)		Parameter	Concentration	qual	units	Soil PRG
	top	bottom					
B-15	10	12	Benzo(a)anthracene	1200		ug/kg	900
B-15	10	12	Benzo(a)pyrene	730		ug/kg	400
B-15	10	12	Benzo(b)fluoranthene	1300		ug/kg	900
B-15	10	12	Chrysene	1100		ug/kg	400
B-15	17	19	Benzo(a)anthracene	1300		ug/kg	900
B-15	17	19	Benzo(a)pyrene	760		ug/kg	400
B-15	17	19	Benzo(b)fluoranthene	1400		ug/kg	900
B-15	17	19	Chrysene	1100		ug/kg	400
B-15	17	19	Lead	292		mg/kg	150
B-15	17	19	Manganese	419	J	mg/kg	390
B-16	2	4	Benzo(a)anthracene	1200		ug/kg	900
B-16	2	4	Benzo(a)pyrene	1200		ug/kg	400
B-16	2	4	Benzo(b)fluoranthene	1900		ug/kg	900
B-16	2	4	Chrysene	1400		ug/kg	400
B-17	2	4	Beryllium	0.44	B	mg/kg	0.4
B-17	2	4	Manganese	477	J	mg/kg	390
MW-2	6	8	Arsenic	6.3	J*	mg/kg	6.2
MW-2	6	8	Benzo(a)anthracene	1800	J	ug/kg	900
MW-2	6	8	Benzo(a)pyrene	1600	J	ug/kg	400
MW-2	6	8	Benzo(b)fluoranthene	1400	J	ug/kg	900
MW-2	6	8	Benzo(k)fluoranthene	1400	J	ug/kg	900
MW-2	6	8	Chrysene	1700	J	ug/kg	400
MW-2	6	8	Lead	777	J*	mg/kg	150
MW-7	2	4	Arsenic	6.2	S	mg/kg	6.2
MW-7	2	4	Benzo(a)anthracene	1300		ug/kg	900
MW-7	2	4	Benzo(a)pyrene	1000		ug/kg	400
MW-7	2	4	Benzo(b)fluoranthene	1800		ug/kg	900
MW-7	2	4	Chrysene	1100		ug/kg	400
MW-7	2	4	Manganese	396	J	mg/kg	390
MW-11	2	4	Dieldrin	44	J	ug/kg	40
MW-11	2	4	Lead	554		mg/kg	150
MW-11	2	4	Manganese	401	J	mg/kg	390
MW-10	4	6	Arsenic	7		mg/kg	6.2
MW-10	4	6	Manganese	588	J	mg/kg	390

TABLE 2-12 (continued)
SUBSURFACE SOIL CONCENTRATIONS EXCEEDING PRGs
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Location	Sample Depth (ft) top	bottom	Parameter	Concentration	qual	units	Soil PRG
MW-101	6	8	Arsenic	9.3	J	mg/kg	6.2
MW-101	6	8	Chrysene	430		ug/kg	400
MW-101	6	8	Total Petroleum Hydrocarbons	1900	J	mg/kg	500
MW-102	6	8	Antimony	12	J	mg/kg	10
MW-102	6	8	Arsenic	53.6	J	mg/kg	6.2
MW-102	6	8	Benzo(a)anthracene	3400		ug/kg	900
MW-102	6	8	Benzo(a)pyrene	4000		ug/kg	400
MW-102	6	8	Benzo(b)fluoranthene	2700	J	ug/kg	900
MW-102	6	8	Benzo(g,h,i)perylene	1900	J	ug/kg	800
MW-102	6	8	Benzo(k)fluoranthene	2200	J	ug/kg	900
MW-102	6	8	Chrysene	3200	J	ug/kg	400
MW-102	6	8	Dibenz(a,h)anthracene	820	J	ug/kg	400
MW-102	6	8	Indeno(1,2,3-cd)pyrene	2300	J	ug/kg	900
MW-102	6	8	Lead	5400		mg/kg	150
MW-102	6	8	Manganese	562	J	mg/kg	390
MW-102	6	8	Total Petroleum Hydrocarbons	8200	J	mg/kg	500
TP2	2	2	Benzo(a)pyrene	460	J	ug/kg	400
TP2	2	2	Chrysene	580	J	ug/kg	400
TP3	3	3	Benzo(a)pyrene	630	J	ug/kg	400
TP3	3	3	Chrysene	640	J	ug/kg	400
TP3	7	7	Benzo(a)anthracene	2400	J	ug/kg	900
TP3	7	7	Benzo(a)pyrene	2900	J	ug/kg	400
TP3	7	7	Benzo(b)fluoranthene	2300	J	ug/kg	900
TP3	7	7	Benzo(g,h,i)perylene	1700	J	ug/kg	800
TP3	7	7	Benzo(k)fluoranthene	2500	J	ug/kg	900
TP3	7	7	Chrysene	2500	J	ug/kg	400
TP3	7	7	Dibenz(a,h)anthracene	780	J	ug/kg	400
TP3	7	7	Indeno(1,2,3-cd)pyrene	1700	J	ug/kg	900
TP3	7	7	Manganese	413	J	mg/kg	390
TP3	7	8	Arsenic	16.3	J	mg/kg	6.2
TP3	7	8	Chrysene	690	J	ug/kg	400
TP3	7	8	Lead	3090	J	mg/kg	150
TP-05	7	8	Arsenic	14.3	J	mg/kg	6.2
TP-05	7	8	Benzo(a)pyrene	690		ug/kg	400
TP-05	7	8	Chrysene	810		ug/kg	400
TP-05	7	8	Lead	540	J	mg/kg	150
TP-05	7	8	Manganese	698	J	mg/kg	390

TABLE 2-12 (continued)
SUBSURFACE SOIL CONCENTRATIONS EXCEEDING PRGs
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Location	Sample Depth (ft)		Parameter	Concentration	qual	units	Soil PRG
	top	bottom					
TP-06	6	7	Benzo(a)pyrene	500		ug/kg	400
TP-06	6	7	Chrysene	650		ug/kg	400
TP-06	6	7	Manganese	410	J	mg/kg	390
TP-07	7	8	Arsenic	6.2	J	mg/kg	6.2
TP-07	7	8	Manganese	417	J	mg/kg	390
TP-08	3	4	Arsenic	13.8	J	mg/kg	6.2
TP-08	3	4	Manganese	478	J	mg/kg	390
TP-11	5	6	Arsenic	8.3		mg/kg	6.2
TP-11	5	6	Chrysene	460		ug/kg	400
TP-11	5	6	Lead	563		mg/kg	150
TP-11	5	6	Total Petroleum Hydrocarbons	7500		mg/kg	500
TP12	3.5	4	Benzo(a)pyrene	660	J	ug/kg	400
TP12	3.5	4	Chrysene	730	J	ug/kg	400
TP12	3.5	4	Lead	475	J	mg/kg	150
TP-12	4	5	Lead	283	J	mg/kg	150
TP-12	4	5	Manganese	516	J	mg/kg	390
TP-12	4	5	Total Petroleum Hydrocarbons	4100	J	mg/kg	500
TP-13	6	7	Antimony	39.2	J	mg/kg	10
TP-13	6	7	Arsenic	18.3	J	mg/kg	6.2
TP-13	6	7	Lead	7820	J	mg/kg	150
TP-13	6	7	Manganese	898	J	mg/kg	390
TP-13	6	7	Total Petroleum Hydrocarbons	7400	J	mg/kg	500
TP-14	3	4	Arsenic	10.5		mg/kg	6.2
TP-14	3	4	Total Petroleum Hydrocarbons	4800		mg/kg	500
TP-15	5	6	Arsenic	9.9	J	mg/kg	6.2
TP-15	5	6	Benzo(a)anthracene	1200	J	ug/kg	900
TP-15	5	6	Benzo(a)pyrene	970	J	ug/kg	400
TP-15	5	6	Chrysene	1700	J	ug/kg	400
TP-15	5	6	Lead	766	J	mg/kg	150
TP-15	5	6	Total Petroleum Hydrocarbons	21000	J	mg/kg	500
TP-16	10	11	Arsenic	74.4	J	mg/kg	6.2
TP-16	10	11	Lead	3350		mg/kg	150
TP-16	10	11	Manganese	1110	J	mg/kg	390
TP-16	10	11	Total Petroleum Hydrocarbons	6400	J	mg/kg	500
TP-17	8	9	Arsenic	8.2		mg/kg	6.2

Data qualifiers:
J = estimated
B = greater than IDL but less than CRDL
S = value obtained using Method of Standard Addition
* = qualifier changed as a result of data validation

TABLE 2-13
SUMMARY OF SEDIMENT COPC SELECTION
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Parameter	COPC Based on Human Health Direct Contact	COPC Based on Human Health Shellfish Ingestion	COPC Based on Ecological Risk
SEMIVOLATILE ORGANIC COMPOUNDS			
2-Methylnaphthalene			X
Acenaphthylene			X
Benzo(a)anthracene	X	X	
Benzo(a)pyrene	X	X	X
Benzo(b)fluoranthene	X	X	
Benzo(g,h,i)perylene			X
Dibenzo(a,h)anthracene	X	X	
Indeno(1,2,3-cd)pyrene		X	X
PESTICIDES/PCBs			
Total PCB Congeners		X	
METALS			
Arsenic	X	X	
Copper			X
Cadmium		X	
Chromium		X	
Lead			X
Mercury		X	
Silver			X
Zinc			X

TABLE 2-14
SUMMARY OF SEDIMENT PRELIMINARY REMEDIATION GOALS
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Parameter	Shoreline Sediment	Nearshore and Offshore Marine Sediment	
	PRG Based on Human Health Direct Contact	PRG Based on Human Health Shellfish Ingestion	PRG Based on Ecological Risk
SEMIVOLATILE ORGANIC COMPOUNDS (ug/kg)			
2-Methylnaphthalene			135
Acenaphthylene			502
Benzo(a)anthracene	1338	34270	
Benzo(a)pyrene	134	9360	2929
Benzo(b)fluoranthene	1338	51296	
Benzo(g,h,i)perylene			3518
Dibenzo(a,h)anthracene	134	6742	
Indeno(1,2,3-cd)pyrene		72519	4266
PESTICIDES/PCBs (ug/kg)			
Total PCB Congeners		175	
METALS (mg/kg)			
Arsenic	6.2	82	
Cadmium		10	
Chromium		3708	
Mercury		2.3	

TABLE 2-15
SELECTION OF SEDIMENT COCs
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Parameter	Units	Sediment PRG	Maximum Detected	Selected as COC?
SHORELINE SEDIMENT				
Benzo(a)anthracene	ug/kg	1338	1900 J	Yes
Benzo(a)pyrene	ug/kg	134	1400 J	Yes
Benzo(b)fluoranthene	ug/kg	1338	1700 J	Yes
Dibenzo(a,h)anthracene	ug/kg	134	290 J	Yes
Arsenic	mg/kg	6.2	7.1	Yes
NEARSHORE SEDIMENT				
2-Methylnaphthalene	ug/kg	135	330 J	Yes
Acenaphthylene	ug/kg	502	509	Yes
Benzo(a)anthracene	ug/kg	34270	9300	No
Benzo(a)pyrene	ug/kg	2929	4830	Yes
Benzo(b)fluoranthene	ug/kg	51296	25000	No
Dibenzo(a,h)anthracene	ug/kg	6742	3410 J	No
Benzo(g,h,i)perylene	ug/kg	3518	5990 J	Yes
Indeno(1,2,3-cd)pyrene	ug/kg	4266	7390 J	Yes
Total PCB Congeners	ug/kg	175	51.6	No
Arsenic	mg/kg	82	8 J	No
Cadmium	mg/kg	10	0.31	No
Chromium	mg/kg	3708	43.1	No
Mercury	mg/kg	2.3	0.371	No
OFFSHORE SEDIMENT				
2-Methylnaphthalene	ug/kg	135	210	Yes
Acenaphthylene	ug/kg	502	156 J	No
Benzo(a)anthracene	ug/kg	34270	1200	No
Benzo(a)pyrene	ug/kg	2929	1420	No
Benzo(b)fluoranthene	ug/kg	51296	2730	No
Dibenzo(a,h)anthracene	ug/kg	6742	280 J	No
Benzo(g,h,i)perylene	ug/kg	3518	899	No
Indeno(1,2,3-cd)pyrene	ug/kg	4266	785	No
Total PCB Congeners	ug/kg	175	95.5	No
Arsenic	mg/kg	82	8.5 J	No
Cadmium	mg/kg	10	0.8	No
Chromium	mg/kg	3708	73.7	No
Mercury	mg/kg	2.3	1.36	No

Data Qualifiers:
J = estimated

TABLE 2-16
SEDIMENT CONCENTRATIONS EXCEEDING PRGs
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Location	Sample Depth (ft) top	bottom	Parameter	Concentration	qual	units	Sediment PRG
SHORELINE SEDIMENT							
SSD-333	0	0.5	Benzo(a)pyrene	910	J	ug/kg	134
SSD-334	0	0.5	Dibenzo(a,h)anthracene	290	J	ug/kg	134
SSD-335	0	0.5	Benzo(a)anthracene	1800	J	ug/kg	1338
SSD-335	0	0.5	Benzo(a)pyrene	1300	J	ug/kg	134
SSD-335	0	0.5	Benzo(b)fluoranthene	1700	J	ug/kg	1338
SSD-336	0	0.5	Benzo(a)pyrene	520	J	ug/kg	134
SSD-337	0	0.5	Arsenic	7.1		mg/kg	6.2
NEARSHORE SEDIMENT							
OFF-3	0	0.5	Benzo(a)pyrene	3450	J	ug/kg	2929
OFF-3	0	0.5	Benzo(g,h,i)perylene	5370	J	ug/kg	3518
OFF-3	0	0.5	Indeno(1,2,3-cd)pyrene	6560	J	ug/kg	4266
OFF-5	0	0.5	2-Methylnaphthalene	330	J	ug/kg	135
OFF-5	0	0.5	Acenaphthylene	509		ug/kg	502
OFF-5	0	0.5	Benzo(a)pyrene	4830		ug/kg	2929
OFF-5	0	0.5	Benzo(g,h,i)perylene	5990	J	ug/kg	3518
OFF-5	0	0.5	Indeno(1,2,3-cd)pyrene	7390		ug/kg	4266
OFF-6	0	0.5	2-Methylnaphthalene	170	J	ug/kg	135
OFF-6	0.7	0.8	2-Methylnaphthalene	280		ug/kg	135
OFFSHORE SEDIMENT							
OFF-18	1.6	1.8	2-Methylnaphthalene	210		ug/kg	135

Data qualifiers:
J = estimated

TABLE 3-1
IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTION	DESCRIPTION OF PROCESS OPTION	SCREENING COMMENTS
No Action	No Action	Not Applicable	No Action	Retained. Used as baseline for comparison with other options as required by NCP.
Limited Action	Institutional Controls	Deed Restrictions	Administrative action used to restrict future site activities on individual properties. Restrictions would prevent activities such as excavation or residential development.	Retained for protection of human health. Not protective of ecological receptors or groundwater. Does not allow unrestricted residential reuse.
	Access Restrictions	Fencing	Barrier erected to restrict access to contaminated properties.	Retained for protection of human health. Not protective of ecological receptors or groundwater. Does not allow unrestricted residential reuse.
		Post Signs	Post "No Trespassing" or hazard warning signs.	Retained for protection of human health. Not protective of ecological receptors or groundwater. Does not allow unrestricted residential reuse.
	Long-Term Monitoring	Monitoring	Periodic monitoring events to determine whether the soil is a continuing source of contamination.	Retained to ensure effectiveness of any remedial action taken. As a stand-alone option, does not allow unrestricted residential reuse.
Containment	Horizontal Barriers	Impermeable Cap	Asphalt, concrete, geosynthetics, or multi-media materials are used to form an impermeable barrier to prevent direct contact with contaminated soil and to minimize leaching of contaminants from soil to groundwater.	Retained for protection of human health and the environment. Does not allow unrestricted residential reuse because of contaminants left in the subsurface.
		Permeable Cover	Soil, crushed stone, geosynthetics and vegetative cover used to prevent direct contact with contaminated soil and minimize erosion and surface migration of contaminated soil.	Retained for protection of human health. Does not allow unrestricted residential reuse because of contaminants left in the subsurface..

TABLE 3-1 (cont'd)
IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES
AND PROCESS OPTIONS FOR SOIL
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTION	DESCRIPTION OF PROCESS OPTION	SCREENING COMMENTS
Removal	Excavation	Bulk Excavation	Use of common construction equipment to remove contaminated soil. Able to address all soil above the groundwater table.	Retained for protection of human health and protection of ecological receptors. Effective for all site contaminants.
Disposal	Disposal	Off-Base Landfill	Transport and disposal of untreated soil to an approved off-base landfill.	Retained as potentially effective. Must be reviewed in concert with excavation technology.
		On-Base Landfill	Transport and disposal of untreated soil to a new or existing on-base landfill.	Eliminated. No landfill currently available. Extensive permitting for a new landfill.
		On-Site Backfill	Backfill of treated soil to the excavated areas. Clean fill from off site can also be used.	Retained. Must be reviewed in concert with excavation technology and possibly treatment technology.
		Treatment, Storage, or Disposal Facility (TSDF)	Transport and disposal of untreated soil to an approved off-base TSDF.	Retained as potentially effective. Must be reviewed in concert with excavation technology.
Treatment	Immobilization	Solidification/ Stabilization	Soil mixing equipment used to mix reagents with contaminated soil to physically and/or chemically decrease the mobility of contaminants. Potential reagents include cement, pozzolanic material, thermoplastics, polymers and asphalt. Treatment may be done in situ or ex situ.	Retained as potentially effective. Demonstrated to be effective with metals and other inorganic and organic contaminants.
		Microencapsul-ation	Contaminated material is encapsulated by containers or inert and impervious coatings that will minimize leaching. Treatment will be done ex situ.	Eliminated. Effectively isolates all site contaminants but no treatment occurs. Not feasible in cases involving large quantities of contaminated material.

Eliminated process option (see screening comment)

TABLE 3-1 (cont'd)
IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES
AND PROCESS OPTIONS FOR SOIL
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTION	DESCRIPTION OF PROCESS OPTION	SCREENING COMMENTS
Treatment (Cont'd)	Thermal Treatment	Incineration	Destruction of organic contaminants by subjecting them to high temperatures under controlled conditions in a combustion chamber. Treatment would be done ex situ.	Retained. Effective for organic contaminants but not effective for inorganic contaminants. Not easily undertaken on base.
		Pyrolysis	Chemical decomposition of organic contaminants by heating the material in the absence of oxygen. Treatment would be done ex situ.	Eliminated. Effective for organic contaminants but not effective for inorganic contaminants. Not easily undertaken on base. Not readily available.
		Low-Temperature Thermal Stripping	Air, heat and mechanical agitation are used to volatilize organic contaminants from soil into a vapor stream. Vapor is usually further treated. Treatment would be done ex situ.	Retained for potential use on site. Effective for organic contaminants but not effective for inorganic contaminants. May be used as part of a treatment train.
		Supercritical Water Oxidation	Contaminated soil is exposed to water in a high temperature, high pressure environment. Under such conditions, organic substances are oxidized.	Eliminated. Effective for some organic contaminants (SVOCs) but not effective for inorganic contaminants.
		Vitrification	Melting of contaminated material to volatilize or pyrolyze organics and entrain inorganics in a stable vitreous residual. Treatment may be done in situ or ex situ.	Retained. Potentially effective for all site contaminants.

Eliminated process option (see screening comment)

TABLE 3-1 (cont'd)
IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES
AND PROCESS OPTIONS FOR SOIL
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTION	DESCRIPTION OF PROCESS OPTION	SCREENING COMMENTS
Treatment (Cont'd)	Physical Treatment	Soil Flushing	Contaminants sorbed to soil are mobilized or dissolved in an aqueous flushing solution in situ. The flushing solution is then extracted from the subsurface and treated. Flushing solution may be augmented by chemicals that increase the mobilization or dissolution of organics and some heavy metals from the soil. Treatment would be done in situ.	Retained. Potentially effective for organics and some inorganics, but repeated flushing may be necessary. Difficult to ensure capture of flushing solution due to shallow water table. More difficult in cases involving multiple types of contaminants.
		Soil Washing	Process reduces the amount of contaminated material by two means. Finer particles, which contain the bulk of contaminants, are separated from more coarse material. Contaminants sorbed to soil are dissolved in an aqueous washing solution. The wash water may be augmented by chemicals which increase the leaching of organics and some heavy metals from the soil. Treatment would be done ex situ.	Retained. Potentially effective for organics and some inorganics, but multiple washing steps may be necessary. Washing solution would need to be recovered and treated. More difficult in cases involving multiple types of contaminants. May be used as part of a "treatment train." Can be done on or off base.
		Liquefied Gas Solvent Extraction	Liquefied gas solvents, such as propane, are used to extract organics from soil. Treatment would be done ex situ.	Eliminated. Technology is not commercially available and effectiveness is not well established. Cost information not available.

Eliminated process option (see screening comment)

TABLE 3-1 (cont'd)
IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES
AND PROCESS OPTIONS FOR SOIL
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTION	DESCRIPTION OF PROCESS OPTION	SCREENING COMMENTS
Treatment (Cont'd)	Physical Treatment	Soil Vapor Extraction	In situ technology in which vacuum blowers and extraction wells are used to strip volatile organic compounds from unsaturated soil. Treatment would be done in situ.	Eliminated. Only effective for volatile organic compounds (VOCs) in non-saturated soil. Not effective for SVOCs or inorganics.
		Electrokinetics	Electrodes are used to manipulate soil conditions to recover or destroy organics and metals. Treatment would be done in situ.	Eliminated. Potentially effective for organic and some inorganics. Less effective in cases involving shallow water table.
	Chemical Treatment	Chemical Dechlorination	Chlorine atoms are stripped from chlorinated contaminants through chemical reactions to produce less toxic byproducts. These byproducts are generally more amenable to biodegradation. Treatment will be done ex situ.	Eliminated. Only addresses chlorinated compounds. Not effective for non-chlorinated organics (SVOCs) or inorganics.
		Solvent Extraction	Chemical desorption and dissolution of organic and some inorganic contaminants by washing soil with a solvent solution. Treatment would be done ex situ.	Retained. May not be effective for wastes with multiple contaminant types. Solvent solution would need to be recovered and treated.
	Biological Treatment	Aerobic Biodegradation	Microorganisms degrade organic contaminants to carbon dioxide and water. Oxygen is used as an electron acceptor in the degradation process. Treatment would be done ex situ.	Retained, but effectiveness is limited to certain organic contaminants. Inorganics are generally not amenable to biological treatment.

Eliminated process option (see screening comment)

TABLE 3-1 (cont'd)
IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES
AND PROCESS OPTIONS FOR SOIL
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTION	DESCRIPTION OF PROCESS OPTION	SCREENING COMMENTS
Treatment (Cont'd)	Biological Treatment (Cont'd)	Anaerobic Biodegradation	An electron acceptor other than oxygen is used in the process in which microorganisms degrade organic contaminants. Treatment may be done in situ or ex situ.	Eliminated. While this technology is commonly used in the wastewater treatment industry to effectively treat solid organic waste, applications in hazardous waste treatment are limited. Effectiveness is limited to certain organic contaminants. Inorganics are generally not amenable to biological treatment.
		Phytoremedia-tion	Plants are used to naturally remediate contaminants via three mechanisms: direct uptake and accumulation of contaminants in plant tissue, release of enzymes that stimulate microbial activity and biochemical transformation, and enhancement of mineralization in plants' roots. Effective for destruction of some VOCs and SVOCs and effective for absorbing many inorganics. Treatment would be done in situ.	Eliminated. Potentially effective for metals, SVOCs. Root systems of plants may not extend deep enough to remediate contaminants at depth. Plants would require harvesting, proper disposal, and replanting.

Notes:

Eliminated process option (see screening comment)

TABLE 3-2
REPRESENTATIVE PROCESS OPTIONS FOR SOIL
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION (GRA)	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTION	REPRESENTATIVE PROCESS OPTION	RATIONALE
No Action	No Action	Not Applicable	No Action	Required
Limited Action	Long-Term Monitoring	Monitoring	Monitoring	Used for 5-year reviews to ensure remediation is complete
Removal	Excavation	Bulk Excavation	Bulk Excavation	Most effective means of removal
Disposal	Disposal	Off-Base Landfill	On-Site Backfill TSDF	Treated soil would have concentrations below PRGs Excavated soil may require treatment prior to disposal to meet LDRs
		On-Site Backfill		
		TSDF		
Treatment	Immobilization	Solidification/ Stabilization	LTTS Soil Washing	Effectively removes PAHs Addresses inorganic compounds
	Thermal Treatment	Low Temperature Thermal Stripping (LTTS)		
	Physical/Chemical Treatment	Soil Washing		
		Solvent Extraction		

TABLE 3-3
IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SEDIMENT
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTION	DESCRIPTION OF PROCESS OPTION	SCREENING COMMENTS
No Action	None	Not Applicable	No activities conducted to address contamination.	Retained. Use for baseline comparison, as required by NCP.
Limited Action	Institutional Controls	Use Restrictions	Implementation of administrative action to restrict recreational use.	Retained for protection of human health. Not protective of ecological receptors.
	Access Restrictions	Fencing/Signs/ Buoys/Enforcement	Placement of fencing and buoys, and posting of warning signs to inform public of use restrictions and to deter access.	Retained for protection of human health. Not protective of ecological receptors.
	Long-Term Monitoring	Sediment Monitoring	Periodic sediment sampling and analysis to assess potential contaminant migration. Provides information to evaluate existing exposure risks.	Retained as potentially applicable. Can be combined with other GRAs for assessment of existing site conditions and exposure risks.
Containment	Permeable Cap	Natural Cap	Placement of natural materials (silts, fill, sand, gravel, and/or crushed stone) and stone/rock bedding over contaminated sediment to prevent direct contact and minimize erosion/ contaminant migration	Eliminated for affected areas because it would significantly alter bottom elevations and limit future access to the harbor.
		Multi-Media Cap	Placement of multi-media cap (natural materials, geotextile, and armament material) over contaminated sediment. Provides greater protection than does natural cap, especially in high energy areas.	Eliminated for affected areas because it would significantly alter bottom elevations and limit future access to the harbor.

TABLE 3-3 (cont'd)
IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES
AND PROCESS OPTIONS FOR SEDIMENT
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTION	DESCRIPTION OF PROCESS OPTION	SCREENING COMMENTS
Containment (Cont'd)	Impermeable Cap	Natural (Clay) Cap	Placement of natural materials (clay) and stone/rock bedding over contaminated sediment to prevent direct contact and minimize erosion and contaminant migration.	Eliminated. Impermeable (low permeability and transmissivity) cap not appropriate for underwater application. Any water movement and gas formation under the cap could become trapped and stress the integrity of the cap. Placement of cap would cause excessive turbulence in water column because of low settleability of fine clay particles.
		Multi-Media Cap	Placement of multi-media cap (natural material, geomembrane, and bedding material) over contaminated sediment to prevent direct contact and minimize erosion and contaminant migration.	Eliminated. Impermeable (low permeability and transmissivity) cap not appropriate for underwater application. Any water movement and gas formation under the cap could become trapped and stress the integrity of the cap. Placement of the geomembrane would be difficult; it would tend to float on the water surface.
Removal	Excavation/Dredging	Mechanical Excavation/ Dredging	Use of mechanical force to dislodge contaminated sediment. Includes clamshell, dipper, bucket ladder, or dragline dredges or conventional earthmoving equipment. Also applicable for removal of debris.	Retained. Potentially applicable. Extensive erosion control measures required. Particularly useful in areas where large rocks or debris is present.

TABLE 3-3 (c nt'd)
IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES
AND PROCESS OPTIONS FOR SEDIMENT
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTION	DESCRIPTION OF PROCESS OPTION	SCREENING COMMENTS
Removal (Cont'd)	Excavation/Dredging (Cont'd)	Hydraulic Dredging	Use of centrifugal force to remove contaminated sediment in a slurry. Includes suction, cutterhead, and/or portable hydraulic dredges.	Retained. Potentially applicable. Less extensive erosion control measures required. Dewatering of slurry is required.
		Pneumatic Dredging	Use of compressed air and/or hydraulic pressure to remove contaminated sediment in a slurry. Includes Airlift, Pneuma, and Oozer dredges.	Eliminated. Not widely available in USA.
Disposal	On-Site/On-Base Disposal	Confined Aquatic Disposal	Disposal of dredged sediment in deep water disposal site.	Eliminated. Must be combined with containment to prevent marine biota exposure risks. No known disposal area available.
		Upland On-Site or On-Base Disposal	Disposal of dredged sediment at on-site location adjacent to McAllister Point Landfill cap or at other on-base location.	Eliminated. Sufficient space not available at on-base disposal locations.
	Off-Base Disposal	Off-Base Landfill or TSDF	Transport and disposal of dredged sediment at off-base landfill or TSDF licensed to accept the contaminant types detected.	Retained. Potentially applicable.
Treatment (In-Situ)	Chemical Treatment	Neutralization/ Precipitation/ Oxidation	Injection of treatment reagents into contaminated media to convert the contaminants to a less toxic form through chemical reactions. Reagents are typically chosen for treatment of specific contaminants. Toxic byproducts may form.	Eliminated. Containment of treated area and/or diversion of water required for the duration of the treatment. Difficult to ensure treatment reagents are thoroughly mixed with contaminated sediment. Reagents are not typically suited for treatment of all contaminants present.

TABLE 3-3 (cont'd)
IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES
AND PROCESS OPTIONS FOR SEDIMENT
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTION	DESCRIPTION OF PROCESS OPTION	SCREENING COMMENTS
Treatment (In-Situ) (Cont'd)	Biological Treatment	Aerobic/Anaerobic Treatment	Biodegradation of contaminants by injection of nutrients and/or organisms into contaminated media. Effective for destruction of VOCs and SVOCs. Ineffective for inorganics.	Eliminated. Containment of treated area and/or diversion of water required. Difficult to ensure complete mixing of nutrients. Not effective in treating all site contaminants. Lack of nutrients and low temperature may impede degradation process.
		Phytoremediation	Use of plants to naturally remediate contaminants via three mechanisms: direct uptake and accumulation in plant tissue, release of enzymes that stimulate microbial activity and biochemical transformation, and enhancement of mineralization in plants' roots. Effective for destruction of some VOCs and SVOCs and effective for absorbing many inorganics.	Eliminated. Root systems of plants may not extend deep enough to remediate contaminants at depth. Wave action may impede adequate rooting of plants. Not effective in treating all site contaminants. Inorganics accumulate in plants, so plants would require harvesting and replanting.
	Physical Treatment	Solidification/ Stabilization	Immobilization of sediment and contaminants by treatment with reagents to solidify/fix them. Most suitable for treatment of inorganics in a controlled environment.	Eliminated. Not feasible in area where solidified mass cannot be tolerated.

TABLE 3-3 (cont'd)
IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES
AND PROCESS OPTIONS FOR SEDIMENT
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTION	DESCRIPTION OF PROCESS OPTION	SCREENING COMMENTS
Treatment (Ex-Situ; On-Site/On-Base)	Thermal Treatment	Thermal Desorption	Volatilization of organic contaminants by an externally-fired rotary dryer and removal as a condensed liquid. Proven for treatment of VOCs. Limited applicability to remove SVOCs and PAHs. Not applicable for inorganics or contaminants with low vapor pressures.	Eliminated. Does not address inorganic contaminants. Dredged sediment may require significant dewatering prior to treatment. Would require pilot testing.
		Infrared Incineration	Pyrolysis of organic contaminants using near infrared radiation. Not effective for treating inorganics. Most applicable to low BTU soils and homogeneous waste streams.	Eliminated. Does not address inorganic contaminants. Inefficient for material with high water content. Not cost effective; simpler processes available to treat contaminants.
		Vitrification	Contaminated sediment is melted into a glassy, crystalline monolith using electric current. Applicable to treatment of both inorganics and organics.	Eliminated. Inefficient for high water content material. Performance may be affected by high concentrations of organics.
	Chemical/Physical Treatment	Soil Washing	Particle-size separation process to reduce volume of materials requiring aggressive treatment. Fraction containing fines is separated from coarse by washing process; fines containing majority of contaminants require additional treatment. Contaminant removal using extractant solution. Solutions used include water, surfactants, acids, bases, and/or oxidizing or reducing agents. Can remove both organics and inorganics in multiple extraction process.	Eliminated. Only suitable for materials with low fines content. Would require numerous extraction processes to remove the various contaminants identified in site sediments. Residual solvents and surfactants may be difficult to remove from treated sediment. Not cost effective; simpler processes available to treat contaminants.

TABLE 3-3 (cont'd)
IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES
AND PROCESS OPTIONS FOR SEDIMENT
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTION	DESCRIPTION OF PROCESS OPTION	SCREENING COMMENTS
Treatment (Ex-Situ; On-Site/On-Base) (Cont'd)	Chemical/Physical Treatment (Cont'd)	Solvent Extraction	Preferential dissolution of contaminants from sediment into solvent. Most effective for organic contaminants. Can treat sediments in slurry form. Solvent requires further processing or disposal. Treated material requires dewatering prior to disposal.	Eliminated. Residual solvents may be difficult to remove from treated sediment. Requires bench-scale testing. Not cost effective; simpler processes available to treat contaminants.
		Wet Air Oxidation	Oxidation of organic and inorganic contaminants in an aqueous reactor using molecular oxygen at elevated temperatures/ pressures. Effectiveness proportional to sediment particle size; less effective on large grain sizes and heterogeneous waste streams.	Eliminated. Most effective on concentrated waste streams.
		Solidification/ Stabilization	Mixing of sediment with Portland cement, siliceous materials, lime, and/or proprietary agents, to form a chemically stable matrix of limited permeability. Most suitable for immobilizing inorganics. Not proven effective for many organic contaminants. May be used for bulking agents to reduce free liquids in dewatered sediment.	Retained. Potentially applicable for treatment of inorganics and/or for use as a bulking agent. Space is available on site for treatment.

TABLE 3-3 (cont'd)
IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES
AND PROCESS OPTIONS FOR SEDIMENT
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTION	DESCRIPTION OF PROCESS OPTION	SCREENING COMMENTS
Treatment (Ex-Situ; On-Site/On-Base) (Cont'd)	Chemical/Physical Treatment (Cont'd)	Acid Extraction	Washing of sediment with acid, and processing of effluent through a membrane or ion exchange system. Most effective for inorganics. Not effective for organic wastes or waste materials.	Eliminated. Similar to solvent extraction, but for treatment of inorganics only. Better suited for material with low fines content. Requires bench-scale testing. Not cost effective; simpler processes available to treat contaminants.
		Dechlorination	Stripping of chlorine atoms from hazardous halogenated hydrocarbons using alkali metals or alkali metal/polyethylene glycol. Effective for destruction of chlorinated organics, dioxin, and PCBs. Ineffective for treatment of inorganics.	Eliminated. Not effective for treatment of PAHs, or metals.
	Biological Treatment	Slurry Phase Biodegradation	Preparation of dredged sediment into a pumpable slurry to which a nutrient-rich bacteria is added for degradation in a reactor system. Most effective for organic contaminants. Not effective for inorganics. Limited effectiveness for PAHs. Treated material requires dewatering prior to disposal.	Eliminated. Not effective in treating site contaminants.
		Landfarming	Aerobic biodegradation of contaminants in sediment applied to the ground surface and amended with nutrients. Effective for destruction of VOCs. Ineffective for inorganics. Limited effectiveness for PAHs.	Eliminated. Not effective in treating site contaminants.

TABLE 3-3 (cont'd)
IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES
AND PROCESS OPTIONS FOR SEDIMENT
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTION	DESCRIPTION OF PROCESS OPTION	SCREENING COMMENTS
Treatment (Ex-Situ; Off-Base) (Cont'd)	Biological Treatment (cont'd)	Phytoremediation	Use of plants to naturally remediate contaminants via three mechanisms: direct uptake and accumulation in plant tissue, release of enzymes that stimulate microbial activity and biochemical transformation, and enhancement of mineralization in plants' roots. Effective for destruction of some VOCs and SVOCs and effective for absorbing many inorganics.	Eliminated. Not effective in treating all site contaminants. Would require harvesting of plants and subsequent treatment/disposal and replanting.

Eliminated process option (see screening comment)

TABLE 3-4
REPRESENTATIVE PROCESS OPTIONS FOR SEDIMENT
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING TRAINING AREA, NAVSTA NEWPORT
NEWPORT, RHODE ISLAND

GENERAL RESPONSE ACTION (GRA)	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTION	REPRESENTATIVE PROCESS OPTION	RATIONALE
No Action	No Action	Not Applicable	No Action	Required
Limited Action	Institutional Controls	Use Restrictions	Use Restrictions	Used to prevent exposure.
	Access Restrictions	Fencing/Signs/ Buoys/Enforcement		
	Long-Term Monitoring	Sediment Monitoring	Sediment Monitoring	Used for 5-year reviews
Removal	Excavation/ Dredging	Mechanical Excavation/ Dredging	Mechanical Excavation/ Dredging	Most effective means of removal
Disposal	Off-Base Disposal	Off-Base Landfill or TSDF	Off-Base Landfill or TSDF	Most effective means of disposal
Treatment (ex situ; on site)	Chemical/Physical Treatment	Solidification/ Stabilization	Solidification/Stabilization	Effectively immobilizes contaminants

TABLE 4-1
SUMMARY OF SOIL ALTERNATIVES
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Alternative	Alternative Description
Alternative 1: No Action	• 5-year review
Alternative 2: Removal, Ex situ Treatment, Backfill	• PDI • Excavation of contaminated soil using trackhoe • Confirmatory sampling for contaminant removal • Treatment of excavated soils to levels below PRGs using LTTS and soil washing • Backfill excavation with treated soil • Establish vegetative cover.
Alternative 3: Removal, Disposal, Backfill	• PDI • Excavation of contaminated soil using trackhoe • Confirmatory sampling for contaminant removal • Disposal of contaminated soil at TSDF or landfill • Treatment at TSDF if needed • Backfill excavation with clean fill • Establish vegetative cover.

TABLE 4-2
SUMMARY OF DETAILED ANALYSES OF ALTERNATIVES FOR SOIL REMEDIATION
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Criteria	Alternative 1 No Action	Alternative 2 Removal, Ex situ Treatment, Backfill	Alternative 3 Removal and Disposal
THRESHOLD CRITERIA			
Overall Protection of Human Health and the Environment			
Does Alternative Protect Current and Future Users?	No	Yes	Yes
Are Environmental Risks Reduced by Alternative?	No	Yes	Yes
Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)			
Compliance with Chemical-Specific ARARs	No	Yes	Yes
Compliance with Location-Specific ARARs	Not applicable	Yes	Yes
Compliance with Action-Specific ARARs	Not applicable	Yes	Yes
Compliance with Other Criteria	No	Yes	Yes
BALANCING CRITERIA			
Long-Term Effectiveness and Permanence			
Does Alternative Reduce Residual Risk?	No	Yes	Yes
Does Alternative Provide Adequate Remedial Controls?	No	Yes	Yes
Need a 5-Year Review?	Yes	No	No
Need for Long-Term Management?	Yes	No	No
Reduction of Toxicity, Mobility, or Volume through Treatment			
Treatment Process Used	None	Volatilization, liquid dissoluton	None
Soil Treated	No	Yes	Only if required (minimal volume(
Reduction in Toxicity, Mobility, or Volume	None	Toxicity, mobility, and volume – reduced	Mobility – reduced
Type and Quantity of Residuals Remaining after Treatment	No treatment so no residuals	Solid and liquid residuals; low quantity	No residuals
Short-Term Effectiveness			
Risks to the Community during Remedial Action	No treatment so no construction risks	Minimal	Minimal
Risk to Workers during Remedial Action	No treatment so no construction risks	Some risks; easily controlled	Some risks; easily controlled
Environmental Impacts	No treatment so no additional impacts	Minimal	Minimal
Time until Remedial Action Objectives Achieved	No remedial action; time >30 years.	Estimated 6 to 8 months	Estimated 4 to 6 months

TABLE 4-2 (c nt'd)
SUMMARY OF DETAILED ANALYSES OF ALTERNATIVES FOR SOIL REMEDIATION
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Criteria	Alternative 1 No Action	Alternative 2 Removal, Ex situ Treatment, Backfill	Alternative 3 Removal and Disposal
Implementability			
Constructable	No construction activities	Yes	Yes
Reliability of Technology	No technology implemented	Reliable	Reliable
Ease of Undertaking Additional Remedial Action, if Necessary	Easily implementable	High	High
Ability to Monitor Effectiveness of Remedy	Not applicable	Yes	Yes
Ability to Coordinate with Other Agencies	Easy	Moderately easy	Moderately easy
Availability of Off-Site Disposal Services	None required	Available	Available
Availability of Equipment and Specialists	None required	Available	Available
Availability of Prospective Technologies	None required	Available	Available
Cost[a,b]			
Capital Costs	$0	$10,919,000	$7,700,000
Total Annual Operations and Maintenance (O&M)	$0	$30,000	$30,000
5-Year Review Costs	$22,000	$22,000	$22,000
Total Present Worth Project Costs	$46,000	$10,975,000	$7,757,000

[a]Detailed cost estimates are presented in Appendix D.
[b]These costs have been rounded off to the nearest $1,000.

TABLE 4-3
ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs
SOIL ALTERNATIVE 1: NO ACTION
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
EPA Human Health Assessment Cancer Slope Factors (CSFs).		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media.
EPA Risk Reference Doses (RfDs)		To Be Considered	Toxicity values for evaluating non-carcinogenic hazards from exposures to contamination.	Used to characterize human health risks due to non-carcinogens in site media.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
State of Rhode Island Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases (Short Title: Remediation Regulations)	DEM-DSR-01-93, as amended August 1996	Relevant and Appropriate	The Remediation Regulations ensure consistency and certainty in the process of establishing clean up objectives for soil and groundwater. They include specific criteria for remediation of soil.	These standards are relevant and appropriate and were used in developing soil PRGs. This alternative fails to meet this standard because soil exceeding PRGs is not addressed.

TABLE 4-4
ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
SOIL ALTERNATIVE 1: NO ACTION
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
There are no federal location-specific ARARS.				

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
There are no state location-specific ARARs				

TABLE 4-5
ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
SOIL ALTERNATIVE 1: NO ACTION
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT,NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
There are no federal action-specific ARARs.				

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
There are no state action-specific ARARs.				

TABLE 4-6
ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs
SOIL ALTERNATIVE 2: REMOVAL, EX SITU TREATMENT, BACKFILL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT,NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
EPA Human Health Assessment Cancer Slope Factors (CSFs).		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media.
EPA Risk Reference Doses (RfDs)		To Be Considered	Toxicity values for evaluating non-carcinogenic hazards from exposures to contamination.	Used to characterize human health risks due to non-carcinogens in site media.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
State of Rhode Island Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases (Short Title: Remediation Regulations)	DEM-DSR-01-93, as amended August 1996	Relevant and Appropriate	The Remediation Regulations ensure consistency and certainty in the process of establishing clean up objectives for soil and groundwater. The regulations contain remediation criteria for contaminated soil.	These standards are relevant and appropriate and were used to develop soil PRGs. This alternative meets this standard because soil exceeding PRGs is treated to meet desired goals.

TABLE 4-7
ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
SOIL ALTERNATIVE 2: REMOVAL, EX SITU TREATMENT, BACKFILL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Coastal Zone Management Act	16 USC Parts 1451 *et. seq.*	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The site is located next to a coastal zone management area, therefore, applicable coastal zone management requirements need to be addressed.
Executive Order 11988 RE: Floodplain Management	40 CFR Part 6, Appendix A	Applicable	The Order requires Federal agencies to evaluate the potential effects of actions it may take within a designated 100-year floodplain of a waterway to avoid adversely impacting floodplains wherever possible.	Excavation next to bay may impact floodplain. The potential for restoring and preserving floodplains so that their natural and beneficial values can be realized will be considered and incorporated into any plan or action wherever feasible. No long-term impact to the floodplain is anticipated.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Coastal Resources Management	RIGL 46-23-1 *et seq.*	Applicable	Sets standards for management and protection of coastal resources.	The entire site is located in a coastal resource management area, therefore, applicable coastal resource management requirements need to be addressed.

TABLE 4-8
ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
SOIL ALTERNATIVE 2: REMOVAL, EX SITU TREATMENT, BACKFILL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Clean Air Act (CAA), National Emission Standards for Hazardous Air Pollutants (NESHAPS)	42 USC 7411, 7412; 40 CFR Part 61	Applicable	NESHAPS are a set of emission standards for specific chemicals, including naphthalene, arsenic, cadmium, chromium, lead, mercury, nickel, PCBs, DDE, and hexachlorobenzene. Certain activities are regulated including site remediation.	Monitoring of air emissions from LTTS will be used to assess compliance with these standards if threshold levels are reached. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Hazardous Waste Management - Standards for Treatment, Storage, and Disposal Facilities	RIGL 23-19.1 *et seq.*; CRIR 12-030-003(10.00)	Applicable	Outlines specifications and standards for design, operation, closure, and monitoring of performance for hazardous waste storage, treatment, and disposal facilities. The standards of 40 CFR Part 264 are incorporated by reference.	Treated soil will be tested to meet all requirement before used as backfill.
Clean Air Act - Fugitive Dust Control	RIGL 23-23 *et seq.*; CRIR 12-31-05	Applicable	Requires that reasonable precaution be taken to prevent particulate matter from becoming airborne.	Removal, LTTS Treatment and processing, and temporary storage of debris and soil during the implementation of alternative would be implemented to prevent material from becoming airborne.

TABLE 4-8 (cont'd)
ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
SOIL ALTERNATIVE 2: REMOVAL, EX SITU TREATMENT, BACKFILL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

STATE OF RHODE ISLAND REQUIREMENTS (CONT'D)

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Clean Air Act - Emissions Detrimental to Persons or Property	RIGL 23-23 *et seq.*; CRIR 12-31-07	Applicable	Prohibits emissions of contaminants which may be injurious to humans, plant or animal life or cause damage to property or which reasonably interferes with the enjoyment of life and property.	Removal, LTTS Treatment and processing, and temporary storage of debris and soil during the implementation of alternative would be implemented to prevent material from becoming airborne. Monitoring of air emissions from the LTTS will be used to assess compliance with these standards if threshold levels are reached.
Clean Air Act - Air Pollution Control	RIGL 23-23 *et seq.*; CRIR 12-31-09	Applicable	Establishes guidelines for the construction, installation, or operation of potential air emission units. Establishes permissible emission rates for some contaminants.	Site processing of soil through LTTS and treatment of off-gas will meet the substantive provisions of the standards if threshold levels are reached.
Clean Air Act - Odors	RIGL 23-23 *et seq.*; CRIR 12-31-17	Applicable	Prohibits the release of objectionable odors across property lines.	Site processing of soil through LTTS and treatment of off-gas will meet the substantive provisions of the standards.
Clean Air Act - Air Toxics	RIGL 23-23 *et seq.*; CRIR 12-31-22	Applicable	Prohibits the emission of specified contaminants at rates which would result in ground level concentrations greater than acceptable ambient levels or acceptable ambient levels as set in the regulations	Monitoring of air emissions from the LTTS facility will be used to assess compliance with these standards if threshold levels are reached. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.

TABLE 4-8 (cont'd)
ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
SOIL ALTERNATIVE 2: REMOVAL, EX SITU TREATMENT, BACKFILL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

STATE OF RHODE ISLAND REQUIREMENTS (CONT'D)

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Water Pollution Control - Water Quality	RIGL 42-16 *et seq.*; CRIR 12-190-001	Applicable	Establishes water use classification and water quality criteria for waters of the state. Also establishes criteria for discharge to a water body.	Any water from temporary storage area will be treated as required to meet this ARAR before being discharged.
Water Pollution Control - Pollution Discharge Elimination Systems	RIGL 42-16 *et seq.*; CRIR 12-190-003	Applicable	Contains applicable effluent monitoring requirements, and standards and special conditions for discharges.	The substantive provisions of these standards will be satisfied through on-site treatment of all discharges prior to being discharged.

TABLE 4-9
ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs
SOIL ALTERNATIVE 3: REMOVAL AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
EPA Human Health Assessment Cancer Slope Factors (CSFs).		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media.
EPA Risk Reference Doses (RfDs)		To Be Considered	Toxicity values for evaluating non-carcinogenic hazards from exposures to contamination.	Used to characterize human health risks due to non-carcinogens in site media.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
State of Rhode Island Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases (Short Title: Remediation Regulations)	DEM-DSR-01-93, as amended August 1996	Relevant and Appropriate	The Remediation Regulations ensure consistency and certainty in the process of establishing clean up objectives for soil and groundwater. The regulations contain remediation criteria for contaminated soil.	These standards are relevant and appropriate and were used to develop soil PRGs. This alternative meets this standard because soil exceeding PRGs is excavated and disposed at TSDF.

TABLE 4-10
ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
SOIL ALTERNATIVE 3: REMOVAL AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Coastal Zone Management Act	16 USC Parts 1451 *et. seq.*	Applicable	Requires that any actions must be conducted in a manner consistent with state-approved management programs.	The site is located next to a coastal zone management area; therefore, applicable coastal zone management requirements need to be addressed.
Executive Order 11988 RE: Floodplain Management	40 CFR Part 6, Appendix A	Applicable	The Order requires Federal agencies to evaluate the potential effects of actions it may take within a designated 100-year floodplain of a waterway to avoid adversely impacting floodplains wherever possible.	Excavation next to bay may impact floodplain. The potential for restoring and preserving floodplains so that their natural and beneficial values can be realized will be considered and incorporated into any plan or action wherever feasible.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Coastal Resources Management	RIGL 46-23-1 *et seq.*	Applicable	Sets standards for management and protection of coastal resources.	The entire site is located in a coastal resource management area, therefore, applicable coastal resource management requirements need to be addressed.

TABLE 4-11
ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
SOIL ALTERNATIVE 3: REMOVAL AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Clean Air Act (CAA), National Emission Standards for Hazardous Air Pollutants (NESHAPS)	42 USC 7411, 7412; 40 CFR Part 61	Applicable	NESHAPS are a set of emission standards for specific chemicals, including naphthalene, arsenic, cadmium, chromium, lead, mercury, nickel, PCBs, DDE, and hexachlorobenzene. Certain activities are regulated including site remediation.	Monitoring of air emissions during excavation will be used to assess compliance with these standards if threshold levels are reached. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Clean Air Act - Fugitive Dust Control	RIGL 23-23 *et seq.*; CRIR 12-31-05	Applicable	Requires that reasonable precaution be taken to prevent particulate matter from becoming airborne.	Removal, and temporary storage of debris and soil during the implementation of alternative would be implemented to prevent material from becoming airborne.

TABLE 4-11 (cont'd)
ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
SOIL ALTERNATIVE 3: REMOVAL AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA, NAVSTA NEWPORT
NEWPORT, RHODE ISLAND

STATE OF RHODE ISLAND REQUIREMENTS (CONT'D)

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Clean Air Act - Emissions Detrimental to Persons or Property	RIGL 23-23 *et seq.*; CRIR 12-31-07	Applicable	Prohibits emissions of contaminants which may be injurious to humans, plant or animal life or cause damage to property or which reasonably interferes with the enjoyment of life and property.	Removal and temporary storage of debris and soil during the implementation of alternative would be implemented to prevent material from becoming airborne. Monitoring of air emissions during removal will be used to assess compliance with these standards if threshold levels are reached.
Clean Air Act - Air Pollution Control	RIGL 23-23 *et seq.*; CRIR 12-31-09	Applicable	Establishes guidelines for the construction, installation, or operation of potential air emission units. Establishes permissible emission rates for some contaminants.	No emissions are expected, however, removal action would be monitored and any if any control system is required it will meet the substantive provisions of the standards if threshold levels are reached.
Clean Air Act - Odors	RIGL 23-23 *et seq.*; CRIR 12-31-17	Applicable	Prohibits the release of objectionable odors across property lines.	Soil removal action will meet the substantive provisions of the standards.
Clean Air Act - Air Toxics	RIGL 23-23 *et seq.*; CRIR 12-31-22	Applicable	Prohibits the emission of specified contaminants at rates which would result in ground level concentrations greater than acceptable ambient levels or acceptable ambient levels as set in the regulations	Monitoring of air emissions during excavation will be used to assess compliance with these standards if threshold levels are reached. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.

TABLE 4-12
SUMMARY OF COMPARATIVE ANALYSIS OF SOIL ALTERNATIVES
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Criteria	Alternative 1 No Action	Alternative 2 Removal, Ex situ Treatment, Backfill	Alternative 3 Removal and Disposal
THRESHOLD CRITERIA			
Overall Protection of Human Health and the Environment			
Human Health Protection	No reduction in risk	Provides high level of protection Exposure reduced by excavation and treatment Treatment reduces exposure hazard from soil	Provides high level of protection Removal reduces future site exposure hazard from soil
Environmental Protection	Allows continued exposure of contaminated soil	Will prevent further exposure through removal and treatment.	Will provide protection at the site, however, future exposure from contaminants depends on treatment, storage, and disposal facility (TSDF)
Compliance with Applicable or Relevant and Appropriate Requirements			
Compliance with Chemical-Specific ARARs	No	Will meet PRGs within 1 year	Will meet PRGs within 1 year.
Compliance with Location-Specific ARARs	Not applicable	Will be performed in accordance with floodplain, wetland, wildlife, and historic preservation regulations	Will be performed in accordance with floodplain, wetland, wildlife, and historic preservation regulations
Compliance with Action-Specific ARARs	Not applicable	Excavation and treatment systems will require dust suppression, silt fences, etc	Excavation and treatment systems will require dust suppression, silt fences, etc

TABLE 4-12 (cont'd)
SUMMARY OF COMPARATIVE ANALYSIS OF SOIL ALTERNATIVES
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Criteria	Alternative 1 No Action	Alternative 2 Removal, Ex situ Treatment, Backfill	Alternative 3 Removal and Disposal
BALANCING CRITERIA			
Long-Term Effectiveness and Permanence			
Magnitude of Residual Risk	Will not meet either RIDEM or EPA risk target levels	Will be less than target cumulative cancer risk of 10^{-5} and HI of 1 0	Will be less than target cumulative cancer risk of 10^{-5} and HI of 1 0
Need for 5-Year Review	Required	Not Required	Not Required
Need for Long-Term Management	Not applicable	None	None
Adequacy and Reliability of Controls	Not applicable	Provides a good level of reliability of residual management Controls are adequate and reliable.	No residuals requiring management will be generated.
Reduction of Toxicity, Mobility, or Volume through Treatment			
Amount Destroyed or Treated	None; only natural attenuation	Contaminant reduction of 99%	Removal (by excavation) efficiency of 99% Small amount destroyed or treated
Reduction in Toxicity, Mobility, and Volume	None; only natural attenuation	Mobility and volume reduced	Mobility reduced
Degree to which Treatment Is Irreversible	No active treatment	Low-Temperature Thermal Stripping (LTTS) and soil washing are considered permanent.	Removal is not considered permanent unless there is treatment at the TSDF.
Type and Quantity of Residuals Remaining after Treatment	No active treatment	LTTS and soil washing treatments will produce small quantity of liquids and activated carbon residuals.	Not applicable, no residuals

TABLE 4-12 (cont'd)
SUMMARY OF COMPARATIVE ANALYSIS OF SOIL ALTERNATIVES
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Criteria	Alternative 1 No Action	Alternative 2 Removal, Ex situ Treatment, Backfill	Alternative 3 Removal and Disposal
BALANCING CRITERIA			
Short-Term Effectiveness			
Community Protection during Implementation	No active treatment, no risk to community	Dust and air emissions from excavation and treatment activities can be controlled	Dust from excavation and removal activities can be controlled
Worker Protection during Implementation	No active treatment; no risk to workers	PPE required against dermal contact, dust inhalation, and air emissions during construction and treatment	PPE required against dermal contact and dust inhalation during excavation
Environmental Impacts	No impact from alternative implementation	Impacts from dust and air emissions, soil erosion, etc., can be controlled.	Impacts from dust and soil erosion, etc , can be controlled
Time until Remedial Action Objectives Achieved	> 30 years	Estimated 5-6 months	Estimated 5-6 months
Implementability			
Ability to Construct and Operate the Technology	No construction activities	Implementable Applicability depends on type of soil and pilot testing may be required	Implementable Contractors and equipment readily available
Reliability of the Technology	No treatment	Average reliability. Requires considerable maintenance.	Better reliability Properly maintained earthmoving equipment will have few failures.
Ease of Undertaking Additional Remedial Actions, if Necessary	Easily implementable	Additional soil removals can be easily implemented	Additional soil removals can be easily implemented.
Ability to Monitor Effectiveness of Remedy	Not applicable	System efficiencies and failures can readily be monitored System failure may allow uncontrolled air emissions and backfilling of contaminated soil.	Area and depth of removal can easily be monitored Monitoring failure could allow contaminated soil to remain in place

TABLE 4-12 (cont'd)
SUMMARY OF COMPARATIVE ANALYSIS OF SOIL ALTERNATIVES
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Criteria	Alternative 1 No Action	Alternative 2 Removal, Ex situ Treatment, Backfill	Alternative 3 Removal and Disposal
BALANCING CRITERIA			
Administrative Requirements with Regulators	No active tr-eatment	Federal, state, and/or base permits may be required for construction, air emissions, etc	Federal, state, and/or base permits may be required for construction, transportation, off-site treatment and disposal. TSDF should have a permit
Availability of Off-Site TSDF	None required	Available	Available
Availability of Necessary Equipment and Specialists	None required	Available	Available
Availability of Prospective Technologies	None required	Available	Available
Cost[a,b]			
Capital Costs	$0	$10,914,000	$7,699,000
Total Annual Operations and Maintenance (O&M)	$0	$30,000	$30,000
5-Year Reviews	$22,000	$22,000	$22,000
Total Present Worth Project Costs	$46,000	$10,971,000	$7,756,000

[a]Detailed cost estimates are presented in Appendix D
[b]These costs have been rounded off to the nearest $1,000.

TABLE 5-1
SUMMARY OF SEDIMENT ALTERNATIVES
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Alternative	Alternative Description
Alternative 1: No Action	• Five-Year Reviews
Alternative 2: Limited Action	• Access Restrictions • Long-Term O&M of Access Restrictions • Long-Term Monitoring • Five-Year Reviews
Alternative 3: Limited Dredging	• PDI • Installation of Engineering Controls to Minimize Erosion and Sediment Migration During Construction • Removal and Disposal of Debris along the affected areas • Installation of bay haul road along shoreline to facilitate Excavation/Dredging • Excavation/Dredging of about 7,080 cy of contaminated Sediment from areas with no Eelgrass Beds • Sediment Dewatering • Treatment of Dewatering Fluids and Discharge to Bay • Disposal of Sediment at TSDF • Backfill With Natural Fill • Access Restrictions to the Areas with Eelgrass Beds • Protection of Eelgrass Beds in Stations 3, 4 and 5 • Long-Term O&M of Access Restrictions • Long-Term Monitoring of Eelgrass Beds and Shell Fish • Five-Year Reviews
Alternative 4: Dredging and Disposal	• PDI • Installation of Engineering Controls to Minimize Erosion and Sediment Migration During Construction • Removal and Disposal of Debris along the affected areas • Installation of bay haul road along shoreline to facilitate Excavation and Dredging • Excavation/Dredging of about 8670 cy of Contaminated Sediment • Sediment Dewatering • Treatment of Dewatering Fluids and Discharge to Bay • Disposal of Sediment at TSDF • Backfill With Natural Fill • Assisted Restoration of Aquatic Community • Natural Restoration of Eelgrass Beds • Long-Term Monitoring (Years 1, 2, and 5 Only) • Five-Year Review (Year 5 Only)

TABLE 5-2
SUMMARY OF DETAILED ANALYSES OF ALTERNATIVES FOR SEDIMENT REMEDIATION
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Criteria	Alternative 1 No Action	Alternative 2 Limited Action	Alternative 3 Limited Dredging, Disposal	Alternative 4 Dredging, Disposal
THRESHOLD CRITERIA				
Overall Protection of Human Health and the Environment				
Does Alternative Protect Current and Future Users?	No	To some extent	Yes	Yes
Are Environmental Risks Reduced by Alternative?	No	No	To some extent	Yes
Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)				
Compliance with Chemical-Specific ARARs	No	No	Only in certain areas	Yes
Compliance with Location-Specific ARARs	Not applicable	No	No	Potentially
Compliance with Action-Specific ARARs	Not applicable	Potentially	Potentially	Yes
Compliance with Other Criteria	No	No	No	Potentially
BALANCING CRITERIA				
Long-Term Effectiveness and Permanence				
Does Alternative Reduce Residual Risk?	No	No	To some extent	Yes
Does Alternative Provide Adequate Remedial Controls?	No	To some extent	No controls in place	No controls in place
Need 5-Year Reviews?	Yes	Yes	Yes	No (only once)
Need for Long-Term Management?	Yes	No	Yes	No
Reduction of Toxicity, Mobility, or Volume through Treatment				
Treatment Process Used	None	None	Sediment may be stabilized prior to disposal and may be treated at TSDF to meet LDRs	Sediment may be stabilized prior to disposal and may be treated at TSDF to meet LDRs
Sediment Treated	No	No	Only if required	Only if required
Reduction in Toxicity, Mobility, or Volume	None	None	Toxicity (if treated) and Mobility reduced	Toxicity (if treated) and Mobility reduced
Type and Quantity of Residuals Remaining after Treatment	No treatment so no residuals	No treatment so no residuals	Residual water from dewatering-small quantity Lime based residuals if treated – small quantity	Residual water from dewatering-small quantity Lime based residuals if treated – small quantity

TABLE 5-2 (cont'd)
SUMMARY OF DETAILED ANALYSES OF ALTERNATIVES FOR SEDIMENT REMEDIATION
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Criteria	Alternative 1 No Action	Alternative 2 Limited Action	Alternative 3 Limited Dredging, Disposal	Alternative 4 Dredging, Disposal
Short-Term Effectiveness				
Risks to the Community during Remedial Action	No treatment so no construction risks	No risks	No risks	No risks
Risk to Workers during Remedial Action	No treatment so no construction risks	Some risks, easily controlled	Exposure risks during dredging, require PPE	Exposure risks during dredging, require PPE
Environmental Impacts	No treatment so no additional impacts	Minimal. Sediment resuspension	Dredging disturbs sediment and require control measures	Dredging disturbs sediment and require control measures
Time until Remedial Action Objectives Achieved	No remedial action, time >30 years	Estimated 1 to 2 months	Estimated 6 to 8 months	Estimated 6 to 8 months
Implementability				
Constructable	No construction activities	Yes	Yes	Yes
Reliability of Technology	No technology implemented	No technology implemented	Dredging/Excavation is Reliable	Dredging/Excavation is Reliable
Ease of Undertaking Additional Remedial Action, if Necessary	Easily implementable	High	High	High
Ability to Monitor Effectiveness of Remedy	Not applicable	Moderate	Medium	High
Ability to Coordinate with Other Agencies	Easy	Moderately easy	Need significant coordination	Need significant coordination
Availability of Off-Site Disposal Services	None required	None required	Available	Available
Availability of Equipment and Specialists	None required	Available	Available	Available
Availability of Prospective Technologies	None required	None required	Available	Available
Cost[a,b]				
Capital Costs	$0	$10,000	$3,554,000	$4,134,000
Total Annual Operations and Maintenance (O&M)	$0	$50,000	$61,000	$61,000
5-Year Reviews	$22,000	$22,000	$22,000	$22,000
Total Present Worth Project Costs	$46,000	$394,000	$3,937,000	$4,302,000

[a]Detailed cost estimates are presented in Appendix D.
[b]These costs have been rounded off to the nearest $1,000

TABLE 5-3
ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 1 - NO ACTION
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
EPA Human Health Assessment Cancer Slope Factors (CSFs).		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media.
EPA Risk Reference Doses (RfDs)		To Be Considered	Toxicity values for evaluating non-carcinogenic hazards from exposures to contamination.	Used to characterize human health risks due to non-carcinogens in site media.
Clean Water Act, Section 304	40 USC 1314; 40 CFR 122.44	Relevant and Appropriate	Establish Ambient Water Quality Criteria (AWQC): Guidelines established for the protection of human health and/or the aquatic organisms.	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria. This alternative fails to meet this standard because sediments exceeding PRGs are not adequately addressed.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Water Pollution Control	RIGL 46-12 *et seq.*; ENVM 112-88.97-1	Relevant and Appropriate	Establishes water use classification and water quality criteria for waters of the state. Also establishes acute and chronic water quality criteria for the protection of aquatic life.	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria. This alternative fails to meet this standard because sediments exceeding PRGs are not adequately addressed.

TABLE 5-4
ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 1: NO ACTION
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
There are no federal location-specific ARARS.				

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
There are no state location-specific ARARs				

TABLE 5-5
ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 1 - NO ACTION
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
There are no federal action-specific ARARs.				

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
There are no state action-specific ARARs.				

TABLE 5-6
ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 2: LIMITED ACTION
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
EPA Human Health Assessment Cancer Slope Factors (CSFs).		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media.
EPA Risk Reference Doses (RfDs)		To Be Considered	Toxicity values for evaluating non-carcinogenic hazards from exposures to contamination.	Used to characterize human health risks due to non-carcinogens in site media.
Clean Water Act, Section 304	40 USC 1314; 40 CFR 122.44	Relevant and Appropriate	Establish Ambient Water Quality Criteria (AWQC): Guidelines established for the protection of human health and/or the aquatic organisms.	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria. This alternative fails to meet this standard because sediments exceeding PRGs are not adequately addressed.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Water Pollution Control	RIGL 46-12 *et seq.*; ENVM 112-88.97-1	Relevant and Appropriate	Establishes water use classification and water quality criteria for waters of the state. Also establishes acute and chronic water quality criteria for the protection of aquatic life.	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria. This alternative fails to meet this standard because sediments exceeding PRGs are not adequately addressed.

TABLE 5-7
ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 2: LIMITED ACTION
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Executive Order 11990 RE: Protection of Wetlands	40 CFR Part 6, Appendix A	Applicable	This Order requires Federal agencies to take action to avoid adversely impacting wetlands wherever possible, to minimize wetlands destruction and to preserve the values of wetlands, and to prescribe procedures to implement the policies and procedures of this Executive Order.	Fails to comply with this standard because the action to be taken does not address the risk to the wetland environment posed by the contamination. Installation of fencing and buoys would be conducted to minimize damage of the wetlands.
Executive Order 11988 RE: Floodplain Management	40 CFR Part 6, Appendix A	Applicable	The Order requires Federal agencies to evaluate the potential effects of actions it may take within a designated 100-year floodplain of a waterway to avoid adversely impacting floodplains wherever possible.	Fails to comply with this standard because the action to be taken does not address the risk to the floodplain environment posed by the contamination.
Fish and Wildlife Coordination Act	16 USC Part 661 *et. seq.*; 40 CFR 122.49	Applicable	This statute requires consultation with appropriate agencies to protect fish and wildlife when federal actions result in control or structural modification of a body of water or to critical habitat upon which endangered or threatened species depends.	Appropriate agencies will be consulted to find ways to minimize adverse effects to fish and wildlife from installation of fencing and buoys.

TABLE 5-7 (cont'd)
ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 2: LIMITED ACTION
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS (Cont'd)

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Endangered Species Act	16 USC 1531 *et seq.*, 50 CFR Part 200, 50 CFR Part 402	Applicable	If a location contains a federal endangered or threatened species or its critical habitat, and an action may impact the species or its habitat, the U.S. Fish & Wildlife Service or the National Marine Fisheries Service must be consulted.	The federally endangered loggerhead turtle (*Caretta caretta*) and federally threatened Kemp's ridley turtle (*Lepidochelys kempii*) occur in the waters of Narragansett Bay. Appropriate agencies will be consulted to find ways to minimize adverse effects to the listed species and its habitat from installation of fencing and buoys.
Coastal Zone Management Act	16 USC Parts 1451 *et. seq.*	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore, applicable coastal zone management requirements need to be addressed.
National Historic Preservation Act	16 USC 470 *et seq.*, 26 CFR Part 800	Applicable	Requires action to take into account effects on properties included on or eligible for the National Register of Historic Places and minimizes harm to National Historic Landmarks	Historic vessels may be sunken in the area. Monitoring and installation of fencing and buoys will be carried out to minimize potential harm to historic sites.

TABLE 5-7 (cont'd)
ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 2: LIMITED ACTION
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Coastal Resources Management	RIGL 46-23-1 *et seq.*	Applicable	Sets standards for management and protection of coastal resources.	The entire Site is located in a coastal resource management area, therefore, applicable coastal resource management requirements need to be addressed.
Endangered Species Act	RIGL 20-37-1 *et seq.*	Applicable	Regulates activities affecting state-listed endangered or threatened species or their critical habitat.	The state listed loggerhead turtle (*Caretta caretta*) and Kemp's ridley turtle (*Lepidochelys kempii*) occur in the waters of Narragansett Bay. Appropriate agencies will be consulted to find ways to minimize adverse effects to the listed species and its habitat from installation of fencing and buoys.

TABLE 5-8
ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 2: LIMITED ACTION
DRAFT FEASIBILITY STUD
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
None				

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Water Pollution Control - Water Quality	RIGL 42-16 *et seq.*; CRIR 12-190-001	Applicable	Establishes water use classification and water quality criteria for waters of the state.	Monitoring and installation of access restrictions will not cause degradation of surface water quality in Narragansett Bay.

TABLE 5-9
ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 3: LIMITED DREDGING AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
EPA Human Health Assessment Cancer Slope Factors (CSFs).		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media.
EPA Risk Reference Doses (RfDs)		To Be Considered	Toxicity values for evaluating non-carcinogenic hazards from exposures to contamination.	Used to characterize human health risks due to non-carcinogens in site media.
Clean Water Act, Section 304	40 USC 1314; 40 CFR 122.44	Relevant and Appropriate	Establish Ambient Water Quality Criteria (AWQC): Guidelines for the protection of human health and/or the aquatic organisms	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria. Sediments exceeding PRGs must be adequately addressed to meet these standards.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Water Pollution Control	RIGL 46-12 *et seq.*; ENVM 112-88.97-1	Relevant and Appropriate	Establishes water use classification and water quality criteria for waters of the state. Also establishes acute and chronic water quality criteria for the protection of aquatic life.	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria. Sediments exceeding PRGs must be adequately addressed to meet these standards.

TABLE 5-10
ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 3 -LIMTED DREDGING AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA, NAVSTA NEWPORT
NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Executive Order 11990 RE: Protection of Wetlands	40 CFR Part 6, Appendix A	Applicable	This Order requires Federal agencies to take action to avoid adversely impacting wetlands wherever possible, to minimize wetlands destruction and to preserve the values of wetlands, and to prescribe procedures to implement the policies and procedures of this Executive Order.	Restoration and preservation of the wetlands altered by the removal action will be conducted so that the wetlands' natural and beneficial values can be realized. Implementation of the Order will be considered and incorporated into any plan or action, wherever feasible.
Clean Water Act, Section 404	33 USC 1344; 40 CFR Part 230 and 33 CFR Parts 320-323	Applicable	This statute regulates the discharge of dredge and fill materials into Waters of the United States, including special aquatic sites - such as wetlands, intertidal habitats, and vegetated shallows. Such discharges are not allowed if practicable alternatives are available.	Refilling of the excavated/dredged intertidal habitats will only satisfy this requirement if no practicable alternative that has less effect is available. Impacts to aquatic habitats would be mitigated as part of this alternative.
Rivers and Harbors Act, Section 10	33 USC 403; 33 CFR Parts 320-323	Applicable	Sets forth criteria for obstructions or alterations of navigable waters.	Excavation, dredging, and habitat restoration will comply with the Act's environmental standards.

TABLE 5-10 (cont'd)
ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 3 -LIMTED DREDGING AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS (Cont'd)

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Executive Order 11988 RE: Floodplain Management	40 CFR Part 6, Appendix A	Applicable	The Order requires Federal agencies to evaluate the potential effects of actions it may take within a designated 100-year floodplain of a waterway to avoid adversely impacting floodplains wherever possible.	The potential for restoring and preserving floodplains so that their natural and beneficial values can be realized will be considered and incorporated into any plan or action wherever feasible.
Fish and Wildlife Coordination Act	16 USC Part 661 *et. seq.*; 40 CFR 122.49	Applicable	This statute requires consultation with appropriate agencies to protect fish and wildlife when federal actions result in control or structural modification of a body of water or to critical habitat upon which endangered or threatened species depends.	The appropriate agencies will be consulted to find ways to minimize adverse effects to fish and wildlife from the implementation of the proposed removal, containment, and restoration remedy.
Endangered Species Act	16 USC 1531 *et seq.*, 50 CFR Part 200, 50 CFR Part 402	Applicable	If a location contains a federal endangered or threatened species or its critical habitat, and an action may impact the species or its habitat, the U.S. Fish & Wildlife Service or the National Marine Fisheries Service must be consulted.	The federally endangered loggerhead turtle (*Caretta caretta*) and federally threatened Kemp's ridley turtle (*Lepidochelys kempii*) occur in the waters of Narragansett Bay. Appropriate agencies will be consulted to find ways to minimize adverse effects to the listed species from the removal, containment, and restoration remedy.

TABLE 5-10 (c nt'd)
ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 3 -LIMTED DREDGING AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS (Cont'd)

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Coastal Zone Management Act	16 USC Parts 1451 *et. seq.*	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area; therefore, applicable coastal zone management requirements need to be addressed.
National Historic Preservation Act	16 USC 470 *et seq.*, 26 CFR Part 800	Applicable	Requires action to take into account effects on properties included on or eligible for the National Register of Historic Places and minimizes harm to National Historic Landmarks	Historic vessels may be sunken in the area. Excavation/dredging, containment, and restoration activities will be carried out to minimize potential harm to historic sites.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Coastal Resources Management	RIGL 46-23-1 *et seq.*	Applicable	Sets standards for management and protection of coastal resources.	The entire site is located in a coastal resource management area; therefore, applicable coastal resource management requirements need to be addressed.
Endangered Species Act	RIGL 20-37-1 *et seq.*	Applicable	Regulates activities affecting state-listed endangered or threatened species or their critical habitat.	The state listed loggerhead turtle (*Caretta caretta*) and Kemp's ridley turtle (*Lepidochelys kempii*) occur in the waters of Narragansett Bay. Appropriate state agencies will be consulted to find ways to minimize adverse effects to the listed species from the implementation of the removal and restoration remedy.

TABLE 5-11
ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 3: LIMTED DREDGING AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Clean Water Act (CWA), Section 402, National Pollutant Discharge Elimination System (NPDES)	33 USC 1342; 40 CFR 122-125, 131	Applicable	These standards govern discharge of water into surface waters. Regulated discharges must meet ambient water quality criteria (AWQC).	Any drainage from the temporary debris/sediment storage area and any dewatering discharge will be treated by as necessary to meet this requirement and discharged into Narragansett Bay.
Clean Air Act (CAA), National Emission Standards for Hazardous Air Pollutants (NESHAPS)	42 USC 7411, 7412; 40 CFR Part 61	Applicable	NESHAPS are a set of emission standards for specific chemicals, including naphthalene, arsenic, cadmium, chromium, lead, mercury, nickel, PCBs, DDE, and hexachlorobenzene. Certain activities are regulated including site remediation.	Monitoring of air emissions from the dewatering facility will be used to assess compliance with these standards if threshold levels are reached. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken t Attain ARAR
Clean Air Act - Fugitive Dust Control	RIGL 23-23 *et seq.*; CRIR 12-31-05	Applicable	Requires that reasonable precaution be taken to prevent particulate matter from becoming airborne.	Removal, processing, and temporary storage of debris and sediments during dewatering and before shipment would be implemented to prevent material from becoming airborne.

TABLE 5-11 (cont'd)
ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 3: LIMTED DREDGING AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

STATE OF RHODE ISLAND REQUIREMENTS (Cont'd)

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Clean Air Act - Emissions Detrimental to Persons or Property	RIGL 23-23 *et seq.*; CRIR 12-31-07	Applicable	Prohibits emissions of contaminants which may be injurious to humans, plant or animal life or cause damage to property or which reasonably interferes with the enjoyment of life and property.	Removal, processing, and temporary storage of debris and sediments during dewatering and before shipment would be implemented to prevent emissions of contaminants. Monitoring of air emissions from the dewatering facility will be used to assess compliance with these standards if threshold levels are reached.
Clean Air Act - Air Pollution Control	RIGL 23-23 *et seq.*; CRIR 12-31-09	Applicable	Establishes guidelines for the construction, installation, or operation of potential air emission units. Establishes permissible emission rates for some contaminants.	Site processing of debris and sediment and treatment of dewatering liquid will meet the substantive provisions of the standards if threshold levels are reached.
Clean Air Act - Odors	RIGL 23-23 *et seq.*; CRIR 12-31-17	Applicable	Prohibits the release of objectionable odors across property lines.	Site processing of debris and sediment and treatment of dewatering liquid will meet the substantive provisions of the standards.

TABLE 5-11 (cont'd)
ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 3: LIMTED DREDGING AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

STATE OF RHODE ISLAND REQUIREMENTS (Cont'd)

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Clean Air Act - Air Toxics	RIGL 23-23 *et seq.*; CRIR 12-31-22	Applicable	Prohibits the emission of specified contaminants at rates which would result in ground level concentrations greater than acceptable ambient levels or acceptable ambient levels as set in the regulations	Monitoring of air emissions from the dewatering facility will be used to assess compliance with these standards if threshold levels are reached. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.
Water Pollution Control - Water Quality	RIGL 42-16 *et seq.*; CRIR 12-190-001	Applicable	Establishes water use classification and water quality criteria for waters of the state. Also establishes criteria for discharge to a water body.	Monitoring operations must not cause degradation of surface water quality in the bay. Any drainage off the temporary debris/sediment storage area and any dewatering discharge will be treated as necessary to meet these requirements and discharged.
Water Pollution Control - Pollution Discharge Elimination Systems	RIGL 42-16 *et seq.*; CRIR 12-190-003	Applicable	Contains applicable effluent monitoring requirements, and standards and special conditions for discharges.	The substantive provisions of these standards will be satisfied through on-site treatment of all discharges prior to being discharged.

TABLE 5-12
ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 4: DREDGING AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
EPA Human Health Assessment Cancer Slope Factors (CSFs).		To Be Considered	These are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media.
EPA Risk Reference Doses (RfDs)		To Be Considered	Toxicity values for evaluating non-carcinogenic hazards from exposures to contamination.	Used to characterize human health risks due to non-carcinogens in site media.
Clean Water Act, Section 304	40 USC 1314; 40 CFR 122.44	Relevant and Appropriate	Establish Ambient Water Quality Criteria (AWQC): Guidelines for the protection of human health and/or the aquatic organisms.	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria. Sediments exceeding PRGs must be adequately addressed to meet these standards.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Water Pollution Control	RIGL 46-12 *et seq.*; ENVM 112-88.97-1	Relevant and Appropriate	Establishes water use classification and water quality criteria for waters of the state. Also establishes acute and chronic water quality criteria for the protection of aquatic life.	These standards are relevant and appropriate for sediment PRGs derived using these water quality criteria. Sediments exceeding PRGs must be adequately addressed to meet these standards.

TABLE 5-13
ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 4- DREDGING AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Executive Order 11990 RE: Protection of Wetlands	40 CFR Part 6, Appendix A	Applicable	This Order requires Federal agencies to take action to avoid adversely impacting wetlands wherever possible, to minimize wetlands destruction and to preserve the values of wetlands, and to prescribe procedures to implement the policies and procedures of this Executive Order.	Restoration and preservation of the intertidal wetlands altered by the remedial action will be conducted so that the wetlands' natural and beneficial values can be realized. Implementation of the Order will be considered and incorporated into any plan or action, wherever feasible.
Clean Water Act, Section 404	33 USC 1344; 40 CFR Part 230 and 33 CFR Parts 320-323	Applicable	This statute regulates the discharge of dredge and fill materials into Waters of the United States, including special aquatic sites - such as wetlands, intertidal habitats, and vegetated shallows. Such discharges are not allowed if practicable alternatives are available.	Refilling of the excavated/dredged aquatic habitats will only satisfy this requirement if no practicable alternative that has less effect is available. Impacts to aquatic habitats would be mitigated as part of this alternative.
Rivers and Harbors Act, Section 10	33 USC 403; 33 CFR Parts 320-323	Applicable	Sets forth criteria for obstructions or alterations of navigable waters.	Excavation/dredging and habitat restoration will comply with the Act's environmental standards.

TABLE 5-13 (cont'd)
ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 4- DREDGING AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS (Cont'd)

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Executive Order 11988 RE: Floodplain Management	40 CFR Part 6, Appendix A	Applicable	The Order requires Federal agencies to evaluate the potential effects of actions it may take within a designated 100-year floodplain of a waterway to avoid adversely impacting floodplains wherever possible.	The potential for restoring and preserving floodplains so that their natural and beneficial values can be realized will be considered and incorporated into any plan or action wherever feasible.
Fish and Wildlife Coordination Act	16 USC Part 661 *et. seq.*; 40 CFR 122.49	Applicable	This statute requires consultation with appropriate agencies to protect fish and wildlife when federal actions result in control or structural modification of a body of water or to critical habitat upon which endangered or threatened species depends.	The appropriate agencies will be consulted to find ways to minimize adverse effects to fish and wildlife from the implementation of the proposed removal and restoration remedy.

TABLE 5-13 (cont'd)
ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 4- DREDGING AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS (Cont'd)

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Endangered Species Act	16 USC 1531 *et seq.*, 50 CFR Part 200, 50 CFR Part 402	Applicable	If a location contains a federal endangered or threatened species or its critical habitat, and an action may impact the species or its habitat, the U.S. Fish & Wildlife Service or the National Marine Fisheries Service must be consulted.	The federally endangered loggerhead turtle (*Caretta caretta*) and federally threatened Kemp's ridley turtle (*Lepidochelys kempii*) occur in the waters of Narragansett Bay. Appropriate agencies will be consulted to find ways to minimize adverse effects to the listed species from the removal and restoration remedy.
Coastal Zone Management Act	16 USC Parts 1451 *et. seq.*	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	The entire site is located in a coastal zone management area, therefore, applicable coastal zone management requirements need to be addressed.
National Historic Preservation Act	16 USC 470 *et seq.*, 26 CFR Part 800	Applicable	Requires action to take into account effects on properties included on or eligible for the National Register of Historic Places and minimizes harm to National Historic Landmarks	Historic vessels may be sunken in the area. Excavation/dredging, and restoration activities will be carried out to minimize potential harm to historic sites.

TABLE 5-13 (cont'd)
ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 4- DREDGING AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Coastal Resources Management	RIGL 46-23-1 *et seq.*	Applicable	Sets standards for management and protection of coastal resources.	The entire site is located in a coastal resource management area, therefore, applicable coastal resource management requirements need to be addressed.
Endangered Species Act	RIGL 20-37-1 *et seq.*	Applicable	Regulates activities affecting state-listed endangered or threatened species or their critical habitat.	The state listed loggerhead turtle (*Caretta caretta*) and Kemp's ridley turtle (*Lepidochelys kempii*) occur in the waters of Narragansett Bay. Appropriate state agencies will be consulted to find ways to minimize adverse effects to the listed species from the implementation of the removal and restoration remedy.

TABLE 5-14
ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 4: DREDGING AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

FEDERAL REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Clean Water Act (CWA), Section 402, National Pollutant Discharge Elimination System (NPDES)	33 USC 1342; 40 CFR 122-125, 131	Applicable	These standards govern discharge of water into surface waters. Regulated discharges must meet ambient water quality criteria (WQC).	Any drainage off the temporary debris/sediment storage area and any dewatering discharge will be treated by an on-site treatment plant and discharged into Narragansett Bay.
Clean Air Act (CAA), National Emission Standards for Hazardous Air Pollutants (NESHAPS)	42 USC 7411, 7412; 40 CFR Part 61	Applicable	NESHAPS are a set of emission standards for specific chemicals, including naphthalene, arsenic, cadmium, chromium, lead, mercury, nickel, PCBs, DDE, and hexachlorobenzene. Certain activities are regulated including site remediation.	Monitoring of air emissions from the dewatering facility will be used to assess compliance with these standards if threshold levels are reached. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.

STATE OF RHODE ISLAND REQUIREMENTS

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Clean Air Act - Fugitive Dust Control	RIGL 23-23 *et seq.*; CRIR 12-31-05	Applicable	Requires that reasonable precaution be taken to prevent particulate matter from becoming airborne.	Removal, processing, and temporary storage of debris and sediments during dewatering and before shipment would be implemented to prevent material from becoming airborne.

TABLE 5-14 (cont'd)
ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 4: DREDGING AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

STATE OF RHODE ISLAND REQUIREMENTS (CONT'D)

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Clean Air Act - Emissions Detrimental to Persons or Property	RIGL 23-23 *et seq.*; CRIR 12-31-07	Applicable	Prohibits emissions of contaminants which may be injurious to humans, plant or animal life or cause damage to property or which reasonably interferes with the enjoyment of life and property.	Removal, processing, and temporary storage of debris and sediments during dewatering and before shipment would be implemented to prevent emissions of contaminants. Monitoring of air emissions from the dewatering facility will be used to assess compliance with these standards if threshold levels are reached.
Clean Air Act - Air Pollution Control	RIGL 23-23 *et seq.*; CRIR 12-31-09	Applicable	Establishes guidelines for the construction, installation, or operation of potential air emission units. Establishes permissible emission rates for some contaminants.	Site processing of debris and sediment and treatment of dewatering liquid will meet the substantive provisions of the standards if threshold levels are reached.
Clean Air Act - Odors	RIGL 23-23 *et seq.*; CRIR 12-31-17	Applicable	Prohibits the release of objectionable odors across property lines.	Site processing of debris and sediment and treatment of dewatering liquid will meet the substantive provisions of the standards.
Clean Air Act - Air Toxics	RIGL 23-23 *et seq.*; CRIR 12-31-22	Applicable	Prohibits the emission of specified contaminants at rates which would result in ground level concentrations greater than acceptable ambient levels or acceptable ambient levels as set in the regulations	Monitoring of air emissions from the dewatering facility will be used to assess compliance with these standards if threshold levels are reached. Operation and maintenance activities will be carried out in a manner which will minimize potential air releases.

TABLE 5-14 (cont'd)
ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs
SEDIMENT ALTERNATIVE 4: DREDGING AND DISPOSAL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

STATE OF RHODE ISLAND REQUIREMENTS (CONT'D)

Requirement	Citation	Status	Synopsis of Requirement	Action to Be Taken to Attain ARAR
Water Pollution Control - Water Quality	RIGL 42-16 *et seq.*; CRIR 12-190-001	Applicable	Establishes water use classification and water quality criteria for waters of the state. Also establishes criteria for discharge to a water body.	Any drainage from the temporary debris/sediment storage area and any dewatering discharge will be treated as required to meet this ARAR and discharged.
Water Pollution Control - Pollution Discharge Elimination Systems	RIGL 42-16 *et seq.*; CRIR 12-190-003	Applicable	Contains applicable effluent monitoring requirements, and standards and special conditions for discharges.	The substantive provisions of these standards will be satisfied through on-site treatment of all discharges prior to being discharged.

TABLE 5-15
SUMMARY OF COMPARATIVE ANALYSIS OF SEDIMENT ALTERNATIVES
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

CRITERIA	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: LIMITED ACTION	ALTERNATIVE 3: LIMITED DREDGING AND DISPOSAL	ALTERNATIVE 4: DREDGING AND DISPOSAL
Overall Protection of Human Health and the Environment:				
Human Health	No reduction in risk is anticipated Risks associated with shoreline access would remain. RAOs for protection of human health would not be achieved	Limited risk reduction would be provided by deterring recreational use. RAOs for protection of human health would be partially addressed by the installation of fencing, signs and buoys.	Would provide protection by removal of shoreline and nearshore sediment exceeding PRGs Risk still exists from the remaining sediment. RAOs for protection of human health would be achieved.	Would provide protection by removal and disposal of shoreline and nearshore sediment RAOs for protection of human health would be achieved
Environment	No reduction in risk is anticipated. Low to high probability of risk to marine biota would remain. PAHs and metals contaminants would continue to migrate. RAOs for protection of the environment would not be achieved.	Same as Alternative 1 RAOs for protection of the environment would not be achieved	Possible short-term impacts from sediment resuspension during dredging and no long-term impacts from filling Eelgrass beds would be protected. Approximately 90% of the contaminated sediment would be removed and disposed in a secure landfill. RAOs for protection of the environment would be partially achieved	Possible short-term impacts from sediment resuspension during dredging Total removal of contaminated sediment would ensure long-term protection. Eelgrass beds may not be restored completely RAOs for protection of the environment would be achieved

TABLE 5-15 (cont'd)
SUMMARY OF COMPARATIVE ANALYSIS OF SEDIMENT ALTERNATIVES
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

CRITERIA	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: LIMITED ACTION	ALTERNATIVE 3: LIMITED DREDGING AND DISPOSAL	ALTERNATIVE 4: DREDGING AND DISPOSAL
Compliance with ARARs/TBCs:				
Chemical-Specific	Fails to meet sediment PRGs that were derived from federal and state water quality standards	Fails to meet sediment PRGs that were derived from federal and state water quality standards.	Would meet chemical-specific ARARs only in the excavated areas.	Would meet chemical-specific ARARs because sediments exceeding the PRGs derived from state and federal water quality criteria would be removed
Location-Specific	No Location-Specific ARARs/TBCs	Fails to meet wetland and floodplain standards since it will leave contaminated waste in place and would not address the risk to the wetland and floodplain environments posed by the contamination	Fails to meet wetland and floodplain standards since it will leave some contaminated waste in place and would not address all risk to the wetland and floodplain environments posed by the contamination. Temporary and permanent habitat losses would have to be mitigated to meet CWA requirements Would be conducted in accordance with all other identified ARARs/TBCs.	Temporary and permanent habitat losses would have to be mitigated to meet CWA requirements. Would be conducted in accordance with all other identified ARARs/TBCs
Action-Specific	No Action-Specific ARARs/TBCs.	Would be conducted in accordance with identified ARARs/TBCs	Would be conducted in accordance with identified ARARs/TBCs	Would be conducted in accordance with identified ARARs/TBCs

TABLE 5-15 (cont'd)
SUMMARY OF COMPARATIVE ANALYSIS OF SEDIMENT ALTERNATIVES
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

CRITERIA	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: LIMITED ACTION	ALTERNATIVE 3: LIMITED DREDGING AND DISPOSAL	ALTERNATIVE 4: DREDGING AND DISPOSAL
Long-Term Effectiveness and Permanence:				
Magnitude of Residual Risk	All existing risks to human health and the environment would remain	Use and access restrictions would discourage/deter continued human health risk, while enforcement would be required to prevent risk. No reduction in risk to ecological receptors would occur	Some contaminated marine sediment would remain on site Removal of large volume of sediment will reduce long-term risks	Contaminants would be removed No residual risks would remain on site. Permanent solution
Adequacy and Reliability of Controls	Not applicable.	Would require enforcement of use and access restrictions. Long-term adequate enforcement of state-imposed ban in state waters difficult to ensure	No control would be in place for contaminated sediment remaining in-place.	No on-site controls needed to ensure reliability because all sediment exceeding PRGs would be disposed off site

TABLE 5-15 (cont'd)
SUMMARY OF COMPARATIVE ANALYSIS OF SEDIMENT ALTERNATIVES
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

CRITERIA	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: LIMITED ACTION	ALTERNATIVE 3: LIMTED DREDGING AND DISPOSAL	ALTERNATIVE 4: DREDGING AND DISPOSAL
Reduction of Toxicity, Mobility, or Volume Through Treatment:				
Need for 5-Year Review	Review would be required since contaminants would remain on site	Review would be required since contaminants would remain on site	Review would be required since contaminants would remain on site	All contaminants exceeding PRGs would be removed Assumed 1 review would be conducted in year 5 to assess the remediation
Treatment Process Used and Materials Treated	None	None	TSDF may have treatment to meet LDRs	TSDF may have treatment to meet LDRs
Amount of Hazardous Materials Destroyed or Treated	None.	None	None. TSDF may treat sediment to meet LDRs	None. TSDF may treat sediment to meet LDRs
Degree of Expected Reductions in Toxicity, Mobility, or Volume Through Treatment	No reduction is anticipated	No reduction is anticipated	Would provide reduction in toxicity and mobility through treatment at off site May result in increase in volume associated with solidification/ stabilization of the treated portion	Would provide reduction in toxicity and mobility through treatment at off site May result in increase in volume associated with solidification/ stabilization of the treated portion

TABLE 5-15 (cont'd)
SUMMARY OF COMPARATIVE ANALYSIS OF SEDIMENT ALTERNATIVES
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

CRITERIA	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: LIMITED ACTION	ALTERNATIVE 3: LIMITED DREDGING AND DISPOSAL	ALTERNATIVE 4: DREDGING AND DISPOSAL
Degree to Which Treatment is Irreversible	Not applicable.	Not applicable	Irreversible for sediment receiving treatment	Irreversible for sediment receiving treatment
Type and Quantity of Residuals Remaining after Treatment	Not applicable.	Not applicable.	Residuals from treatment would depend on process(es) used Residuals would be handled by TSDF or landfill. Residual water from sediment dewatering would require treatment prior to discharge; volume depends on sediment removal technique	Same as Alternative 3
Statutory Preference for Treatment	Not achieved	Not achieved.	Achieved for that portion of excavated/ dredged sediment receiving treatment at TSDF	Same as Alternative 3.

TABLE 5-15 (cont'd)
SUMMARY OF COMPARATIVE ANALYSIS OF SEDIMENT ALTERNATIVES
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

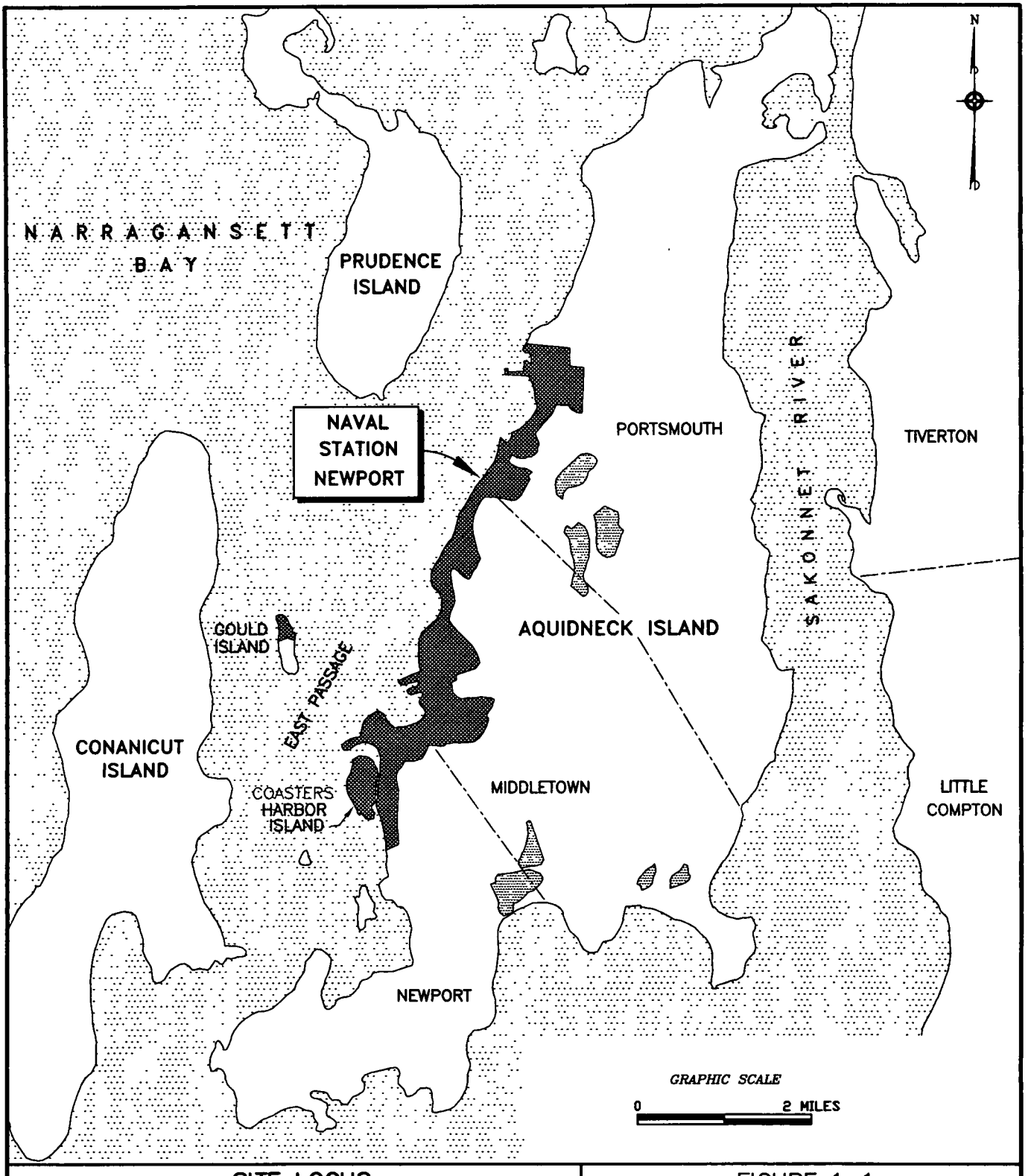
CRITERIA	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: LIMITED ACTION	ALTERNATIVE 3: LIMITED DREDGING AND DISPOSAL	ALTERNATIVE 4: DREDGING AND DISPOSAL
Short-Term Effectiveness:				
Community Protection	No short-term risks are anticipated	Same as Alternative1	Same as Alternative1.	Same as Alternative 1.
Worker Protection	No short-term risks are anticipated	Exposure risks (direct contact) associated with monitoring activities and installation of fencing and buoy system in intertidal zone would be minimized by use of PPE	Exposure risks associated with excavation/dredging and monitoring would be minimized by use of PPE	Exposure risks associated with excavation/dredging and monitoring would be minimized by use of PPE
Environmental Impacts	Not applicable.	Minimal impacts (sediment resuspension) associated with installation of fencing and buoy system in intertidal zone would be minimized by use of silt curtains, silt fences, etc.	Short-term risks (sediment resuspension) associated with site preparation and would be minimized by use of silt curtains, silt fences, etc.	Short-term risks (sediment resuspension) associated with site preparation and would be minimized by use of silt curtains, silt fences, etc Eelgrass beds may not be fully restored
Time Until RAOs are Achieved	Not achieved	One month to meet human health RAOs only RAOs for protection of the environment would not be achieved	6-8 months (assuming no interruption of alternative implementation).	6-8 months (assuming no interruption of alternative implementation)

TABLE 5-15 (cont'd)
SUMMARY OF COMPARATIVE ANALYSIS OF SEDIMENT ALTERNATIVES
DRAFT FEASIBILITY STUDY REPORT
OLD FIRE FIGHTING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

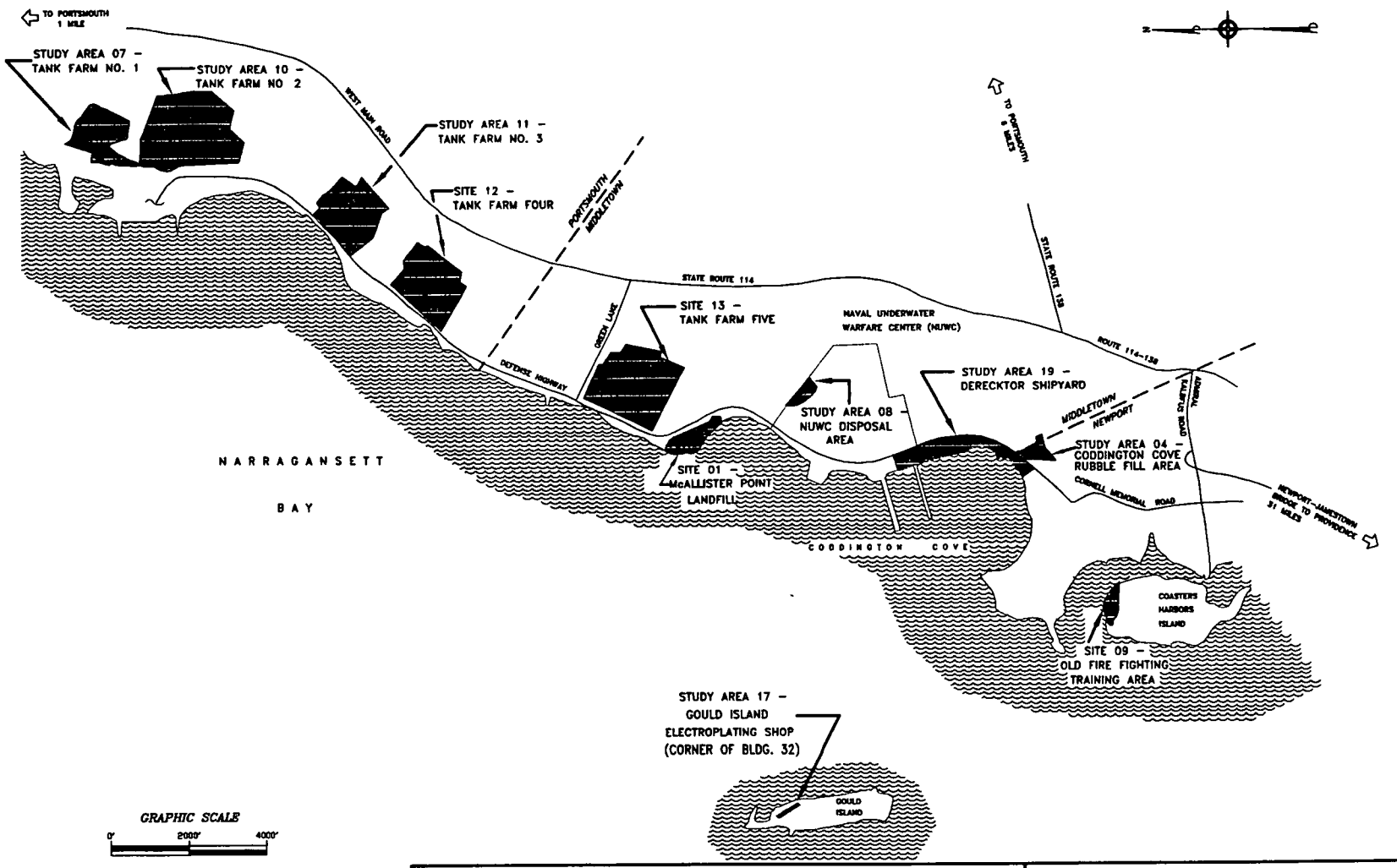
CRITERIA	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: LIMITED ACTION	ALTERNATIVE 3: LIMITED DREDGING AND DISPOSAL	ALTERNATIVE 4: DREDGING AND DISPOSAL
Cost[a, b]				
Capital Costs	$0	$10,000	$3,554,000	$4,134,000
Total Annual Operations and Maintenance (O&M)	$0	$50,000	$61,000	$61,000
5-Year Reviews	$22,000	$22,000	$22,000	$22,000
Total Present Worth Project Costs	$46,000	$394,000	$3,937,000	$4,302,000

[a]Detailed cost estimates are presented in Appendix D.
[b]These costs have been rounded off to the nearest $1,000.

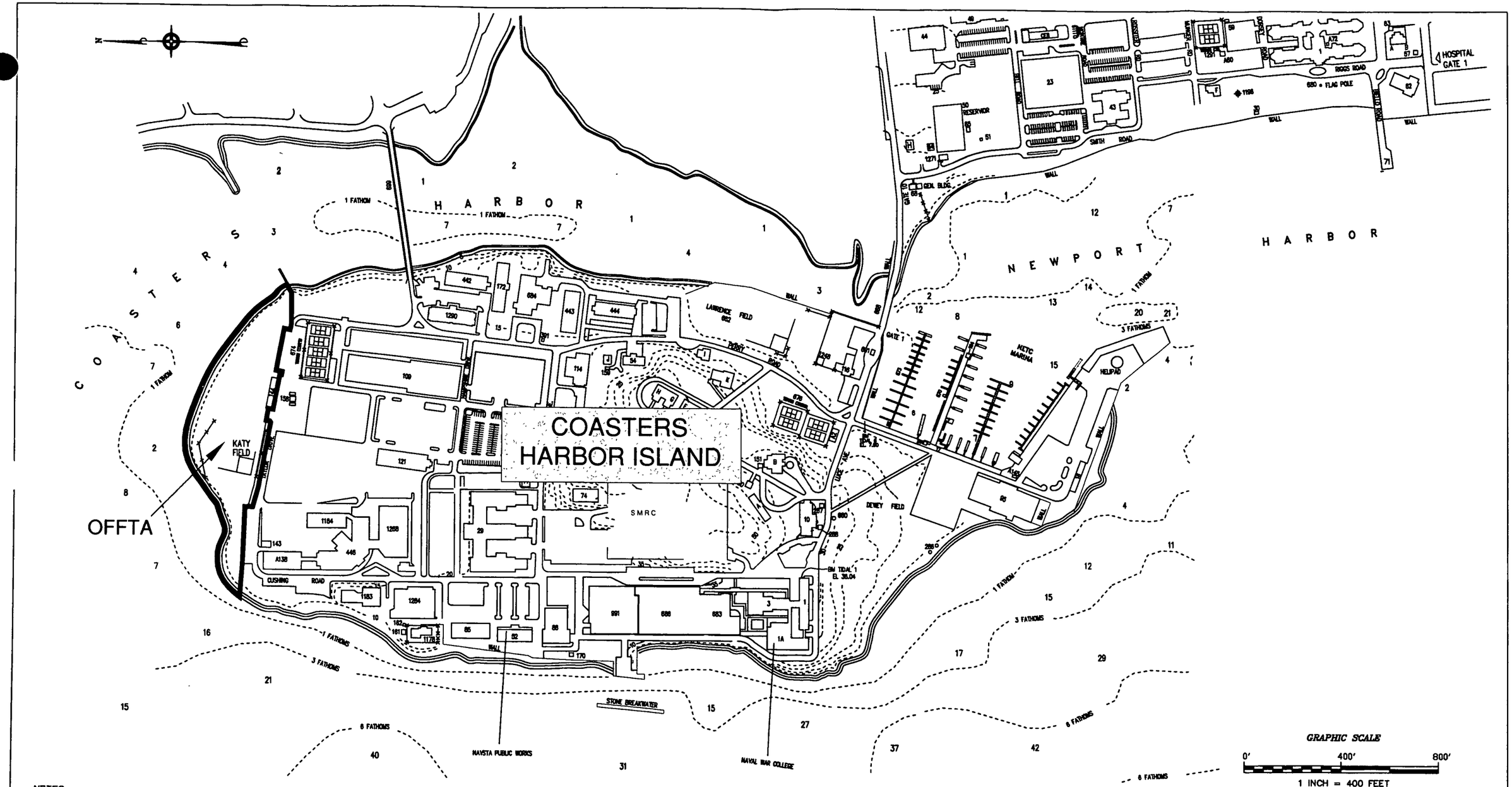
FIGURES



SITE LOCUS		FIGURE 1-1	
OLD FIRE FIGHTING TRAINING AREA		TETRA TECH NUS, INC.	
NAVSTA NEWPORT – NEWPORT, RHODE ISLAND		55 Jonspin Road Wilmington, MA 01887 (978)658-7899	
DRAWN BY.	D.W. MACDOUGALL	REV..	0
CHECKED BY:	D. BAXTER	DATE:	SEPTEMBER 5, 2000
SCALE:	AS NOTED	ACAD NAME:	DWG\5278\0531\FIG_1-1 DWG



NAVSTA NEWPORT SITES AND STUDY AREAS			FIGURE 1–2
OLD FIRE FIGHTING TRAINING AREA			TETRA TECH NUS, INC.
NAVSTA NEWPORT – NEWPORT, RHODE ISLAND			55 Jonspin Road Wilmington, MA 01887 (978)658–7899
DRAWN BY:	D W MACDOUGALL	REV.. 0	
CHECKED BY	D McKENNA	DATE: SEPTEMBER 20, 2000	
SCALE:	AS NOTED	FILE NO ·DWG\5278\0531\FIG_1–2.DWG	

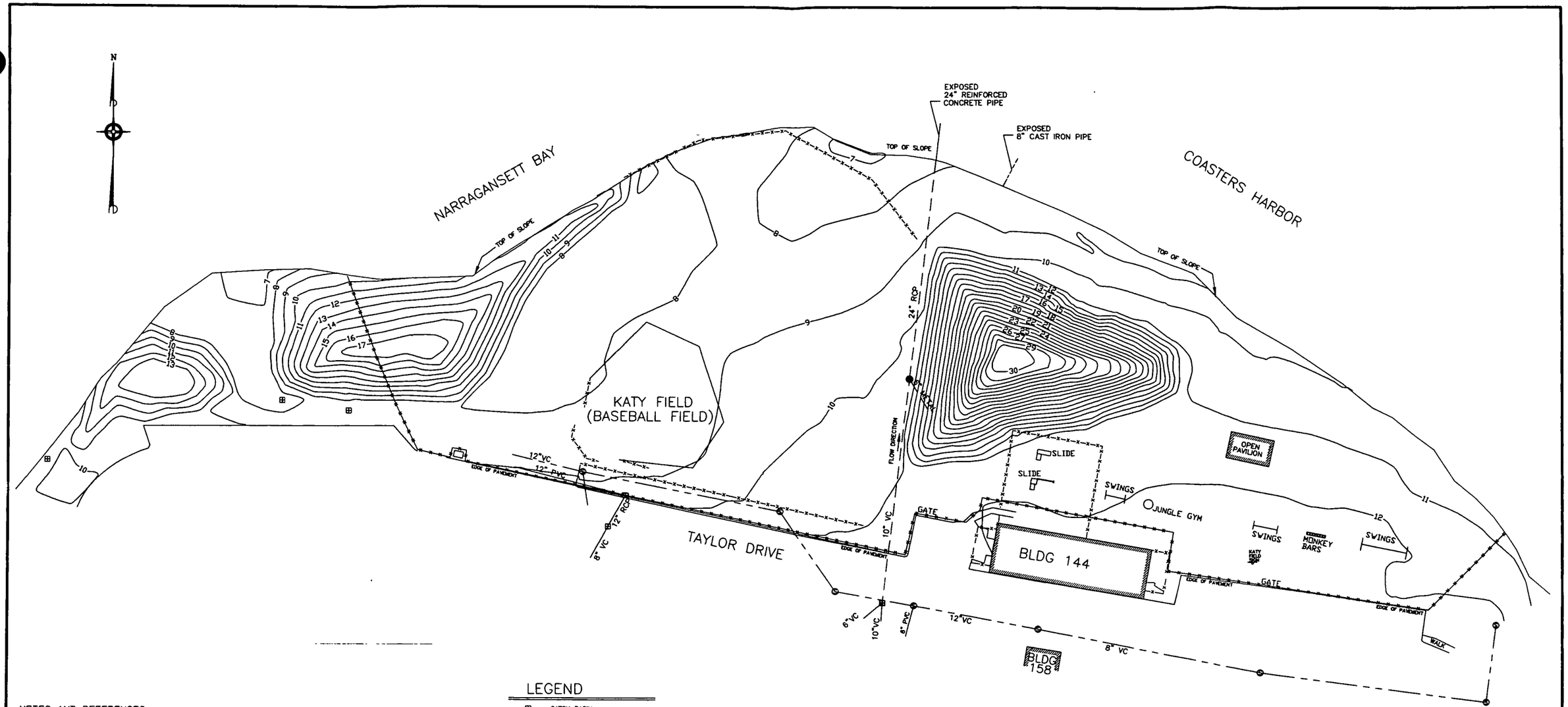


NOTES:

BASE MAP FROM PLAN BY DEPT. OF NAVY, "COASTERS HARBOR ISLAND AND NAVAL HOSPITAL EXISTING CONDITIONS MAP", DATED: 9/98, NETC DWG NO.: 31058-307, CODE ID NO.: 80091, SCALE: 1"=200'.

NARRAGANSETT BAY

OFFTA LOCATION MAP			FIGURE 1-3
OLD FIRE FIGHTING TRAINING AREA			TETRA TECH NUS, INC.
NAVSTA NEWPORT – NEWPORT, RHODE ISLAND			55 Jonspin Road Wilmington, MA 01887 (978)658-7899
DRAWN BY: D.W. MACDOUGALL	REV.: 0		
CHECKED BY: D. BAXTER	DATE: OCTOBER 9, 2000		
SCALE: 1" = 400'	FILE NO.: DWG\5278\0531\FIG_1-3.DWG		



NOTES AND REFERENCES:

1. DRAWING COMPILED FROM A DRAWING ENTITLED 'BASE MAP OLD FIRE FIGHTING TRAINING AREA NETC, NEWPORT, RHODE ISLAND, JULY 1997, PROJ. NO. 7578 CTO: 288, BY BROWN & ROOT ENVIRONMENTAL, SOURCE: BASE PLAN BY GUERRIERE & HALNON, INC., DATED NOVEMBER 10, 1997, AND THE ADDITION OF FIELD MEASURED FEATURES, BY LOUIS FEDERICI AND ASSOCIATES 3/16/99, PRESENTED ON A DRAWING ENTITLED 'KADY FIELD, TOPOGRAPHIC, SOIL SAMPLE LOCATION, AND SITE SURVEY AT THE OLD FIRE FIGHTING TRAINING AREA, NAVAL STATION NEWPORT IN NEWPORT, RHODE ISLAND FOR TETRA TECH NUS, INC., LOUIS FEDERICI & ASSOCIATES, 3/16/99, DWG NO. 990205-01.

2. HORIZONTAL DATUM BASE ON THE RI STATE PLANE COORDINATE SYSTEM NAD 1927. VERTICAL DATUM BASED ON NAVAL BASE MEAN LOW WATER.

3. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.

4. PLAN NOT TO BE USED FOR DESIGN.

LEGEND

- CATCH BASIN
- SIGN
- FENCE
- EXISTING CONTOUR
- SANITARY SEWER MANHOLE
- SANITARY SEWER
- STORM SEWER MANHOLE
- STORM SEWER MANHOLE

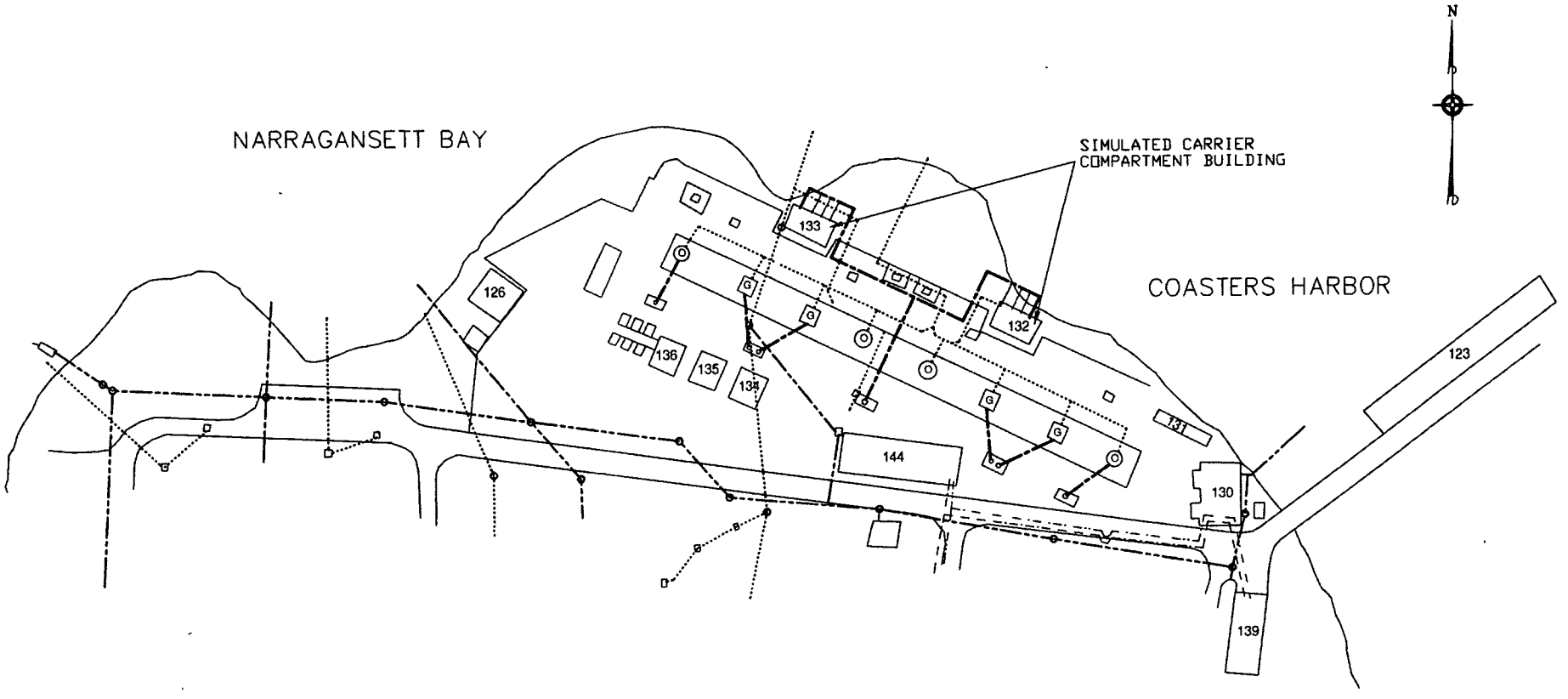
GRAPHIC SCALE

0' 80' 160'

1 INCH = 80 FEET

SITE PLAN			FIGURE 1-4
OLD FIRE FIGHTING TRAINING AREA			
NAVSTA NEWPORT – NEWPORT, RHODE ISLAND			TETRA TECH NUS, INC.
DRAWN BY:	D.W. MACDOUGALL	REV.	0
CHECKED BY:	D. BAXTER	DATE:	OCTOBER 17, 2000
SCALE:	1" = 80'	FILE NO..	DWG\5278\0531\FIG_1-4 DWG

55 Jonspin Road Wilmington, MA 01887
(978)658-7899

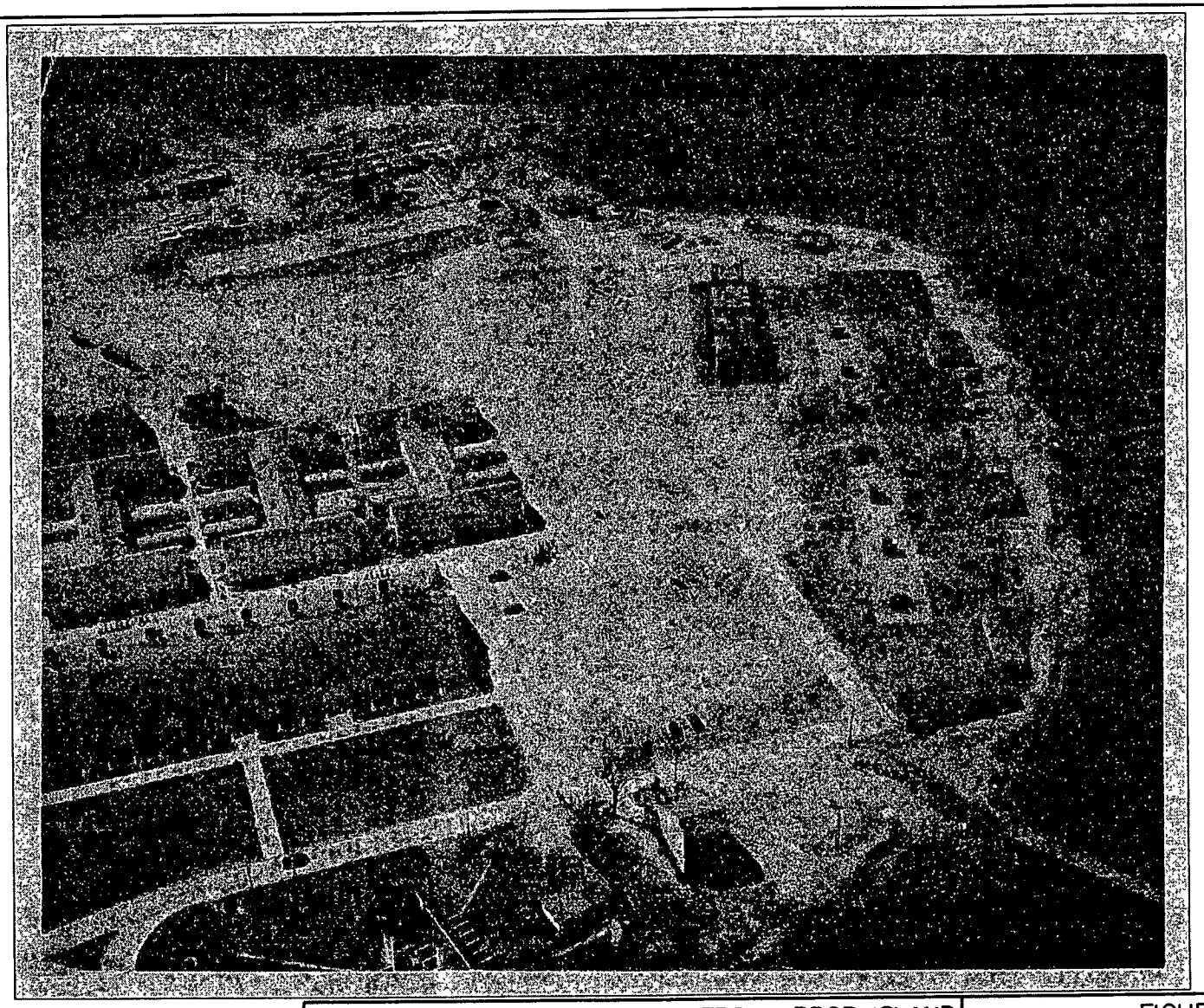


LEGEND

- 135 BUILDING AND BUILDING ID
- STEAM LINE RETURN
- STEAM LINE SUPPLY
- STORM SEWER LINE
- SANITARY SEWER LINE
- OIL LINE
- OIL TANKS
- GAS TANKS

SOURCE: MASTER SHORE STATION DEVELOPMENT PLANS, US NAVAL STATION NEWPORT, R. I., 1953

1953 FACILITY DESIGN MAP			FIGURE 1-5
OLD FIRE FIGHTING TRAINING AREA			TETRA TECH NUS, INC.
NAVSTA NEWPORT – NEWPORT, RHODE ISLAND			55 Jonspin Road Wilmington, MA 01887 (978)658-7899
DRAWN BY.	D.W. MACDOUGALL	REV.:	0
CHECKED BY:	D. McKENNA	DATE	SEPTEMBER 29, 2000
SCALE.	NOT TO SCALE	FILE NO.:	DWG\5278\0531\FIG_1-5 DWG



SOURCE: OFFICIAL PHOTOGRAPH; US NAVAL AIR STATION; QUONSET POINT, RHODE ISLAND; NEG NO. 5979; DATE - MAY 1, 1944.

1944 AERIAL PHOTO – COASTERS HARBOR ISLAND			
OLD FIRE FIGHTING TRAINING AREA			
NAVSTA NEWPORT – NEWPORT, RHODE ISLAND			
DRAWN BY.	D W. MACDOUGALL	REV.:	0
CHECKED BY	D BAXTER	DATE	AUGUST 28, 2000
SCALE	NOT TO SCALE	FILE NO.	DWG\5278\0531\FIG_1-6 DWG

FIGURE 1–6

TETRA TECH NUS, INC.

55 Jonspin Road Wilmington, MA 01887
(978)658-7899

OFF-3	DEPTH = 0-0.5 FT	
BENZO(A)PYRENE	3450 J	UG/KG
BENZO(GHI)PERYLENE	5370 J	UG/KG
INDENO(1,2,3-CD)PYRENE	6560 J	UG/KG

OFF-333(HH-W)	DEPTH = 0-0.5 FT.	
BENZO(A)PYRENE (DUP)	770 J	UG/KG
BENZO(A)PYRENE (DUP)	910 J	UG/KG

OFF-5	DEPTH = 0-0.5 FT	
2-METHYLNAPHTHALENE	330 J	UG/KG
ACENAPHTHYLENE	509	UG/KG
BENZO(A)PYRENE	4830	UG/KG
BENZO(GHI)PERYLENE	5990 J	UG/KG
INDENO(1,2,3-CD)PYRENE	7390	UG/KG

INNER TIDAL AREA NO.	LOW-TIDE AREA
333	3,660 sf
334	8,990 sf
335	12,700 sf
336	10,610 sf
337	10,300 sf

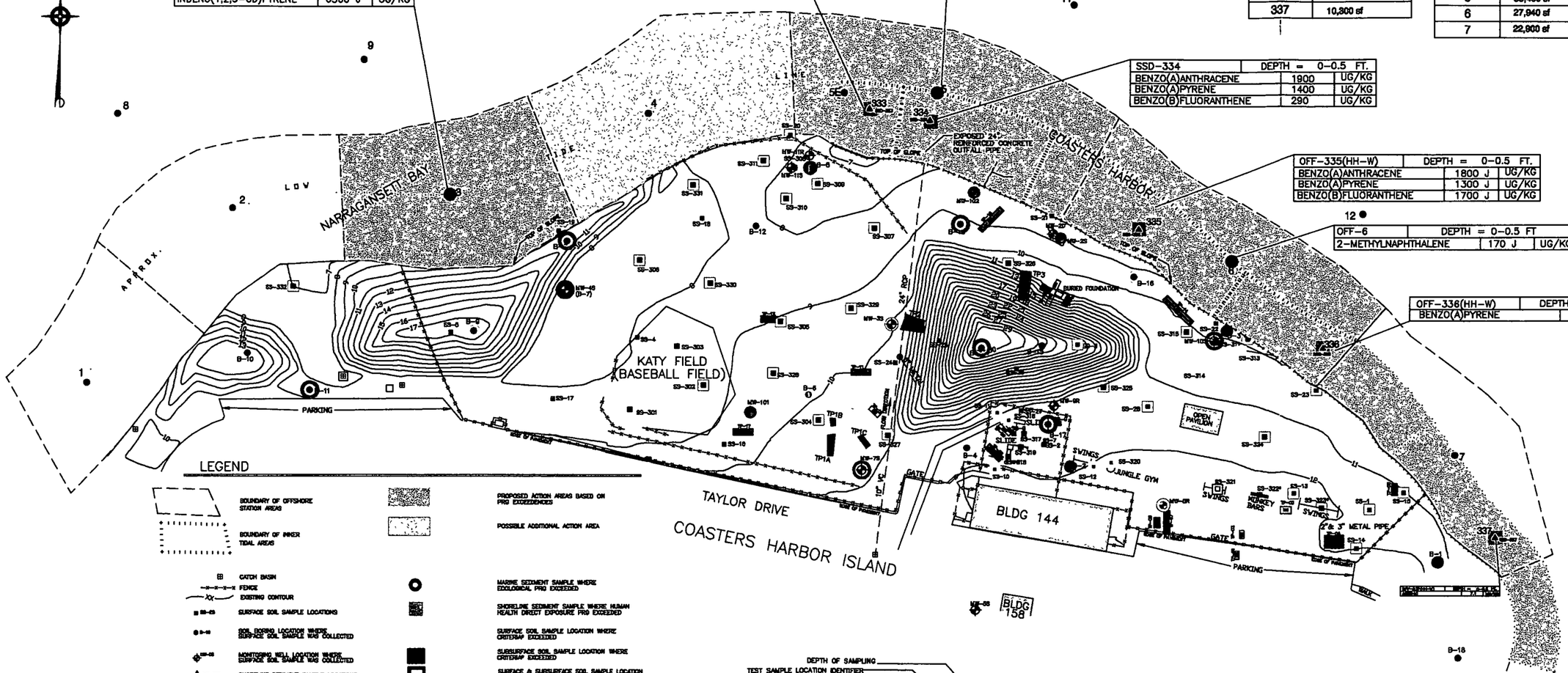
AREA NO.	AREA
1	19,430 sf
2	25,110 sf
3	24,980 sf
4	27,440 sf
5	33,460 sf
6	27,940 sf
7	22,900 sf

SSD-334	DEPTH = 0-0.5 FT.	
BENZO(A)ANTHRACENE	1900	UG/KG
BENZO(A)PYRENE	1400	UG/KG
BENZO(B)FLUORANTHENE	290	UG/KG

OFF-335(HH-W)	DEPTH = 0-0.5 FT.	
BENZO(A)ANTHRACENE	1800 J	UG/KG
BENZO(A)PYRENE	1300 J	UG/KG
BENZO(B)FLUORANTHENE	1700 J	UG/KG

OFF-6	DEPTH = 0-0.5 FT	
2-METHYLNAPHTHALENE	170 J	UG/KG

OFF-336(HH-W)	DEPTH = 0-0.5 FT.	
BENZO(A)PYRENE	520 J	UG/KG



LEGEND

- BOUNDARY OF OFFSHORE STATION AREAS
- BOUNDARY OF INNER TIDAL AREAS
- CATCH BASIN
- FENCE
- EXISTING CONTOUR
- SURFACE SOIL SAMPLE LOCATIONS
- SOIL BORING LOCATION WHERE SURFACE SOIL SAMPLE WAS COLLECTED
- MONITORING WELL LOCATION WHERE SURFACE SOIL SAMPLE WAS COLLECTED
- SHORELINE SEDIMENT SAMPLE LOCATIONS
- STORM SEWER
- TEST PIT LOCATION WHERE SUBSURFACE SOIL SAMPLE(S) WERE COLLECTED (SBARE, 6/97)
- TEST PIT LOCATION WHERE SUBSURFACE SOIL SAMPLE(S) WERE COLLECTED (TRC, 1/94)
- PROPOSED ACTION AREAS BASED ON PRG EXCEEDENCES
- POSSIBLE ADDITIONAL ACTION AREA
- MARINE SEDIMENT SAMPLE WHERE ECOLOGICAL PRG EXCEEDED
- SHORELINE SEDIMENT SAMPLE WHERE HUMAN HEALTH DIRECT EXPOSURE PRG EXCEEDED
- SURFACE SOIL SAMPLE LOCATION WHERE CRITERIAP EXCEEDED
- SUBSURFACE SOIL SAMPLE LOCATION WHERE CRITERIAP EXCEEDED
- SURFACE & SUBSURFACE SOIL SAMPLE LOCATION WHERE CRITERIAP EXCEEDED

* RIDEM RESIDENTIAL DIRECT EXPOSURE CRITERIA EXCEPT FOR ARSENIC (PROPOSED 6.2 MG/KG BACKGROUND LEVEL WAS USED)

SELECT CONTAMINANTS INCLUDE ARSENIC, LEAD, BENZO(A)PYRENE, AND TPH

DEPTH OF SAMPLING
TEST SAMPLE LOCATION IDENTIFIER
CONTAMINANT TESTED
SAMPLE RESULTS

OFF-3	DEPTH = 0-0.5 FT	
INDENO(1,2,3-CD)PYRENE	6560 J	UG/KG

TYPICAL CONTAMINANT LEVEL BOX

U INDICATES CONTAMINANT NOT DETECTED AT DETECTION LEVEL SPECIFIED
J INDICATES THAT QUANTITATION IS APPROXIMATE

TAGS WITH GRAY BACKGROUNDS HAVE OTHER CONTAMINANTS THAT EXCEED THE CRITERIA.
TAGS WITH WHITE BACKGROUNDS LIST ALL CONTAMINANTS THAT EXCEED THE CRITERIA.
SEE TABLES 1 AND 2 FOR A COMPLETE LIST OF CONTAMINANTS EXCEEDING CRITERIA.

GRAPHIC SCALE

0' 100' 200'

1 INCH = 100 FEET

NOTES AND REFERENCES:

1. DRAWING COMPILED FROM A DRAWING ENTITLED "BASE MAP OLD FIRE FIGHTING TRAINING AREA NETC, NEWPORT, RHODE ISLAND, JULY 1997, PROJ. NO. 7578 CTO: 288, BY BROWN & ROOT ENVIRONMENTAL, SOURCE: BASE PLAN BY GUERRIERE & HALNON, INC., DATED NOVEMBER 10, 1997, AND THE ADDITION OF FIELD MEASURED FEATURES, BY LOUIS FEDERICI AND ASSOCIATES 3/16/99, PRESENTED ON A DRAWING ENTITLED "KADY FIELD, TOPOGRAPHIC, SOIL SAMPLE LOCATION, AND SITE SURVEY AT THE OLD FIRE FIGHTING TRAINING AREA, NAVAL STATION NEWPORT IN NEWPORT, RHODE ISLAND FOR TETRA TECH NUS, INC., LOUIS FEDERICI & ASSOCIATES, 3/16/99, DWG NO. 990205-01.

2. HORIZONTAL DATUM BASE ON THE RI STATE PLANE COORDINATE SYSTEM NAD 1927. VERTICAL DATUM BASED ON NAVEL BASE MEAN LOW WATER.

3. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.

4. PLAN NOT TO BE USED FOR DESIGN.

SEDIMENT AREAS EXCEEDING PRGs

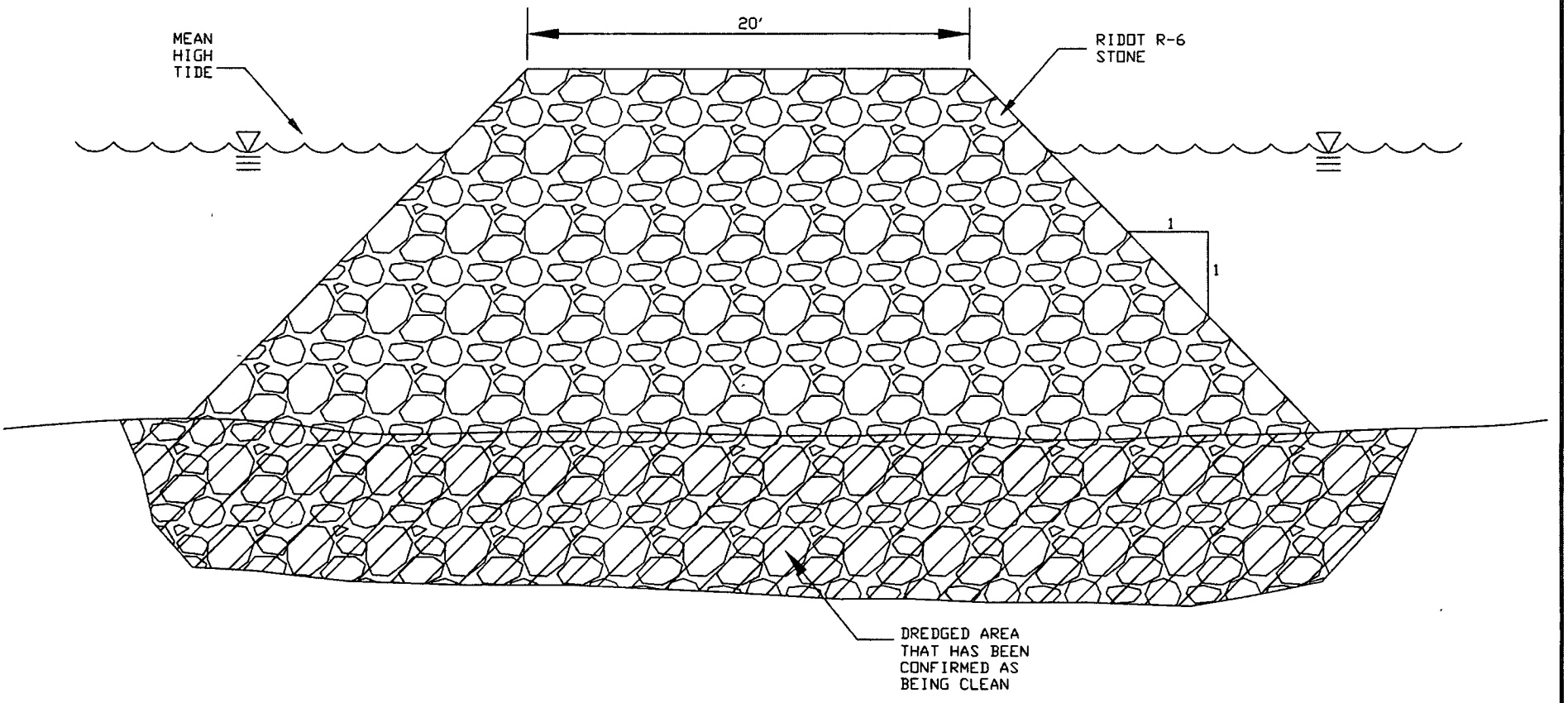
OLD FIRE FIGHTER TRAINING AREA SITE, COASTERS HARBOR ISLAND

NAVAL STATION NEWPORT, RHODE ISLAND

DRAWN BY:	R.G. DEWSNAP	REV.:	0
CHECKED BY:	J. FORRELLI	DATE:	APRIL 20. 2001
SCALE:	1" = 100'	FILE NO.:	\DWG\5278\0445\SED_EX_A.DWG

FIGURE 2-4

TETRA TECH NUS, INC.
55 Jonspin Road Wilmington, MA 01887
(978)658-7899



NOTES:

BAY HAUL ROAD ELEVATION				FIGURE 5–2
OLD FIRE FIGHTING TRAINING AREA				TETRA TECH NUS, INC.
NAVSTA NEWPORT – NEWPORT, RHODE ISLAND				55 Jonspin Road Wilmington, MA 01887 (978)658–7899
DRAWN BY:	D.W. MACDOUGALL	REV	0	
CHECKED BY	J. DAVIS	DATE	APRIL 4, 2001	
SCALE:	NOT TO SCALE	FILE NO.:	DWG\5278\0445\FIG_5–3.DWG	

APPENDIX A

PRG DEVELOPMENT FOR SOIL

APPENDIX A
PRG DEVELOPMENT FOR SOIL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

This appendix provides the supporting documentation for the development of soil PRGs.

A.1 RISK-BASED CONCENTRATIONS

The risk-based concentrations (to be used in the PRG development process) were calculated based on data used in the HHRA. RBCs for carcinogens were based on a risk of 1×10^{-6} for carcinogens and an HQ of 1.0 for non-carcinogens. The scenario used to calculate the carcinogenic RBCs was the lifetime resident, which was the most conservative carcinogenic risk scenario in the HHRA. The scenario used to calculate the non-carcinogenic RBCs was the child resident, which was the most conservative non-carcinogenic risk scenario in the HHRA. For each chemical, the more conservative of the carcinogenic RBC and the non-carcinogenic RBC was chosen during the PRG selection process

The equations and spreadsheet showing the calculations for the risk-based concentrations are included in this appendix.

A.2 RIDEM DIRECT EXPOSURE CRITERIA

The RIDEM Remediation Regulations provide the methodology for determining remedial objectives for soil. Method 1 Soil Objectives are published in tables in the regulation, and site concentrations are compared directly to these numbers If no Method 1 Soil Objective has been promulgated for a specific chemical, then a Method 2 Soil Objective is calculated for the site using the prescribed method and assumptions provided in the regulation For direct exposure, the Method 2 calculations use the same equations and assumptions as those for the Method 1.

Many of the chemicals detected at OFFTA have Method 1 Objectives listed in the tables. For those chemicals not listed, Method 2 Direct Exposure Criteria were calculated for use in the screening process. The procedure for the calculations is outlined in Appendix D of the RIDEM Remediation Regulations. A copy of that appendix from the Remediation Regulations and the spreadsheets used to calculate the Method 2 criteria for chemicals at OFFTA are included in this appendix.

EQUATIONS FOR RISK-BASED CONCENTRATIONS

The following equations were used to calculate the risk-based concentrations. The assumptions are the same as those in the HHRA found in the RI, and the equations directly correspond to the HHRA, except that they have been rearranged to calculate the concentration instead of the risk. The values used for each variable are provided on the accompanying spreadsheet.

Non-Carcinogenic Ingestion (child resident)

$$C = \frac{HI \cdot RfD \cdot BW_{child} \cdot 365 \frac{days}{yr}}{EF \cdot 10^{-6} \frac{kg}{mg} \cdot IR_{soil-child}}$$

Non-Carcinogenic Dermal Contact (child resident)

$$C = \frac{HI \cdot RfD \cdot AT_{non-child}}{EF \cdot EV \cdot 10^{-6} \frac{kg}{mg} \cdot SAADJ_{child} \cdot SSAF_{child} \cdot DABS}$$

Carcinogenic Ingestion (lifetime resident)

$$C = \frac{TargetRisk \cdot AT_{car}}{CSF \cdot EF \cdot 10^{-6} \frac{kg}{mg} \cdot IF_{soil-adj}}$$

Carcinogenic Dermal Contact (lifetime resident)

$$C = \frac{TargetRisk \cdot AT_{car}}{CSF \cdot EV \cdot EF \cdot 10^{-6} \frac{kg}{mg} \cdot SAADJ_{life} \cdot SSAF \cdot DABS}$$

Carcinogenic Inhalation (lifetime resident)

$$C = \frac{TargetRisk \cdot AT_{car} \cdot PEF}{CSF \cdot EF \cdot IR_{air-adj}}$$

where:

C	=	Soil Concentration (mg/kg)
HI	=	Hazard Index (unitless)
RfD	=	Reference Dose (mg/kg-day)
BW_{child}	=	Body Weight, child (kg)
EF	=	Exposure Frequency (days)
$IR_{soil\text{-}child}$	=	Soil Ingestion Rate, child (mg/day)
$AT_{non\text{-}child}$	=	Averaging Time, non-carcinogen, child
EV	=	Event Frequency (events/day)
$SAADJ_{child}$	=	Age-Adjusted Skin Surface Area/Body Weight Ratio, child (cm^2-yr/kg)
$SSAF_{child}$	=	Soil-to-Skin Adherence Factor (mg/cm^2-event)
DABS	=	Dermal Absorption Factor (unitless)
TargetRisk	=	Target Risk
AT_{car}	=	Averaging Time, carcinogen (days)
CSF	=	Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$
$IF_{soil\text{-}adj}$	=	Age-Adjusted Ingestion Rate/Body Weight Ratio (mg-yr/kg-day)
$SAADJ_{life}$	=	Age-Adjusted Skin Surface Area/Body Weight Ratio (cm^2-yr/kg)
PEF	=	Particulate Emission Factor
$IR_{air\text{-}adj}$	=	Age-Adjusted Inhalation Rate/Body Weight Ratio (m^3-yr/kg-day)

RISK-BASED CONCENTRATIONS FOR SOIL
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

INPUT PARAMETER	VALUE
IR soil adult (mg/day)	100
IR soil child (mg/day)	200
IF soil adj (mg-yr/kg-day)	106 6
IR air adult (m^3/day)	28 8
IR air child (m^3/day)	38 4
IR air adj (m^3-yr/kg-day)	23 8
EF (days/year)	240
ED (years)	30
ED child (years)	6
BW adult (kg)	70
BW child (kg)	16 6
ATcar (days)	25550
ATnon child (days)	2190
SA adult (cm^2)	7014
SA-ADJ life (cm^2-yr/kg)	3541
SA-ADJ child (cm^2-yr/kg)	1136
SSAF child (mg/cm^2-event)	0 2
SSAF adult (mg/cm^2-event)	0 08
EV (events/day)	1
PEF (m^3/kg)	1 32E+09
Target HI	1
Target Risk	1 00E-06

CHEMICAL OF POTENTIAL CONCERN	Toxicity and Other Chemical-Specific Data						NON-CARCINOGEN child resident			CARCINOGEN lifetime resident			
	RfD_{oral} (mg/kg/d)	CSF_{oral} $(mg/kg/d)^{-1}$	RfD_{derm} (mg/kg/d)	CSF_{derm} $(mg/kg/d)^{-1}$	CSF_{inh} $(mg/kg/d)^{-1}$	DABS (unitless)	ingestion (mg/kg)	dermal (mg/kg)	combined (mg/kg)	ingestion (mg/kg)	dermal (mg/kg)	inhalation (mg/kg)	combined (mg/kg)
4-Chloro-3-Methylphenol													
4,6-Dinitro-2-Methylphenol													
Benzo(a)anthracene		7 30E-01		7 30E-01		0 13				1 37E+00	2 68E+00		9 06E-01
Benzo(a)pyrene		7 30E+00		7 30E+00	3 10E+00	0 13				1 37E-01	2 68E-01	1 91E+03	9 06E-02
Benzo(b)fluoranthene		7 30E-01		7 30E-01		0 13				1 37E+00	2 68E+00		9 06E-01
Benzo(k)fluoranthene		7 30E-02		7 30E-02		0 13				1 37E+01	2 68E+01		9 06E+00
Carbazole		2 00E-02		2 00E-02		0 13				4 99E+01	9 80E+01		3 31E+01
Chrysene		7.30E-03		7 30E-03		0 13				1 37E+02	2 68E+02		9 06E+01
Dibenzo(a,h)anthracene		7 30E+00		7 30E+00		0 13				1 37E-01	2 68E-01		9 06E-02
Indeno(1,2,3-cd)pyrene		7 30E-01		7 30E-01		0 13				1 37E+00	2 68E+00		9 06E-01
delta-BHC													
Dieldrin	5 00E-05	1 60E+01	5 00E-05	1 60E+01	1 60E+01		6 31E+00		6 31E+00	6 24E-02		3 70E+02	6 24E-02
Aroclor-1254	2 00E-05	2 00E+00	2 00E-05	2 00E+00	2 00E+00	0 14	2 52E+00	5 74E+00	1 75E+00	4 99E-01	9 10E-01	2 96E+03	3 22E-01
Antimony	4 00E-04		6 00E-05				5 05E+01		5 05E+01				
Arsenic	3 00E-04	1 50E+00	3 00E-04	1 50E+00	1 51E+01	0 03	3 79E+01	4 02E+02	3 46E+01	6 66E-01	5 66E+00	3 92E+02	5 95E-01
Chromium	3 00E-03		7 50E-05		4 10E+01		3 79E+02		3 79E+02			1 44E+02	1 44E+02
Lead													
Manganese	7.20E-02		4 32E-03				9 09E+03		9 09E+03				
Mercury	1 00E-04		7 00E-06				1 26E+01		1 26E+01				
Nickel	2 00E-02		8 00E-04				2 52E+03		2 52E+03				
Vanadium	7 00E-03		1 82E-04				8 84E+02		8 84E+02				
Zinc	3 00E-01		3 00E-01				3 79E+04		3 79E+04				
2,3,7,8-TCDD		1 50E+05		1 50E+05	1 50E+05	0 03				6.66E-06	5 66E-05	3 94E-02	5 96E-06

Appendix D
METHOD 2 DIRECT EXPOSURE CRITERIA

Method 2 Direct Exposure Criteria:

A. Ingestion:

i. Residential Activity:

1. Carcinogenic Substances:

RESIDENTIAL INGESTION ALGORITHM FOR CARCINOGENS IN SOIL:

$$C = \left(\frac{RISK \times AT \times CF}{CPSo \times EF} \right) \times \left(\frac{BW_a \times BW_c}{BW_a \times ED_c \times IRS_c + BW_c \times ED_a \times IRS_a} \right)$$

2. Non-Carcinogenic Substances:

RESIDENTIAL INGESTION ALGORITHM FOR NON-CARCINOGENS IN SOIL:

$$C = \left(\frac{HI \times RfD_o \times CF}{EF} \right) \times \left(\frac{BW_c \times AT_c}{ED_c \times IRS_c} \right)$$

3. Acute Toxicity:

ACUTE INGESTION ALGORITHM FOR SOIL:

$$C = \left(\frac{TDHA \times IR_{at\ w}}{IR_{at-s} \times CF_{AT}} \right)$$

RESIDENTIAL DEFAULT INPUT PARAMETERS			
ORAL INGESTION			
TERM	**DESCRIPTION**	**UNITS**	**VALUE**
C	Concentration Of Contaminant In Soil	mg/kg	Calculated
CPSo	Carcinogenic Potency Slope Factor (Oral)	$(mg/kg/d)^{-1}$	Chemical Specific
RfDo	Reference Dose (Oral)	mg/kg/d	Chemical Specific
RISK	Target Cancer Risk Level	Dimensionless	1 E-06
HI	Hazard Index	Dimensionless	1.0
BW_a	Body Weight (Adult)	kg	70
BW_c	Body Weight (Child Ages 1-6)	kg	15
AT	Averaging Time (Carcinogens)	yr	70
AT_c	Averaging Time (Child Ages 1-6)	yr	6
IRS_a	Soil Ingestion (Adult)	mg/d	100
IRS_c	Soil Ingestion (Child Ages 1-6)	mg/d	200
CF	Conversion Factor	mg-d/kg-yr	3.65 E08*
EF	Exposure Frequency	d/yr	350
ED_a	Exposure Duration (Adult)	yr	24
ED_c	Exposure Duration (Child Ages 1-6)	yr	6
ORAL ACUTE TOXICITY			
TDHA	Ten Day Health Advisory (10 kg Child)	mg/l	Chemical Specific
IR_{at-w}	Ingestion Rate Of Water	l/d	1
IR_{at-s}	Ingestion Rate Of Soil	g/d	1
CF_{at}	Conversion Factor (Acute Toxicity)	kg/g	1 E-03

* Conversion factor (365 d/yr)(1xE06 mg/kg) = 3 65 E08 mg-d/kg-yr

ii Industrial/Commercial Activity:

1. Carcinogenic Substances:

INDUSTRIAL/COMMERCIAL INGESTION ALGORITHM FOR CARCINOGENS IN SOIL:

$$C = \left(\frac{RISK \times AT \times CF}{CPSo \times EF} \right) \times \left(\frac{BW_a}{ED \times IRS_a} \right)$$

2. Non-Carcinogenic Substances:

INDUSTRIAL/COMMERCIAL INGESTION ALGORITHM FOR NON-CARCINOGENS IN SOIL:

$$C = \left(\frac{HI \times RfD_o \times CF}{EF} \right) \times \left(\frac{BW_a \times AT_a}{ED \times IRS_a} \right)$$

INDUSTRIAL\COMMERCIAL DEFAULT INPUT PARAMETERS			
TERM	DESCRIPTION	UNITS	VALUE
C	Concentration Of Contaminant In Soil	mg/kg	Calculated
CPSo	Carcinogenic Potency Slope Factor (Oral)	$(mg/kg/d)^{-1}$	Chemical Specific
RfDo	Reference Dose (Oral)	mg/kg/d	Chemical Specific
RISK	Target Cancer Risk Level	Dimensionless	1 E-06
HI	Hazard Index	Dimensionless	1
BW_a	Body Weight (Adult)	kg	70
AT	Averaging Time (Carcinogens)	yr	70
AT_a	Averaging Time, Adult (Non-carcinogens)	yr	25
IRS_a	Soil Ingestion Rate (Adult)	mg/d	50
EF	Exposure Frequency	d/yr	250
ED	Exposure Duration	yr	25
CF	Conversion Factor	mg-d/kg-yr	3.65 E08*

* Conversion factor (365 d/yr)(1xE06 mg/kg) = 3.65 E08 mg-d/kg-yr

B. Inhalation: The **RESIDENTIAL** inhalation concentration shall be calculated using the following equations and the appropriate default input values:

i. Carcinogenic Substances:

INHALATION ALGORITHM FOR CARCINOGENS IN SOIL:

$$C = \frac{RISK \times AT \times 365\ d/yr}{URF \times 1000\ \mu g/mg \times EF \times ED \times \left[\frac{1}{VF} + \frac{1}{PEF} \right] \times TA}$$

ii. Non-Carcinogenic Substances:

INHALATION ALGORITHM FOR NON-CARCINOGENS IN SOIL:

$$C = \frac{HI \times AT \times 365\ d/yr}{EF \times ED \times \left[\frac{1}{RfC} \times \left(\frac{1}{VF} + \frac{1}{PEF} \right) \right] \times TA}$$

iii. Volatilization Factor:

VOLATILIZATION FACTOR ALGORITHM:

iii. Volatilization Factor:

VOLATILIZATION FACTOR ALGORITHM:

$$VF\ (m^3/kg) = (Q/C)\ x\ \frac{(3.14\ x\ \alpha\ x\ T)^{1/2}}{(2\ x\ D_{ei}\ x\ P_a\ x\ K_{as})}\ x\ 10^{-4}\ m^2/cm^2$$

Where :

$$\alpha = \frac{D_{ei}\ x\ P_a}{P_a + (\rho_s)(1 - P_a)/K_{as}}$$

RESIDENTIAL DEFAULT INPUT PARAMETERS			
INHALATION			
TERM	DESCRIPTION	UNITS	VALUE
C	Concentration Of Contaminant In Soil	mg/kg	Calculated
RISK	Target Cancer Risk Level (Carcinogens)	Dimensionless	10^{-6}
HI	Hazard Index (Noncarcinogens)	Dimensionless	1
AT	Averaging Time (Carcinogens)	years	70
AT	Averaging Time (Noncarcinogens)	years	30
URF	Inhalation Unit Risk Factor (Carcinogens)	$(\mu g/m^3)^{-1}$	Chemical Specific
RfC	Inhalation Reference Concentration (Noncarcinogens)	mg/m^3	Chemical Specific
EF	Exposure Frequency	days/year	350
ED	Exposure Duration	years	30
VF	Soil-To-Air Volatilization Factor	m^3/kg	Chemical Specific
PEF	Particulate Emission Factor	m^3/kg	4.51×10^9
TA	Time Adjustment Factor	Dimensionless	1

DEFAULT INPUT PARAMETERS			
VOLATILIZATION FACTOR			
TERM	DESCRIPTION	UNITS	VALUE
VF	Soil-To-Air Volatilization Factor	m^3/kg	Calculated
(Q/C)	Inverse Of The Mean Concentration At The Center Of A 0.5 Acre Square Source	g/m^2-s per kg/m^3	101.8
T	Exposure Interval	seconds	7.9×10^8
D_{eff}	Effective Diffusivity	cm^2/s	$D_i(P_a^{3.33}/P_t^2)$
P_a	Air-Filled Soil Porosity	Dimensionless	$P_t-\Theta\beta$
P_t	Total Soil Porosity	Dimensionless	$1-(\beta/\rho_s)$
Θ	Soil Moisture Content	cm^3-water / g-soil	0.1 (10%)
β	Soil Bulk Density	g/cm^3	1.5
ρ_s	True Soil Density Or Particle Density	g/cm^3	2.65
K_{as}	Soil-Air Partition Coefficient	g-soil / cm^3-air	$(H/K_d) \times 41$
D_i	Diffusivity In Air	cm^2/s	Chemical Specific
H	Henry's Law Constant	atm-m^3/mol	Chemical Specific
K_d	Soil-Water Partition Coefficient	cm^3/g	K_{oc} x OC
K_{oc}	Organic Carbon Partition Coefficient	cm^3/g	Chemical Specific
OC	Organic Carbon Content Of Soil	fraction	0.02 (2%)

C. Soil Saturation Limit (Csat):

SOIL SATURATION LIMIT ALGORITHM FOR UNSATURATED SOILS (C_{sat}):

$$C_{sat} = \left(K_d \times S \times n_m \right) + \left(S \times \Theta_m \right)$$

SOIL SATURATION (C_{sat}) DEFAULT INPUT PARAMETERS			
TERM	**DESCRIPTION**	**UNITS**	**VALUE**
C_{sat}	Soil Saturation Concentration	mg/kg	Calculated
K_d	Soil-Water Partition Coefficient	L/kg	Chemical Specific/ or K_{oc} * OC
K_{oc}	Organic Carbon Partition Coefficient	L/kg	Chemical Specific
OC	Organic Carbon Content Of Surface Soil	%	2
S	Solubility	mg/L-water	Chemical Specific
n_m	Soil Moisture Content	Weight Fraction	0.1
Θ_m	Soil Moisture Content	L-water/ kg-soil	0.1

Note: Appendix D was also utilized for the development of Method 1 Direct Exposure Criteria.

SUMMARY OF RIDEM METHOD 2 DIRECT EXPOSURE CRITERIA
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Chemical	Residential Ingestion (mg/kg)			Res. Inhalation (mg/kg)		Csat (mg/kg)	Selected Method 2 Concentration (mg/kg)
	carcin	non-carcin	acute	carcin	non-carcin		
2-hexanone						4557	
carbon disulfide		7821			121	440	121
chloroethane							
chloromethane	49 1		400	0.494		680	0.494
4,6-dinitro-2-methylphenol						175	
4-chloro-3-methylphenol							
9H-carbazole	31.9						31.9
benzoic acid		312857				344	344
butylbenzylphthalate		15643				334	334
carbazole	31.9						31.9
di-n-butylphthalate		7821				27160	7821
di-n-octylphthalate		1564				47424	1564
dibenzofuran		313				164	164
n-nitrosodiphenylamine	130					94.1	94.1
4,4'-DDD	2.66					320	2.66
4,4'-DDE	1.88					358	1.88
4-4'-DDT	1.88	39.1		511		16.3	1.88
aldrin	0 038	2.35	0.300	2.18		4949	0.038
alpha-BHC	0.101			0.514		3.58	0.101
beta-BHC	0.355			6.67		0 341	0.341
delta-BHC						203	
endosulfan I and II		469				2.32	2.32
endosulfan sulfate							
endrin		23.5	5			5 43	5
endrin aldehyde							
endrin ketone							
gamma-BHC	0.491	23.5	1000			3 14	0.491
heptachlor	0 142	39.1	10	2 67		282	0.142
heptachlor epoxide	0.070	1.02		3.20		58.3	0.070
methoxychlor		391	50			7.82	7.82
2,3,7,8-TCDD	4.26E-06			6.12E-06		1.85E-03	4.26E-06

The following pages support the calculations for each individual exposure pathway.

METHOD 2 DIRECT EXPOSURE CRITERIA
BASED ON RESIDENTIAL INGESTION

Residential Default Input Parameters			
Oral Ingestion			
Term	**Description**	**Units**	**Value**
C	Concentration of Contaminant in Soil	mg/kg	calculated
CPSo	Carincogenic Potentcy Slope Factor (Oral)	(mg/kg/d)-1	chem-specific
RfDo	Reference Dose (Oral)	mg/kg/d	chem-specific
RISK	Target Cancer Risk Level	dimensionless	1.E-06
HI	Hazard Index	dimensionless	1
BWa	Body Weight (Adult)	kg	70
BWc	Body Weight (Child Ages 1-6)	kg	15
AT	Averaging Time (Carcinogens)	yr	70
ATc	Averaging Time (Child Ages 1-6)	yr	6
IRSa	Soil Ingestion (Adult)	mg/d	100
IRSc	Soil Ingestion (Child Ages 1-6)	mg/d	200
CF	Conversion Factor	mg-d/kg-yr	3.65E+08
EF	Exposure Frequency	d/yr	350
EDa	Exposure Duration (Adult)	yr	24
EDc	Exposure Duration (Child Ages 1-6)	yr	6

Chemical	CPSo (mg/kg/d)-1	RfDo (mg/kg/d)	Res. Ingestion (mg/kg)	
			carcin	non-carcin
2-hexanone				
carbon disulfide		1.00E-01		7821.4286
chloroethane				
chloromethane	1.30E-02		49.134615	
4,6-dinitro-2-methylphenol				
4-chloro-3-methylphenol				
9H-carbazole	2.00E-02		31.9375	
benzoic acid		4 00E+00		312857 14
butylbenzylphthalate		2 00E-01		15642.857
carbazole	2.00E-02		31.9375	
di-n-butylphthalate		1.00E-01		7821.4286
di-n-octylphthalate		2.00E-02		1564.2857
dibenzofuran		4.00E-03		312.85714
n-nitrosodiphenylamine	4 90E-03		130.35714	
4,4'-DDD	2.40E-01		2.6614583	
4,4'-DDE	3.40E-01		1.8786765	
4-4'-DDT	3.40E-01	5.00E-04	1.8786765	39.107143
aldrin	1.70E+01	3.00E-05	0.0375735	2.3464286
alpha-BHC	6.30E+00		0.1013889	
beta-BHC	1.80E+00		0.3548611	
delta-BHC				
endosulfan I and II		6.00E-03		469.28571
endosulfan sulfate				
endrin		3.00E-04		23.464286
endrin aldehyde				
endrin ketone				
gamma-BHC	1.30E+00	3.00E-04	0.4913462	23.464286
heptachlor	4.50E+00	5.00E-04	0.1419444	39.107143
heptachlor epoxide	9.10E+00	1 30E-05	0.0701923	1 0167857
methoxychlor		5.00E-03		391.07143
2,3,7,8-TCDD	1.50E+05		4.258E-06	

METHOD 2 DIRECT EXPOSURE CRITERIA
BASED ON ACUTE INGESTION

Residential Default Input Parameters			
Oral Acute Toxicity			
Term	**Description**	**Units**	**Value**
TDHA	Ten Day Health Advisory (10 kg child)	mg/l	chem-specific
IRat-w	Ingestion Rate of Water	l/d	1
IRat-s	Ingestion Rate of Soil	g/d	1
CFat	Conversion Factor (Acute Toxicity)	kg/g	1.00E-03

Chemical	TDHA (mg/l)	Non-carcin (mg/kg)
2-hexanone		
carbon disulfide		
chloroethane		
chloromethane	4.00E-01	4.00E+02
4,6-dinitro-2-methylphenol		
4-chloro-3-methylphenol		
9H-carbazole		
benzoic acid		
butylbenzylphthalate		
carbazole		
di-n-butylphthalate		
di-n-octylphthalate		
dibenzofuran		
n-nitrosodiphenylamine		
4,4'-DDD		
4,4'-DDE		
4-4'-DDT		
aldrin	3 00E-04	3.00E-01
alpha-BHC		
beta-BHC		
delta-BHC		
endosulfan I and II		
endosulfan sulfate		
endrin	5.00E-03	5.00E+00
endrin aldehyde		
endrin ketone		
gamma-BHC	1.00E+00	1.00E+03
heptachlor	1.00E-02	1.00E+01
heptachlor epoxide		
methoxychlor	5.00E-02	5.00E+01
2,3,7,8-TCDD		

METHOD 2 DIRECT EXPOSURE CRITERIA
BASED ON RESIDENTIAL INHALATION

Residential Default Input Parameters			
Inhalation			
Term	Description	Units	Value
C	Concentration of Contaminant in Soil	mg/kg	calculated
RISK	Target Cancer Risk Level (Carcinogens)	dimensionless	1.E-06
HI	Hazard Index (Noncarcinogens)	dimensionless	1
AT	Averaging Time (Carcinogens)	yr	70
AT	Averaging Time (Noncarcinogens)	yr	30
URF	Inhalation Unit Risk Factor (Carcinogens)	(ug/m3)-1	chem-specific
RfC	Inhalation Reference Conc. (Noncarcinogen	mg/m3	chem-specific
EF	Exposure Frequency	d/yr	350
ED	Exposure Duration	yr	30
VF	Soil-to-Air Volatilization Factor	m3/kg	chem-specific
PEF	Particulate Emission Factor	m3/kg	4.51E+09
TA	Time Adjustment Factor	dimensionless	1

Chemical	URF (ug/m3)-1	RfC (mg/m3)	VF (m3/kg)	Res. Inhalation (mg/kg)	
				carcin	non-carcin
2-hexanone					
carbon disulfide		7.00E-01	1.66E+02		121.17711
chloroethane					
chloromethane	1.80E-06		3.65E+02	0.4935932	
4,6-dinitro-2-methylphenol			5.22E+05		
4-chloro-3-methylphenol					
9H-carbazole			1.00E+07		
benzoic acid			1.12E+04		
butylbenzylphthalate			6.81E+06		
carbazole			1.00E+07		
di-n-butylphthalate			1.18E+08		
di-n-octylphthalate			3.82E+07		
dibenzofuran					
n-nitrosodiphenylamine			3.82E+05		
4,4'-DDD			1.62E+07		
4,4'-DDE			1.62E+07		
4-4'-DDT	9.70E-05		2 05E+07	511.30762	
aldrin	4.90E-03		4.39E+06	2.1798828	
alpha-BHC	1.80E-03		3.80E+05	0.5135748	
beta-BHC	5.30E-04		1.45E+06	6.6657114	
delta-BHC					
endosulfan I and II			5.42E+05		
endosulfan sulfate					
endrin			1.52E+06		
endrin aldehyde					
endrin ketone					
gamma-BHC			3 08E+05		
heptachlor	1.30E-03		1.43E+06	2.6738459	
heptachlor epoxide	2 60E-03		3.42E+06	3.2011931	
methoxychlor			2 65E+06		
2,3,7,8-TCDD	1 50E+02		3.77E+05	6.116E-06	

METHOD 2 DIRECT EXPOSURE CRITERIA
VOLATILIZATION FACTOR CALCULATION

Default Input Parameters	
Volatilization Factor	
Term and Units	Value
Q/C ($g/m^2/s$ per kg/m^3)	101.8
T (s)	7 90E+08
Θ (cm^3 water/g soil)	0.1
β (g/cm^3)	1.5
ρ_s (g/cm^3)	2 65
P_t (g/cm^3)	0 434
P_a (g/cm^3)	0.284
OC (fraction)	0.02

Chemical	D_i (cm^2/s)	H (unitless)	K_{oc} (cm^3/g)	D_{ei} (cm^2/s)	K_d (cm^3/g)	K_{as} (g-soil/cm^3-air)	α	VF (m^3/kg)
2-hexanone			1.51E+01	0 00E+00	0 302			
carbon disulfide	1 04E-01	1 24E+00	4 57E+01	8 35E-03	0 914	5.56E+01	7 45E-03	166
chloroethane								
chloromethane	1 26E-01	3 62E-01	3 50E+01	1 01E-02	0 7	2.12E+01	7.69E-03	365
4,6-dinitro-2-methylphenol	2 93E-02	5 76E-05	6 34E+02	2 35E-03	12.68	1 86E-04	6.55E-08	521,873
4-chloro-3-methylphenol								
9H-carbazole	3 90E-02	6.30E-07	3 39E+03	3 13E-03	67.8	3.81E-07	1 78E-10	10,001,573
benzoic acid	5 36E-02	6.31E-05	6.00E-01	4 30E-03	0.012	2 16E-01	1.34E-04	11,162
butylbenzylphthalate	1 74E-02	5.17E-05	5.75E+04	1 40E-03	1150	1 84E-06	3 85E-10	6,807,458
carbazole	3 90E-02	6 30E-07	3 39E+03	3 13E-03	67.8	3 81E-07	1.78E-10	10,001,573
di-n-butylphthalate	4 38E-02	4 00E-08	3.39E+04	3 52E-03	678	2 42E-09	1 27E-12	118,441,481
di-n-octylphthalate	1 51E-02	2 74E-03	8.32E+07	1 21E-03	1664000	6 75E-08	1 22E-11	38,182,902
dibenzofuran		8 73E-03	8.13E+03	0 00E+00	162.56	2.20E-03		
n-nitrosodiphenylamine	3 12E-02	2 05E-04	1 29E+03	2 50E-03	25.8	3 26E-04	1 22E-07	382,385
4,4'-DDD	1 69E-02	1 64E-04	1 00E+06	1 36E-03	20000	3 36E-07	6 82E-11	16,173,564
4 4'-DDE	1 44E-02	8 61E-04	4 47E+06	1 16E-03	89400	3 95E-07	6 83E-11	16,167,466
4-4'-DDT	1 37E-02	3 32E-04	2 63E+06	1.10E-03	52600	2 59E-07	4.26E-11	20,474,795
aldrin	1.32E-02	6.97E-03	2 45E+06	1 06E-03	49000	5 83E-06	9 25E-10	4,393,904
alpha-BHC	1.42E-02	4 35E-04	1.23E+03	1 14E-03	24.6	7 25E-04	1 24E-07	379,937
beta-BHC	1 42E-02	3.05E-05	1 26E+03	1 14E-03	25.2	4 96E-05	8 46E-09	1,452,314
delta-BHC		1.76E-05	1.17E+04	0.00E+00	234	3 08E-06		
endosulfan I and II	1.15E-02	4 59E-04	2 14E+03	9 23E-04	42 8	4 40E-04	6 07E-08	542,136
endosulfan sulfate								
endrin	1 25E-02	3.08E-04	1.23E+04	1 00E-03	246	5 13E-05	7.71E-09	1,521,919
endrin aldehyde								
endrin ketone								
gamma-BHC	1 42E-02	5 74E-04	1 07E+03	1 14E-03	21 4	1 10E-03	1.88E-07	308,480
heptachlor	1.12E-02	4 47E-02	1 41E+06	8 99E-04	28200	6 50E-05	8.74E-09	1,428,946
heptachlor epoxide	1 32E-02	3.90E-04	8 32E+04	1.06E-03	1664	9 61E-06	1 52E-09	3,423,049
methoxychlor	1 56E-02	6 48E-04	9 77E+04	1.25E-03	1954	1.36E-05	2 55E-09	2,647,086
2,3,7,8-TCDD	1 43E-02	1 63E-03	4 57E+03	1.15E-03	91 42	7 31E-04	1 26E-07	377,043

METHOD 2 DIRECT EXPOSURE CRITERIA
SOIL SATURATION LIMIT

Soil Saturation (Csat) Default Input Parameters			
Term	**Description**	**Units**	**Value**
Csat	Soil Saturation Concentration	mg/kg	calculated
Kd	Soil-Water Partition Coefficient	L/kg	chem-specific
Koc	Organic Carbon Partition Coefficient	L/kg	chem-specific
OC	Organic Carbon Content of Surface Soil	%	2%
S	Solubility	mg/L-water	chem-specific
nm	Soil Moisture Content	weight fract.	0.1
Θm	Soil Moisture Content	L-water/kg-soil	0.1

Chemical	K_{oc} (L/kg)	S (mg/L-water)	K_d (L/kg)	C_{sat} (mg/kg)
2-hexanone	1.51E+01	3.50E+04	3.02E-01	4.56E+03
carbon disulfide	4.57E+01	2.30E+03	9.14E-01	4.40E+02
chloroethane		3.30E+03		
chloromethane	3.50E+01	4.00E+03	7.00E-01	6 80E+02
4,6-dinitro-2-methylphenol	6.34E+02	1.28E+02	1.27E+01	1 75E+02
4-chloro-3-methylphenol		3 85E+03		
9H-carbazole	3.39E+03		6.78E+01	
benzoic acid	6.00E-01	3.40E+03	1.20E-02	3.44E+02
butylbenzylphthalate	5.75E+04	2.90E+00	1.15E+03	3.34E+02
carbazole	3 39E+03		6.78E+01	
di-n-butylphthalate	3.39E+04	4.00E+02	6.78E+02	2.72E+04
di-n-octylphthalate	8.32E+07	2.85E-01	1.66E+06	4.74E+04
dibenzofuran	8.13E+03	1.00E+01	1 63E+02	1.64E+02
n-nitrosodiphenylamine	1.29E+03	3 51E+01	2 58E+01	9 41E+01
4,4'-DDD	1.00E+06	1.60E-01	2 00E+04	3.20E+02
4,4'-DDE	4.47E+06	4.00E-02	8.94E+04	3.58E+02
4-4'-DDT	2.63E+06	3.10E-03	5.26E+04	1.63E+01
aldrin	2.45E+06	1.01E+00	4 90E+04	4.95E+03
alpha-BHC	1.23E+03	1 40E+00	2.46E+01	3.58E+00
beta-BHC	1.26E+03	1.30E-01	2.52E+01	3.41E-01
delta-BHC	1.17E+04	8.64E+00	2.34E+02	2.03E+02
endosulfan I and II	2.14E+03	5.30E-01	4.28E+01	2.32E+00
endosulfan sulfate		1.17E-01		
endrin	1.23E+04	2.20E-01	2.46E+02	5.43E+00
endrin aldehyde		2.60E-01		
endrin ketone				
gamma-BHC	1.07E+03	1 40E+00	2.14E+01	3.14E+00
heptachlor	1.41E+06	1.00E-01	2.82E+04	2.82E+02
heptachlor epoxide	8.32E+04	3.50E-01	1.66E+03	5.83E+01
methoxychlor	9.77E+04	4.00E-02	1.95E+03	7.82E+00
2,3,7,8-TCDD	4.57E+03	2.00E-04	9.14E+01	1.85E-03

APPENDIX B

PRG DEVELOPMENT FOR SEDIMENT

DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS

MARINE SEDIMENTS

APPENDIX B

TO THE FEASIBILITY STUDY

OLD FIRE FIGHTING TRAINING AREA

NAVAL STATION NEWPORT, NEWPORT RHODE ISLAND

INTRODUCTION

The Navy is mandated to develop Risk Based Preliminary Remediation Goals (PRGs) to direct remedial actions at sites under the Installation Restoration Program. This document has been prepared to support the Feasibility Study (FS) for the Old Firefighing Training Area (OFFTA) in the development of PRGs for marine sediment at and adjacent to this site.

A proposed approach for PRG development was provided to the regulatory agencies in January, 2001. Based on comments received from the USEPA and NOAA, that proposed approach was revised in a letter to EPA dated March 28, 2001. The methodology described in the revision was used to develop PRGs as described within this document.

At the OFFTA site, actionable risk from marine sediment was estimated and calculated in the Remedial Investigation report and supporting documents for sediment under three receptor scenarios. Development of the PRGs in this document are provided for each receptor scenarion in the sections that follow this introduction:

Part 1 - Human lifetime resident exposure to shoreline sediment
Part 2 - Ingestion of shellfish collected from the nearshore and offshore sediment area
Part 3 - Ecological risk associated with the nearshore and offshore sediment

To establish cleanup goals for these three receptor scenarios, PRGs were developed for each scenario separately and applied to the exposure areas described below. Where PRGs overlap, the more conservative will apply. For the purposes of this document and for the FS, the following clarifications are made:

Marine Sediment - All intertidal and subtidal substrate including sand, rock, cobble, silt and other substances that underly the waters of Coasters Harbor and Narragansett Bay.

Shoreline Sediment – Area along the mid-tide line (represented by Sampling Stations SSD-333 through SSD-337). Samples were collected and used for human health risk (shoreline recreation scenario) only. Data available includes bulk chemistry.

Near Shore Marine Sediment – Area along the low-tide line (represented by Sampling Stations OFF-1 through OFF-7). Data available includes bulk sediment chemistry, some shellfish, and porewater. Samples were collected for ecological risk, but shellfish data was also used for human health risk evaluation under shellfish ingestion scenarios.

Offshore Marine Sediment – Area beyond the low tide line (represented by Sampling stations SD-08 through SD-21). Data available includes bulk sediment chemistry, fish, shellfish, benthic diversity, elutriate, toxicity, and porewater. Samples were collected for ecological risk, but shellfish data was also used for human health risk evaluation under shellfish ingestion scenarios.

PART 1 - DEVELOPMENT OF PRGS BASED ON DIRECT CONTACT WITH SEDIMENT

The human health risks associated with direct contact with contaminants in sediment are presented in the RI report (TTNUS, October 2000), Table 6-9.12 through 6-9.17. Risks are presented for a lifetime resident, child resident, adult resident, youth (age 1-12) shoreline visitor, child (age 1-4) shoreline visitor, and a youth (age 5-12) shoreline visitor. Of these, the lifetime resident would receive the greatest cumulative exposure to carcinogens and the child resident would have the greatest chronic risk associated with noncarcinogenic toxicity. No unacceptable noncancer risks were identified for the residential child, so only the lifetime resident cancer risks were considered in developing PRGs.

Chemicals selected as COCs for sediment were identified in the human health risk assessment presented in the RI report. Each contaminant associated with greater than 1E-06 lifetime residential cancer risk and include arsenic, benz(a)anthracene, benzo(a)pyrene, benz(b)fluoranthene, and dibenz(a,h)anthracene. The following equation was used to calculate PRG sediment concentrations for these substances at various target risk levels:

$$\text{PRG} = \text{Exposure Point Conc. in Sediment x } \frac{\text{Target Risk Level}}{\text{Risk at Exposure Point Conc.}}$$

Exposure point concentrations used for this calculation were those used to calculate reasonable maximum exposures for lifetime residential exposure to sediments during shoreline recreation (Table 6-8.25 of the RI report). Target cancer risk levels are 1E-06, 1E-05, and 1E-04. "Risks at the exposure point concentration" are presented in Table 6-8.25 of the RI report also, and reflect the risk from the sum of the combined exposure routes (ingestion and dermal contact).

Sediment concentrations that would yield target cancer risk levels of 1E-06, 1E-05, and 1E-04 are presented in Table B-1.1. This method of PRG estimation is based on the proportionality established in the RI report between estimated risk and exposure point concentrations and therefore incorporates the same residential exposure assumptions delineated in the RI report.

TABLE B-1.1
SHORELINE SEDIMENT PRGS
RESIDENTIAL CONTACT WITH SEDIMENT, LIFETIME RECREATIONAL EXPOSURE
NSN NEWPORT, RHODE ISLAND

Substance	Exposure Point Concentration*	Estimated Risk at Exposure Pt. Conc.	PRGs at various risk levels*		
			1.00E-04	1.00E-05	1.00E-06
Arsenic	6.53	6.09E-06	107.31	10.73	1.07
Benz(a)anthracene	1900	1.42E-06	133821	13382	1338
Benzo(a)pyrene	1400	1.05E-05	13382	1338	134
Benzo(b)fluoranthene	1700	1.27E-06	133821	13382	1338
Dibenz(a,h)anthracene	290	2.17E-06	13382	1338	134

*Units are ug/kg for organics, mg/kg for inorganics.

PART 2 - DEVELOPMENT OF SEDIMENT PRGS BASED ON SHELLFISH CONSUMPTION BY HUMANS

The human health PRGs for shellfish consumption are based upon a lifetime cancer risk for the recreational fisherman. These receptors have the greatest exposure among the plausible receptors considered for the site.

Although the subsistence fishing scenario was evaluated in the Human Health Risk Assessment (TTNUS, 2000), the subsistence fisherman was not considered a plausible receptor because of lack of evidence for this type of activity occuring in the vicinity of the site and because land use patterns indicate that subsistence fishing is improbable in the foreseeable future.

The modeling of biouptake and risks was performed using lobster data, which is a conservative assumption because data for clams and mussels yielded lower shellfish tissue concentrations and hence lower cancer and noncancer risks for the recreational receptors.

The approach taken to estimate PRGs for sediment from shellfish ingestion risk uses three basic steps. The first is to estimate the shellfish concentrations corresponding to a threshold risk (Tissue PRG). The second is to convert the Tissue PRG to dry weight. Thirdly, the average Bioaccumulation Factor (BAF) determined in the ERA (SAIC, 2000) is used to estimate the sediment concentration that would be associated with the target tissue concentration. Table B-2.1 presents the tissue EPCs for lobster, the associated cancer and noncancer risks for recreational fishing, the derived site-specific bioaccumulation factors, and the final PRGs for sediment considered protective for shellfish ingestion.

STEP 1 - Estimate Exposure Point Concentrations and Tissue PRGs

The list of COPCs used to develop the PRGs for shellfish ingestion were taken from the HHRA, presented in the RI report. These consist of chemicals that are associated with a threshold cancer risk of greater than 1E-06 or a significant noncancer toxicity as measured by a hazard quotient (HQ) exceeding 1.0. The list of COCs was developed in the most comprehensive manner considering all receptors used in the RI report, including the subsistence fisherman. COPCs selected in this manner are presented in the first column of Table B-2.1.

The following equation was used to calculate PRG Tissue concentration for these substances at various target risk levels:

$$\text{Tissue PRG} = \text{Exposure point concentration in shellfish} * \frac{\text{Target Risk Level}}{\text{Risk at Exposure Point Concentration}}$$

Exposure point concentrations used for this caculation were those used to calculate reasonable maximum exposures for the lifetime recreational fishermans consumption of lobster. Target cancer risk levels are 1E-06, 1E-05, and 1E-04. Risks at exposure point concentrations are presented in Table 6-8.25 of the RI report.

In the OFFTA RI, arsenic risks in fish were based on EPA's oral slope factor, which in turn is based on studies performed using arsenic trioxide. However, arsenic in seafood exists in an organic state known as arsenobetaine. Approximately 80 to 90 percent of the arsenic available in seafood is in the organic form, which is not toxic (taken from Guidance Document for Arsenic in Shellfish, USFDA, January, 1993). Therefore, the levels of risk estimated for arsenic in seafood at the OFFTA site are overestimates by as much as a factor of 10 because they are not based on toxicity values for arsenobetaine, but rather on inorganic arsenic, which has been demonstrated to be much more toxic than arsenobetaine. Therefore, to compensate for this overestimate of risks in the OFFTA RI, the sediment target arsenic concentration in shellfish was multiplied by 0.1 to estimate the tissue concentration of bioavailable arsenic.

STEP 2 - Conversion of Tissue PRG to Dry Weight

Note that sediment data are in dry weight units and tissue data are in dry weight units for the BSAF and BAF values to be meaningful. This required that the tissue PRG be converted to a dry weight value as follows:

$$\text{tissue PRG (dry wt.)} = \text{tissue PRG (wet wt.)} \times \frac{100}{\text{(average percent solid of fish tissue samples)}}$$

STEP 3 - Calculate the Sediment PRG

Bioaccumulation Factors (BAFs) and Biota-Sediment Accumulation Factors (BSAFs) are used to convert tissue concentrations to sediment concentrations.

For metals, the bioaccumulation factor (BAF) equals the median across all sampling locations of the ratio of tissue concentration for shellfish caught at a given location divided by the sediment concentration at that location:

$$\text{BAF} = \frac{\text{tissue concentration (dry wt.)}}{\text{sediment concentration (dry wt.)}}$$

For organics, the biota-sediment accumulation factor (BSAF) equals the median across all sampling locations of the ratio of the tissue concentration normalized to lipid content divided by the sediment concentration normalized to TOC:

$$\text{BSAF} = \frac{[\text{tissue concentration (dry wt.)} \,/\, \text{lipid concentration (\%)}]}{[\text{sediment concentration (dry wt.)} \,/\, \text{TOC (\%)}]}$$

Calculated BAF and BSAF values are presented in Table B-2.1

The sediment PRG for metals is calculated as follows:

$$\text{sediment PRG for metals} = \frac{\text{tissue PRG (dry wt.)}}{\text{BAF}}$$

The sediment PRG for organics is calculated as follows:

$$\text{sediment PRG for organics} = \frac{[\text{average TOC conc. x tissue PRG (dry wt.)} \,/\text{average tissue lipid conc.}]}{\text{BSAF}}$$

Sediment concentrations that would yield target cancer risk levels of 1E-06, 1E-05 , and 1E-04 for recreational consumption of shellfish are presented in Table B-2.1. This method of PRG estimation is based on the proportionality established in the RI report between estimated risk and shellfish exposure point concentrations (this incorporating the same recreational fisherman exposure assumptions delineated in the RI report) and on the ration of shellfish tissue concentations to sediment concentrations from colocated samples as determined in the ERA.

Table B-2.1
Sediment PRG Summary
Lifetime Recreational Fisherman Exposure to Lobster
NSN, Newport, Rhode Island

Substance	Tissue EPC*	Noncancer Risk	Cancer Risk	Tissue Concentration PRGs*				Median BAF	Median BSAF	Sediment Concentration PRGs*			
				Noncancer (HI = 1)	1E-4 Cancer Risk	1E-5 Cancer Risk	1E-6 Cancer Risk			Noncancer (HI = 1)	1E-4 Cancer Risk	1E-5 Cancer Risk	1E-6 Cancer Risk
Arsenic**	0.855	0.0652	9.74E-06	1.31E+01	8.78E+00	8.78E-01	8.78E-02	0.97		82			
Cadmium	12.7	0.291		4.36E+01				26.165		10			
Chromium	17.1	0.13		1.32E+02				0.215		3708			
Mercury	3.53	0 807		4.37E+00				11.41		2.3			
Total PCB Congeners	265	0.303	4.03E-06	8.75E+02	6 58E+03	6.58E+02	6.58E+01		1.075		17450	1745	175
Dieldrin***	4.47		5.43E-07		8.23E+02	8.23E+01	8.23E+00		***		***	***	***
Benz(a)anthracene	94.6		5.25E-07		1.80E+04	1.80E+03	1.80E+02		0.015		3426991	342699	34270
Benzo(a)pyrene	172		9.54E-06		1.80E+03	1.80E+02	1.80E+01		0.005495		936019	93602	9360
Benzo(b)fluoranthene	187		1.04E-06		1.80E+04	1 80E+03	1 80E+02		0.01		5129566	512957	51296
Dibenz(a,h)anthracene	3.74		2.07E-07		1.81E+03	1 81E+02	1.81E+01		0.007645		674211	67421	6742
Indeno(1,2,3-cd)pyrene	101		5 60E-07		1.80E+04	1.80E+03	1.80E+02		0.007095		7251925	725193	72519

*EPC and PRG Units are mg/kg for inorganics, ug/kg for organics
**Arsenic tissue EPCs are divided by 10 to account for 10 percent bioavailability
Average tissue % solids: 16.5
Average tissue % lipids: 5.651
Average sediment % TOC: 2.66
***Sediment PRG and BAF not calculable because substance not detected in sediment.
BAF and BSAF data from Appendix D-8-1, in Technical Support Document for the Marine Ecological Risk Assessment, OFFTA, Naval Station, Newport RI, December 1998

PART 3 - DEVELOPMENT OF ECOLOGICAL PRGS

PRGs for the nearshore and offshore marine sediments were developed to protect benthic and epibenthic receptors from adverse risks from contaminants present in the sediment. These PRGs were developed based on the data collected in the ecological risk assessment (SAIC, 4/00) for the site.

The basic assumption used for the development of these PRGs is that exposure of benthic and epibenthic receptors to sediment contaminants can be determined by measuring (for metals) or estimating (for organic chemicals) the contaminant concentrations in pore water. The basis of the assumption is presented in detail in the document Technical Basis for Deriving Sediment Quality Criteria for Nonionic Organic Contaminants for the Protection of Benthic Organisms by Using Equilibrium Partitioning (USEPA, 1993).

To summarize, scientific evidence indicates that the partitioning of the chemical between sediment-organic carbon and pore water is at equilibrium. Because the chemicals are at equilibrium, a benthic or epibenthic organism would likely receive an equivalent exposure from a water-only exposure or from any equilibrated phase (from sediment carbon via ingestion, from pore water via respiration, or a mixture of both pathways).

Based on this assumption, the exposure of an organism to a contaminant in the sediment can be estimated by measuring any of the exposure routes. The pore water exposure route was selected for the development of these PRGs. The following text describes the steps that are used to calculate the PRGs for this site using pore water data. Tables B-3.1 through B-3.11 take the data through the calculation steps as referenced in the text of each step.

Step 1 - Identify the Water Quality Screening Value (WQSV)

The primary objective of this step is to identify the WQSVs that will be compared to the pore water concentrations (see Step 2). Table B-3.1 presents the WQSVs that were used for PRG development for this site, and the sources of the values.

The prioritization of use of each of the sources to obtain or calculate the WQSVswas developed as follows: The chronic saltwater RIDEM Water Quality Criteria (WQC) were given first priority. If

none was available, saltwater acute RIDEM WQC were used (RIDEM, 2000). Where acute WQC were used, the acute criteria was divided by an acute to chronic ratio of 8 to estimate the chronic value (Shephard, 1998). Freshwater WQC were used for parameters that did not have saltwater values. Chronic USEPA Recommended WQC (USEPA, 1999) were used next, followed by chronic values presented in Buchman (1999). Finally, if no water values were available at all, the following equilibrium partitioning equation was used to calculate a WQSV from a sediment benchmark (i.e., ER-Ls from Long et al., 1995):

$$WQSV = (\text{Sediment Benchmark})/(Koc*TOC/100)$$

Where: WQSV = Water Quality Screening Value (ug/L)
Sediment Benchmark = Sediment Screening Level (ug/kg)
Koc = Organic Carbon Partition Coefficient (L/kg)
TOC = Total Organic Carbon (mg/kg) (assumed 1% TOC)

Step 2 - Determine the Pore Water Concentrations

The primary objective of this step is to obtain a pore water concentration for each contaminant detected. For metals, the pore water concentrations were obtained by extracting the pore water from the sediment sample and analyzing the pore water directly. Because a large quantity of pore water is needed to achieve low detection limits for organic chemicals, the pore water concentrations for organic chemicals were estimated by substituting the measured sediment concentration for the sediment benchmark in the equation presented in Step 1.

The sediment concentrations that are used for the pore water calculation are presented in Table B-3.2. Note that one-half of the detection limit was used for non-detected parameters. Table B-3.3 presents the calculated pore water concentrations (for the organic parameters) and the measured pore water concentrations (for the inorganic parameters). The pore water concentrations for the High Molecular Weight (HMW) PAHs, Low Molecular Weight (LMW) PAHs, and total PAHs were calculated by summing the calculated pore water concentrations of the applicable individual PAHs.

Step 3 - Identify Toxic and Non-Toxic Samples

The primary objective of this step is to identify which sediment samples were found to be toxic and non-toxic. using both toxicity tests (amphipods and sea urchins) conducted under the ERA for OFFTA (SAIC, 2000). A description of the tests is presented in the ERA (SAIC, 2000). For

the amphipod test, toxic samples are defined as those that have a statistically significant reduction in survival versus the control and are less than 80% of the mean control survival. For the sea urchin test, toxic samples are defined as those that have abnormal development in 50 percent or less pore water concentrations. Table B-3.4 summarizes the list of toxic and non-toxic samples.

Step 4 - Group Toxic and Non-Toxic Samples

The objective of this step is to group the toxic and non-toxic samples for each of the toxicity tests so that a 95% upper confidence limit (UCL) of the pore water concentrations can be calculated for each data set. The Shapiro and Wilk "W-test" (for sample sets </=50) was used to determine whether the data were normally or lognormally distributed. Then an appropriate statistic method is selected to calculate the 95% UCL. If the distribution of the data is undefined, than the maximum detection is used as the pore water for that data group. The maximum detection is also used if there are less than 11 samples in a data group.

Table B-3.5 presents the summary statistics for the non-toxic and toxic sea urchin samples and the non-toxic amphipod samples. No summary statistics were calculated for the toxic amphipod sample since only one sample was toxic (that collected from station OFF-5) and the pore water concentrations for that sample are presented in Table B-3.3. Also note that 95% UCLs were not calculated for the toxic sea urchin samples because an inadequate number of samples was available for the calculations. Therefore, the maximum concentrations were selected as the pore water concentrations to represent this data set.

Step 5 - Develop the Non-Toxic Pore Water Concentration

The objective of this step is to determine the pore water concentration (95% UCL or maximum detection) that is associated with the non-toxic samples. This concentration will then be the basis of the PRG.

The first part of this step involves comparing the selected pore water concentrations (95% UCL or maximum) of the non-toxic samples for each receptor (Step 4) to the WQSV (Step 1). The second part of this step involves comparing the maximum concentration in the toxic samples to the non-toxic concentration and to the WQSV. This comparison is presented on Table B-3.6.

If the non-toxic pore water concentration exceeds the WQSV, and if the toxic pore water concentration exceeds the non-toxic concentration, the non toxic porewater value is named the

No Observed Effects Concentration (NOEC) for that receptor. If the toxic pore water concentration exceeds the WQSV, but the non-toxic concentration does not exceed the WQSV, than the WQSV is selected at the NOEC for that parameter. Contaminants that are thus selected are retained for further PRG development.

For the sea urchin, NOECs were determined for three metals and fourteen PAHs (along with HMW, LMW, and total PAHs). For the amphipod, NOECs were determined for three metals and fourteen PAHs (along with HMW, LMW, and total PAHs). These chemicals are shaded on Table B-3.6. None of the pesticides or total PCBs had pore water concentrations that were greater than the WQSV and were retained as Aquatic NOECs.

The last part of this step is to select the lower of the two NOECs that were retained for PRG development between the two receptors as the Aquatic NOEC. Therefore, Aquatic NOECs were determined for four metals and fourteen PAHs (along with HMW, LMW, and total PAHs).

As part of Step 5, the SEM-AVS results for both sample sets were compared to the screening value of 5 umol/g. All of the data were below the screening value. This indicates that metals are not causing the toxicity measured in the urchin and amphipod tests.

USEPA has developed Draft Sediment Guidelines for six metals [Draft Equilibrium Partitioning Sediment Guidelines (ESGs) for the Protection of Benthic Organisms: Metal Mixtures (Cadmium, Copper, Lead, Nickel, Silver, and Zinc), 2000]. The USEPA document establishes two sets of guidelines for evaluating sediment. The first guideline is based on Acid Volatile Sulfide (AVS) and Simultaneously Extracted Metal (SEM) data, and the second guideline is based on a comparison of dissolved metals concentrations in the pore water to water quality criteria. The USEPA document indicates that either of the two guidelines may be used for evaluating sediment. This discussion focuses on the SEM-AVS guideline, because the pore water samples were not filtered.

The basis premise of the SEM-AVS giuideline is that if there is more AVS than SEM (on a molar basis) in a sample, than the AVS will bind the six simultaneously extracted metals (cadmium, copper, lead, nickel, silver, and zinc) and they will not be toxic (USEPA, 2000). The following equation is used to represent this process:

$$\sum \text{SEM-AVS} \leq 1.0 = \text{non-toxic sediment from the SEM metals}$$

The SEM-AVS guideline also can be normalized to the fraction of organic carbon in the sediment (f_{oc}) by dividing the SEM-AVS value by the f_{oc} (USEPA, 2000). Based on the normalized guideline, toxicity is not likely to occur when the concentration of SEM-AVS is <130 $\mu mol/g_{oc}$, toxicity is likely when the concentration is >3,000 $\mu mol/g_{oc}$, and toxicity is uncertain when the concentration is between 130 and 3,000 $\mu mol/g_{oc}$. The organic carbon normalization does not appear to work for silver (USEPA, 2000).

Table B-3.7 summarizes the SEM-AVS results (normalized and un-normalized) for each station. Two of the twenty-three stations had SEM-AVS values that were slightly greater than 1.0 (1.23 at Station OFF-1 and 1.51 at Station OFF-3). With two exceptions, the remaining stations had SEM-AVS values that were well below 1.0. Only one of the stations had a normalized SEM-AVS value that was slightly greater than 130 $\mu mol/g_{oc}$ (OFF-4 = 168 $\mu mol/g_{oc}$). Finally, although silver was not included in the SEM analysis, when AVS is present, any silver in the sediment is not of toxicological concern and none should occur in the interstitial water (USEPA, 2000).

Table B-3.7 also presents the metals concentrations in sediment that are included in the SEM analysis. The stations that had the overall highest concentrations of the metals [i.e., OFF-2 (zinc) OFF-7 (lead), OFF-13 (copper, lead, zinc), and OFF-14 (copper, lead, zinc)] had SEM-AVS values that were less than 1.0. In fact, Stations OFF-7, OFF-13, and OFF-18 had the lowest SEM-AVS values of -37, -13, and -36, respectively.

In summary, PRGs will not be calculated for the four SEM metals (copper, lead, silver, and zinc) with pore water concentrations that were greater than the WQSV because based on SEM-AVS values presented on Table B-3.7, none of these metals are expected to cause toxicity at most of the stations. Metals concentrations that were greater than the WQSV were probably caused by particulates in the sample, because the samples were not filtered. The metals that are bound to particulates are not expected to be bioavailable or cause toxicity to aquatic organisms. The station with the highest SEM-AVS values (normalized and non-normalized) was Station OFF-4, and neither the pore water or sediment was toxic at this station. Therefore, PRGs for these metals are not necessary.

Step 6 - Select the Toxicity Effects Value (TEV)

The objective of this step is to calculate a TEV for each parameter with an Aquatic NOEC, which will be used to select limiting Contaminants of Concern (COCs) in Step 7. This step is done to ensure that the PRGs will not be below the reference concentrations.

Table B-3.8 presents the Aquatic NOEC from Step 5, the pore water concentrations for the two reference stations (OFF-22 and OFF-23), and the TEV, which is the higher of the three values. Neither reference station had higher pore water concentrations than the Aquatic NOECs, so the Aquatic NOEC becomes the TEV for all contaminants.

Step 7 - Determine the Limiting COCs

The objective of this step is to limit the number of contaminants for which PRGs are developed to the contaminants that are causing the highest risk at each station. The assumption is that if the contaminants that are causing the highest risk at a station are remediated, the remaining contaminants will be remediated in the same proportion. Therefore, the remaining contaminants will not be present at concentrations that are causing a risk to the aquatic receptors.

This step is done by dividing the pore water concentrations presented in Table B-3.3 by the TEVs from Table B-3.8 at each station (except the reference stations) to get a TEV-Hazard Quotient (TEV_{HQ}). These TEV_{HQ} values are presented in Table B-3.9. The chemical with the highest TEV_{HQ} for a station is the limiting COC for that station. The list of limiting COCs across all of the stations is the list of limiting COCs for the site. Note that the same chemical may be a limiting COC at more than one station. Also, a limiting COC is not determined for a station if the sum of all the TEV_{HQ}s for that station is less than 1.0, because the sum of those chemicals at the site are not expected to adversely impact the aquatic organisms.

Table B-3.9 presents the limiting COC calculation for the site. The following five PAHs were retained as limiting COCs across the site: acenaphthalene, benzo(a)pyrene, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, and 2-methylnaphthalene.

Step 8 - Calculate the Baseline PRG

The objective of this step is to convert the pore water-based TEVs into sediment-based PRGs. The sediment PRGs are calculated using the following equation at each station and then averaging the values for each station across all of the stations for the final PRG:

$$PRG(station) = \frac{Cs}{TEV_{HQ}}$$

Where:

PRG	=	Preliminary remediation goal (ug/kg)
Cs	=	Chemical concentration in the sediment (ug/kg)
TEV_{HQ}	=	Toxicity Effects Value Hazard Quotient (ug/L) (From Step 7)

$$PRG(Site) = \sum \frac{PRG(station)}{number\ of\ stations}$$

Table B-3.10 presents the calculated PRGs for each station and the average PRGs across all of the stations. Note that the PRGs that are calculated for each station are used to calculate the average PRG for the site. They are not used as a station-specific PRG to evaluate the sediment at that station.

Table B-3.11 presents the sediment hazard quotients based on the site PRGs. The value is termed the PRG_{HQ}. The table also presents the sum of the PRG_{HQ}s for each station, and the parameter that has the greatest PRG_{HQ} for that station that is greater than 1.0. Based on that table, the sediment PRGs are only exceeded at the following three stations: OFF-4, OFF-5, and OFF-6.

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TABLE B-3.1
WATER QUALITY SCREENING VALUES
ECOLOGICAL PRG DEVELOPMENT STEP 1
OLD FIRE FIGHTING TRAINING AREA
NAVAL STATION NEWPORT, NEWPORT RHODE ISLAND

Parameter	Koc[1]	Water Quality Screening Values (ug/L)				Sediment Benchmarks (ug/kg)		Final WQSV (ug/L)	
		Freshwater Chronic	Saltwater Acute	Saltwater Chronic	Source	Value	Source	Value	Comment
Polyaromatic Hydrocarbons									
1-Methylnaphthalene	7994							NA	
1-Methylphenanthrene	98610							NA	
2,3,5-Trimethylnaphthalene	NA							NA	
2,6-Dimethylnaphthalene	34034							NA	
2-Methylnaphthalene	7994					70	(7)	0 88	A
Acenaphthene	7139			710	(11)			710	B
Acenaphthylene	9581					44	(7)	0.46	A
Anthracene	29712					85.3	(7)	0.29	A
Benzo(a)anthracene	401218					261	(7)	0 065	A
Benzo(a)pyrene	1014869					430	(7)	0.042	A
Benzo(b,j,k)fluoranthene	1244171					1800	(11)	0.14	A
Benzo(e)pyrene	1014869							NA	
Benzo(g,h,i)Perylene	3858158					720	(8)	0.019	A
Biphenyl	7816					1100	(12)	14	A
Chrysene/triphenylene	401218					384	(7)	0.10	A
Dibenzo(a,h)Anthracene	3771812					63.4	(7)	0 0017	A
Fluoranthene	107954			16	(11)			16	B
Fluorene	13763					19	(7)	0.14	A
Indeno(1,2,3-cd)pyrene	3445323					690	(8)	0 020	A
Naphthalene	2010		2350		(11)			294	D
Perylene	885992							NA	
Phenanthrene	29712			4.6	(11)			4.6	B
Pyrene	105538					665	(7)	0.63	A
Sum PAHs (6 High Molecular Weight)	1014869					1700	(7)	0 17	A
Sum PAHs (7 Low Molecular Weight)	11483					552	(7)	4.8	A
Sum PAHs (NOAA Status &Trends)	107954					4022	(7)	3 7	A

TABLE B-3.1
WATER QUALITY SCREENING VALUES
ECOLOGICAL PRG DEVELOPMENT STEP 1
OLD FIRE FIGHTING TRAINING AREA
NAVAL STATION NEWPORT, NEWPORT RHODE ISLAND

Parameter	Koc[1]	Water Quality Screening Values (ug/L)				Sediment Benchmarks (ug/kg)		Final WQSV (ug/L)	
		Freshwater Chronic	Saltwater Acute	Saltwater Chronic	Source	Value	Source	Value	Comment
PCBs/Pesticides									
1a,2a,3b,4a,5a,6b-hexachlorocyclohexane (lindane)	5566		0.16		(2)			0 020	D
2,4'-DDE	4419366			0.001	(2,6)			0 001	B
2,4'-DDT	4419366			0.001	(2)			0 001	B
4,4'-DDD	992156			0 001	(2,6)			0.001	B
4,4'-DDE	4419366			0.001	(2,6)			0.001	B
4,4'-DDT	4419366			0.001	(2)			0 001	B
Aldrin	2453466		1.3		(2)			0.16	D
alpha-Chlordane	2453466			0.004	(2)			0.004	B
Heptachlor	2453466			0.0036	(2)			0.0036	B
Heptachlor Epoxide	2453466			0.0036	(2)			0.0036	B
Hexachlorobenzene	616808					22	(8)	0.0036	A
Mirex	5931301			0.001	(4)			0.001	B
trans-Nonachlor	5668785							NA	
PCBs	NA			0.03	(2)			0.03	B
Metals									
Aluminum	NA	87			(2)			87	C
Arsenic	NA			36	(2,3)			36	B
Barium	NA							NA	
Cadmium	NA			9.4	(2,3)			9 4	B
Chromium	NA			50	(2,3)			50	B
Copper	NA			3 7	(2,3)			3 7	B
Iron	NA	1000			(4)			1000	C
Lead	NA			8.5	(2,3)			8.5	B
Manganese	NA							NA	
Mercury	NA			1.1	(3,4,5)			1.1	B
Nickel	NA			8.3	(2,3)			8.3	B
Silver	NA		2.2		(2,3)			0 28	D
Zinc	NA			86	(2,3)			86	B

TABLE B-3.1
WATER QUALITY SCREENING VALUES
ECOLOGICAL PRG DEVELOPMENT STEP 1
OLD FIRE FIGHTING TRAINING AREA
NAVAL STATION NEWPORT, NEWPORT RHODE ISLAND

Parameter	Koc[1]	Water Quality Screening Values (ug/L)				Sediment Benchmarks (ug/kg)		Final WQSV (ug/L)	
		Freshwater Chronic	Saltwater Acute	Saltwater Chronic	Source	Value	Source	Value	Comment
SEM-AVS	NA					5	(10)	5	E

Sources of Data

1 - See Table 4 for source of Koc values
2 - RIDEM Ambient Water Quality Criteria and Guidelines for Toxic Pollutants, Appendix B, amended June 2000
3 - Values are based on total metals because the pore water samples were not filtered
4 - USEPA National Recommended Water Quality Criteria (USEPA, 1999)
5 - The mercury value from USEPA (1999) was used because it is based on protecting aquatic life The RIDEM value is based on protecting wildlife, which is not an endpoint of the PRGs
6 - Used the DDT value as a surrogate for DDD and DDE
7 - ER-L value from Long et al., (1995)
8 - Apparent Effects Threshold value (Option 2 - with mixcotox data excluded) from PTI (1989)
9 - Used the value for benzofluoranthenes
10 - Source of SEM - AVS value of 5 umole/g dry weight is USEPA (1997)
11 - Lowest Observed Effects Levels cited in Buchman (1999)
12 - Sediment Quality Benchmark from USEPA (1996)

Comments

A - Value was calculated from sediment benchmark using the following equilibrium partitioning equation with the Total Organic Carbon=1%
WQSV - (Sediment Benchmark)/(Koc * TOC/100)
B - Values is the saltwater chronic water quality screening value
C - Value is the freshwater chronic water quality screening value
D - Values is the saltwater chronic water quality screening value divided by and acute-to-chronic ratio of 8
E - Value is the USEPA recommended screening level
NA - No data available

TABLE B-3.2
SEDIMENT RESULTS
ECOLOGICAL PRG DEVELOPMENT STEP 2
OLD FIRE FIGHTING TRAINING AREA
NAVAL STATION NEWPORT, NEWPORT RHODE ISLAND

Sample Location	OFF-1	OFF-2	OFF-3	OFF-4	OFF-5	OFF-6	OFF-7	OFF-8	OFF-9	OFF-10	OFF-11	OFF-12	OFF-13	OFF-14	OFF-15
Sample Depth Interval	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm
Date Sampled	3/27/98	3/27/98	3/27/98	3/27/98	3/27/98	3/27/98	3/27/98	4/7/98	4/7/98	4/3/98	4/3/98	4/3/98	4/3/98	4/7/98	4/7/98
Polyaromatic Hydrocarbons (ug/kg)															
1-Methylnaphthalene	14 8 J	52 4 J	62 2 J	35 8 J	278 J	132 J	34 6	11	1 7 J	2 2 J	6 2 J	78 8 J	43 2 J	9 4	4 6 J
1-Methylphenanthrene	132	364	539	282	1460	680	104	22	4 4 J	3 J	14 8	220	177 J	20 1	11 4
2,3,5-Trimethylnaphthalene	7 7 J	45 2 J	22 J	22 6 J	121 J	36 3 J	17 7	2 3 J	0 4 J	2 4 U	2 J	20 8 J	12 9 J	2 6 J	0 8 J
2,6-Dimethylnaphthalene	18 9 J	103 J	66 9 J	53 5 J	476 J	148 J	59 8	24 5	12 4	9 J	18 5 J	88 9 J	55 2 J	15 6	7 3 J
2-Methylnaphthalene	26 J	77 6 J	89 2 J	38 1 J	330 J	170 J	54 9	14 4	3 1 J	3 1 J	17 5 J	117 J	65 6 J	15 5	9 5
Acenaphthene	23	88 1	371	54	966	344	120	34	4 1 J	2 5 J	27 9	321	110 J	11 4	5 1 J
Acenaphthylene	93	488	350	424	509	195	169	18 5	5 7	4 1 J	9	58 3	156 J	25 2	11 9
Anthracene	255 J	1100 J	1460 J	774 J	2810 J	1170 J	393	70 1	11 3	9 8 J	64 J	572 J	482 J	51 8	35
Benzo(a)anthracene	100	3600	5690	2280	9300	4250	1160	214	57 3	35 2	168	1200	1160 J	216	106
Benzo(a)pyrene	595	2410	3450 J	2090	4830	1990	1330	218	76 1	45 1	148	1420	1150 J	255	103
Benzo(b,j,k)fluoranthene	2780	7710	17300 J	3500	25000	9390	2850	411	152	94 6	284	2730	2430 J	457	366
Benzo(e)pyrene	910 J	2370 J	5250 J	1310 J	7590 J	3270 J	966	161	58 4	41 3 J	107 J	1080 J	939 J	213	140
Benzo(g,h,i)Perylene	876 J	2520 J	5370 J	1290 J	5990 J	2630 J	1020	141	52 5	40 5 J	95 2 J	815 J	744 J	195	100
Biphenyl	7 2	22 1	38 6	6 6	151	46 7	14 7	3 2 U	3 2 U	1 2 J	3 7 J	28 8	20 5 J	3 2 U	3 2 U
Chrysene/triphenylene	790	2340	4560	1850	7300	3350	519 J	196	59 6	31 8	117	998	774 J	190	87 3
Dibenzo(a,h)Anthracene	441 J	1290 J	2810 J	352 J	3410 J	1390 J	293	41 5	6 8 U	8 6 J	23 9 J	280 J	213 J	52 2	44
Fluoranthene	1950	8350	14600	5580	19200	11200	2190	455	117	86 2	388	3120	2600 J	308	185
Fluorene	40 3 J	303 J	598 J	177 J	1360 J	392 J	160	34 7	5 3 J	2 8 J	25 1 J	271 J	123 J	17 2	7 6
Indeno(1,2,3-cd)pyrene	1010	3070	6560 J	1200	7390	3030	968	136	48 1	35 3	86 3	777	646 J	172	116
Naphthalene	31 9	171	149	136	258	161	70	22 8	4 3	4	9 8	128	61 2 J	20 6	11 3
Perylene	225	818	1490 J	607	1460	734	363	60 4	21 4	12 8	34 8	257	253 J	79 4	32 9
Phenanthrene	1060	5610	10700	3030	14600	9470	1320	261	46 3	31 3	238	2510	1440 J	130	87 4
Pyrene	1780	6750	10700	4810	16900	9770	2120	401	102	87 5	337	3020	2530 J	344	187
Sum PAHs (6 High Molecular Weight)	6660	24700	41800	16700	60900	32000	7620	1530	425	294	1180	10000	8430	1360	712
Sum PAHs (7 Low Molecular Weight)	1530	7830	13700	4640	20800	11900	2280	456	80	58	391	3980	2440	271	168
Sum PAHs (NOAA Status &Trends)	14200	49600	92100	29900	132000	64000	16300	2960	858	592	2230	20100	16200	2800	1660
Pesticides/PCBs (ug/kg)															
1a,2a,3b,4a,5a,6b-hexachlorocyclohexane (gamma-BHC)	0 3 U	0 3 U	0 3 U	0 3 U	0 3 U	0 8 J	0 2 J	0 3 J	0 1 J	0 3 U	0 3 U	0 3 U	0 3 U	0 3 U	0 5 J
2,4'-DDE	0 25 U	0 4 U	0 4 U	0 4 U	0 4 U	0 4 U	0 4 U	0 4 U	0 4 U	0 4 U	0 4 U	0 9	0 4 U	0 4 U	0 4 U
2,4'-DDT	1 1	1 8	0 7 J	2 6	1 7	1 4	0 5 U	0 5 U	0 5 U	0 5 U	0 5 U	0 6 J	1 2	0 5 U	0 5 U
4,4'-DDD	3 J	1 4 J	1 8 J	2 4 J	2 J	3 8 J	3 8	0 8 J	0 45 U	0 4 U	0 4 U	11 2 J	19 7 J	1 4	0 6 J
4,4'-DDE	1 25 U	1 25 U	1 1 U	1 U	1 5 U	3 8	3 1	0 7 J	0 45 U	0 45 U	0 45 U	6 2	10 8	0 9 J	0 5 J
4,4'-DDT	4 3	10	4	11.5	11 3	9 8	2 7	1 1	0 8	0 7	1 6	4 8	10 9	2	0 8
Aldrin	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 1 J	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U
alpha-Chlordane	0 8	0 7 J	0.7 J	1 2	1 4	0 6 J	0.7 J	0 1 J	0 1 J	0 4 U	0 4 U	1 2	1 4	0 2 J	0 1 J
Heptachlor	0 25 U	0 25 U	0 25 U	0 7 U	0 25 U	0 25 U	0 3 J	0 25 U	0 25 U	0 25 U	0 25 U	0 25 U	0 65 U	0 2 J	0 1 J
Heptachlor Epoxide	0 25 U	0.25 U	0 25 U	0 6 J	0 25 U	0.25 U	0 25 U	0 25 U	0 25 U	0 25 U	2 8 J	2 4 J	1 1 J	0 25 U	0 25 U
Hexachlorobenzene	0 2 U	0.2 U	0 2 U	0 2 U	0 25 U	0 3 U	0 2 U	0 2 U	0 2 U	0 2 U	0 2 U	0 4 U	0 2 U	0 2 U	0 2 U
Mirex	0 3 J	0.3 U	0 3 U	0 3 U	0 6	0 5 J	0 4 J	0 3 U	0 3 U	0 3 U	0 3 U	0 3 U	0 3 U	0 4 J	0 4 J
PCB 101/90	0 6 U	1 05 U	1 2 U	2 9	1.1 U	1 U	2 7	0 55 U	0 3 U	0 35 U	1 1 U	4 1	5 9	2 2	0 45 U
PCB 105	0 3 U	0 6 U	0 7 U	0 35 U	1.7 J	0 35 U	0 65 UJ	0 3 U	0.3 U	0 15 U	0 65 U	1 7 J	3 5 J	0 45 UJ	0 3 U
PCB 118	0.7 J	2.1	1.8	1 3	1.1	1.6	2 3	1 1	0.5 J	0 7 J	2	3 2	6 6	2 3	0 8
PCB 126	0.25 U	0 9 J	1 3 J	1.7 J	2 5 J	0 25 UJ	0 4 U	0.25 UJ	0 25 U	0 25 U	0 7 J	1 8 J	4 9 J	1 1	0 25 UJ
PCB 128	0 6	0 6 J	0 8 J	2.1	0.9 J	1 8 J	1	0.3 U	0 2 UJ	0 25 U	0.6	1 8	4	0 4 U	0 2 UJ
PCB 138/163/164	1 9	10.7 J	11 2 J	11 4	16 2 J	3 J	5 2	2 4	1	1 2	3 5	7 7	13 3	3 1	1 7
PCB 153	1 5	2 5	2 5	1 9	4	2 7	3 5	2	1	1 1	3 3	5 4	9 3	3 4	1 7

TABLE B-3.2
SEDIMENT RESULTS
ECOLOGICAL PRG DEVELOPMENT STEP 2
OLD FIRE FIGHTING TRAINING AREA
NAVAL STATION NEWPORT, NEWPORT RHODE ISLAND

Sample Location	OFF-1	OFF-2	OFF-3	OFF-4	OFF-5	OFF-6	OFF-7	OFF-8	OFF-9	OFF-10	OFF-11	OFF-12	OFF-13	OFF-14	OFF-15
Sample Depth Interval	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm
Date Sampled	3/27/98	3/27/98	3/27/98	3/27/98	3/27/98	3/27/98	3/27/98	4/7/98	4/7/98	4/3/98	4/3/98	4/3/98	4/3/98	4/7/98	4/7/98
PCB 170	0 45 U	0 35 U	0 35 U	1 8	1 8	1 8 J	0 6 U	0 45 U	0 25 UJ	0 35 U	1 5	3 8	5 8	0 45 U	0 3 U
PCB 18	1 3 J	0 35 U	1 7	0 35 U	1 4	2 8	0 6 J	0 35 U	0.35 U	0 35 U	3 5	2 4	0 5 J	1 1	0 35 U
PCB 180	1 1	1 5	2 4	2	3 9	2 1 J	2 5	1 2	0 7	0 6	3 2	6 4	9 3	1 6	1 1
PCB 187/182/159	0 6	0 7	0 6	2 8	1 6	1.9 J	1 6	0 45 U	0 3 U	0 6	2	3 7	5 5	1 8	0 35 U
PCB 188	0 3 U	0 3 U	0 8	0 3 U	1 3	2 6	0 7	0 5 J	0 3 U	0 3 U	0 6 J	1	1 6	0 8	0 3 U
PCB 195	0 25 U	0 3 U	0 3 U	1 2	3 5	0 3 UJ	0 3 U	0.3 U	0 3 U	0 3 U	0 7	0 8 J	3 7	0 3 U	0 3 U
PCB 200	0 3 J	1 2	1	1 8	2	1 1 J	0 4 J	0 4 J	0 3 J	0 4 J	0 4 J	1 6	0 25 U	0 4 J	0 4 J
PCB 206	0 25 U	0 25 U	0 25 U	1 2 U	0.3 U	0 3 UJ	0 6	0 8	0 4 J	0 65 U	0 75 U	0 95 U	4	1	0 7
PCB 209	0 25 U	0 25 U	0 25 U	0 25 U	0 35 U	4 1 J	0 8	0 8	0 3 J	0 35 U	0 25 U	2 2	3	1 2	0 6
PCB 28/50	0 7	0 35 U	0 6 J	0 35 U	1 8	2 7	1	0 3 J	0 5 J	0 35 U	7 4	4 2	1 3	0 9	0 3 J
PCB 29	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U
PCB 44	0 6 J	0 4 J	1 4 J	1 4 J	1 4 J	1 8 J	1 9	0 25 U	0 25 U	0 3 J	3 3 J	2 J	2 4 J	0 6	0 25 U
PCB 50	0 25 U	0 25 U	0 25 U	0 25 U	0 25 U	0 25 U	0.25 U	0 25 U	0 25 U	0 25 U	0 25 U	0 25 U	0 25 U	0 25 U	0 25 U
PCB 52	0 4 U	0 35 U	0 5 U	1 4 J	1 8 J	2 6 J	1 4	0 35 U	0 35 U	0 35 U	3 4 J	3 2 J	2 9 J	1 1	0 35 U
PCB 66/95	1 1	1 4	2	1 7	3 9	3 4	3 3	1 1	0 25 UJ	0 6	6 5	5	4 6	2 2	0 45 U
PCB 8	8 5 J	0.15 U	0 9 J	0 15 U	0 15 U	0 6	0 15 U	0 15 U	0 15 U	0 15 U	0 8	1 5	0 9	0 25 U	0 15 U
PCB 87	0 3 UJ	0 9 J	0 8 J	0 7 J	0 8 J	1 6 J	1	0 3 U	0 3 U	0 3 UJ	0 8 J	1 6 J	2 5 J	0 3 U	0 3 U
Sum of PCB Congeners	18 9	22 9	29 8	36 1	51 6	38 2	30 5	10 6	4 7	5 5	44 2	65 1	95 5	24 8	7 3
Sum of PCB Congeners X 2	37.8	45 8	59 6	72 2	103 2	76.4	61	21 2	9 4	11	88 4	130 2	191	49 6	14 6
trans-Nonachlor	0 6 J	0 4 U	0.7 J	0 4 U	1 3	0 4 U	0 8	0 2 J	0 1 J	0 4 U	0.4 U	0 6 J	1 J	0 4 J	0 2 J
Metals (mg/kg)															
Aluminum	21672 J	26984 J	23219 J	16492 J	16256 J	22707 J	21885 J	27137 J	26673 J	26244 J	19537 J	35681 J	40999 J	28276 J	26843 J
Arsenic	6.3 J	8 J	3 6 J	4 3 J	3 6 J	4 1 J	6 8 J	4 3 J	4 3 J	3 4 J	2 7 J	5 2 J	6 J	8 5 J	3 7 J
Cadmium	0 31	0 14	0 18	0 06	0 23	0 15	0 29	0 19	0 11	0 15	0 22	0 53	0 8	0 12	0 18
Chromium	31 1	36 6	26 5	24 3	27 4	23	43 1	42 3	38 6	32 1	30 2	58 6	73 7	44 9	41
Copper	58 3	23 7	12 3	31 4	16 9	11	32 8	11	6 9	9 8	9 1	37	80 8	18 9	11 6
Iron	24310 J	29487 J	22872 J	22908 J	17649 J	19993 J	27506 J	21704 J	24714 J	17985 J	14919 J	27717 J	33406 J	21879 J	21010 J
Lead	131 4	90 2	60.1	95 5	138 7	47 2	294	37 9	25 2	27 3	38.7	114.2	201 9	44 6	33 1
Manganese	353 6	302.2	387.4	369	166.8	257 5	331 6	356 2	515 8	357 1	331	368 1	335 9	324	366 5
Mercury	0 371	0 081	0 025 U	0 025 U	0 025 U	0 025 U	0.119	0 148	0 025 U	0 07	0 125	0 376	1.355	0 196	0 1
Nickel	34	26 2	22 2	20 2	19	19 3	28 1	15 8	18 3	12 5	5 45 U	21 4	29 7	15 9	14 2
Silver	0 46 J	0 065 UJ	0 065 UJ	0.065 UJ	0 065 UJ	0.065 UJ	0 18 J	0.17 J	0 065 UJ	0.065 UJ	0.17 J	0 48 J	1 06 J	0 23 J	0 19 J
Zinc	156 4	314 8	50 4 U	106	39 9 U	52 85 U	155 5	46.7 U	39 95 U	26 65 U	27 75 U	146 5	263 4	48 4 U	36 65 U
AVS/SEM (µmole/g dry weight)															
Acid Volatile Sulfide	0 05 U	0 05 U	0.23	0.05 U	23 82	26 06	38 21	6 21	4.44	7 29	13 03	24 03	48 59	10.3	7 1
Cadmium	0 001	0 001	0.001	0	0.002	0 002	0.002	0 003	0 001	0 002	0 002	0 005	0 009	0 002	0 002
Copper	0 341	0 0585 U	0 054 U	0 413	0.078 U	0 0885 U	0 045 U	0 397	0 269	0 212	0 0915 U	0 0395 U	0 031 U	0 417	0 393
Lead	0 505	0.215	0.119	0 507	0 386	0.168	0.221	0 122	0 061	0 079	0 094	0 249	0 589	0 15	0 121
Nickel	0 026 U	0 02 U	0 018 U	0.126	0 152	0.0385 U	0 034 U	0 0325 U	0.0245 U	0 031 U	0 033 U	0 0205 U	0 132	0 054 U	0 036 U
SEM-AVS	NA	NA	0 489 J	NA	-22 22 J	-24.97 J	-37.41 J	-4 68 J	-3 65 J	-6 394 J	-12 14 J	-23 08 J	-46 71 J	-8 4 J	-5 592 J
SEM/AVS	NA	NA	3 1261 J	NA	0.0672 J	0 0419 J	0 021 J	0 2465 J	0 178 J	0 1229 J	0 0681 J	0 0394 J	0 0387 J	0 1845 J	0 212 J
Zinc	0 407	0.549	0.527	0 517	0 982	0.794	0 499	0 976	0 435	0 572	0 667	0 632	1 12	1 277	0 957
Total Organic Carbon (percent)															
Total Organic Carbon	1 8	1 1	0.9	0 9	1	1 8	1 9	1 3	1 2	1.1	1 1	2 5	4	2	1 2
Grain Size (percent)															
CLAY	0 2	0 1	0 2	0 1	0 3	0 3	0 6	0 4	0 4	3 7	0 8	1	6 1	1 3	0 5
SAND	96	97 1	95.2	98 5	97.1	94 2	86.7	72 8	88 1	85 7	87.8	44 2	14 5	59 1	87 3
SILT	3 9	2 8	4.6	1.5	2.6	5 5	12 7	26 7	11.5	10.7	11 4	54 7	79 5	39 7	12 2

TABLE B-3.2
SEDIMENT RESULTS
ECOLOGICAL PRG DEVELOPMENT STEP 2
OLD FIRE FIGHTING TRAINING AREA
NAVAL STATION NEWPORT, NEWPORT RHODE ISLAND

Sample Location	OFF-16	OFF-17	OFF-18	OFF-19	OFF-20	OFF-21	OFF-22	OFF-23
Sample Depth Interval	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm
Date Sampled	4/3/98	4/3/98	4/3/98	4/7/98	4/3/98	4/3/98	3/27/98	4/3/98
Polyaromatic Hydrocarbons (ug/kg)								
1-Methylnaphthalene	17 6 J	11 J	31 4 J	18 9	43 7 J	7 7 J	2 J	27 8
1-Methylphenanthrene	43 6 J	25 3	108	20 2	44 4	19 3	2 6 J	49 9
2,3,5-Trimethylnaphthalene	6 J	2 5 J	11 5 J	3 6 J	5 6 J	2 4 J	0 3 J	8 2
2,6-Dimethylnaphthalene	37 8 J	22 1 J	45 3 J	54 3	43 9 J	13 7 J	5 8 J	38 6
2-Methylnaphthalene	23 9 J	19 7 J	63 8 J	31 5	40 4 J	13 1 J	3 1 J	43 4
Acenaphthene	37 6 J	25 6	59 7	43 8	75 3	9 4	1 8 J	89 5
Acenaphthylene	35 8 J	41 1	141	40 6	14 8	18 3	4 4 J	77 5
Anthracene	88 J	120 J	340 J	104	217 J	47 9 J	9 5 J	348
Benzo(a)anthracene	195 J	251	730	316	320	151	35 6	616
Benzo(a)pyrene	220 J	333	964	322	257	176	38 8	758
Benzo(b,j,k)fluoranthene	435 J	654	2290	618	588	375	78 6	1540
Benzo(e)pyrene	187 J	273 J	963 J	234	197 J	158 J	49 3 J	688
Benzo(g,h,i)Perylene	181 J	270 J	899 J	201	131 J	133 J	60 4 J	700
Biphenyl	9 1 J	5 6 J	17 3	18 2	17 9	5 9 J	0 8 J	12 8
Chrysene/triphenylene	151 J	203 J	631	277	296	151	26 7	540
Dibenzo(a,h)Anthracene	49 6 J	76 1 J	273 J	57 4	50 3 J	40 4 J	12 2 J	179
Fluoranthene	444 J	528 J	1880	542	882	291	65 9	1560
Fluorene	34 1 J	30 9 J	74 8 J	51 3	92 6 J	11 3 J	2 4 J	106
Indeno(1,2,3-cd)pyrene	156 J	237	785	195	150	126	33 9	511
Naphthalene	19 9 J	25	68 1	53 3	40 1	8 7	3 2 J	41 6
Perylene	62 9 J	80 5	276	85 6	63 4	43 3	12 9	205
Phenanthrene	331 J	271	918	294	828	126	23 5	770
Pyrene	513 J	544 J	1810	523	751	334	69 2	1420
Sum PAHs (6 High Molecular Weight)	1570	1930	6290	2040	2560	1140	248	5080
Sum PAHs (7 Low Molecular Weight)	570	533	1670	619	1310	234	48	1480
Sum PAHs (NOAA Status &Trends)	3280	4050	13400	4110	5150	2250	543	10300
Pesticides/PCBs (ug/kg)								
1a,2a,3b,4a,5a,6b-hexachlorocyclohexane (gamma-BHC)	0 3 U	0 3 U	0 3 U	0 9	0 3 U	0 3 U	0 3 U	0 3 U
2,4'-DDE	0 4 U	0 4 U	0 4 U	0 4 U	0 4 U	0 4 U	0 4 U	0 4 U
2,4'-DDT	1 2	0 7 J	1 8	0 5 U	0 5 U	0 5 U	0 5 U	0 8
4,4'-DDD	2.2 J	12 9 J	15 8 J	1 1	1 1 J	2 4 J	0 4 U	7 3
4,4'-DDE	0 9 U	1 15 U	10 5	1 2	0 55 U	0 9 U	0 45 U	3 2
4,4'-DDT	1.6	4.1	9.5	1 8	1 7	2.1	0 6 J	4 1
Aldrin	0 35 U	0 35 U	0 35 U	0 2 J	0 35 U	0 35 U	0 35 U	0 35 U
alpha-Chlordane	0 9	0 4 U	1.1	0.8	0 4 U	0 4 U	0.4 U	0 8 J
Heptachlor	0.25 U	0.25 U	0.25 U	0.25 U	0 23 U	0 25 U	0 25 U	0 25 U
Heptachlor Epoxide	0 25 U	0 25 U	1 J	0 25 U	0 25 U	0 25 U	0 25 U	0 25 U
Hexachlorobenzene	0 2 U	0 2 U	0.2 U	0 9	0 2 U	0 2 U	0 2 U	0 5
Mirex	0 3 U	0 3 U	0 3 U	0.3 U	0.3 U	0 3 U	0 3 U	1 1 J
PCB 101/90	0.95 U	1 05 U	4 5	1 8	0.95 U	1 1 U	0 35 U	2 9
PCB 105	0.45 U	0 5 U	2 4 J	0 3 U	0 3 U	0.45 U	0 1 U	1 7 J
PCB 118	2 3	1.7	5 5	1 4	1 8	2	0 35 U	2 7
PCB 126	1 2 J	1.3 J	1.8 J	0 35 U	1 1 J	0 7 J	0 25 U	2
PCB 128	1	0 9	2.4	0 25 U	0 7	0.9	0 25 U	2 3
PCB 138/163/164	4 9	3 2	12 2	3	4.1	2.9	0 9	7 6
PCB 153	3.3	2 8	7 5	2 4	3.6	2 7	0 7	4 2

TABLE B-3.2
SEDIMENT RESULTS
ECOLOGICAL PRG DEVELOPMENT STEP 2
OLD FIRE FIGHTING TRAINING AREA
NAVAL STATION NEWPORT, NEWPORT RHODE ISLAND

Sample Location	OFF-16	OFF-17	OFF-18	OFF-19	OFF-20	OFF-21	OFF-22	OFF-23
Sample Depth Interval	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm
Date Sampled	4/3/98	4/3/98	4/3/98	4/7/98	4/3/98	4/3/98	3/27/98	4/3/98
PCB 170	1 5	0 65 U	2.9	0 45 U	1 5	0 55 U	0 25 U	2 1
PCB 18	0 3 J	0 35 U	0 35 U	1 3 J	0 35 U	0 35 U	0 35 U	0 35 U
PCB 180	1 7	1 3	5 2	1 8	1 9	1 3	0 3 J	3 4
PCB 187/182/159	1 7	1 3	3 8	1 1	1 4	1 5 J	0 5	3 1
PCB 188	1	0.3 U	1 5	0 5 J	0 6	0 6	0 3 U	1
PCB 195	0 3 U	0 3 U	0 3 U	0 3 U	0 3 U	0 3 U	0 3 U	0 75 UJ
PCB 200	0 25 U	0 3 J	1.2	0 6	0 4 J	0 3 J	0 2 J	1 1
PCB 206	0 3 U	0 75 U	1 15 U	0 8	0 5 U	0 55 U	0 5 U	1 2
PCB 209	0 4 U	1 4	2 6	0 9	0 5 U	0 35 U	0 25 U	1 5
PCB 28/50	0 35 U	0 35 U	0 7	0 4 J	0 35 U	0 35 U	0 35 U	1 5
PCB 29	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U	0 35 U
PCB 44	0 8 J	0 5 J	1 2 J	1 1 J	0 4 J	0 5 J	0 2 J	1 1
PCB 50	0 25 U	0 25 U	0 25 U	0 25 U	0 25 U	0.25 U	0 25 U	0 25 U
PCB 52	0 4 U	0 35 U	1 2 J	0 45 UJ	0 35 U	0 45 U	0 35 U	1 4
PCB 66/95	1 7	1 3	3 9	2 3	1 4	1 6	0 5 U	2 7
PCB 8	0 6	0.15 U	0 8	8 5	0 15 U	0 15 U	0 15 U	0 3 U
PCB 87	0 7 J	0 6 J	1 6 J	0 5 J	0 3 UJ	0 6 J	0 3 UJ	1 1
Sum of PCB Congeners	22 7	16 6	62 9	28 4	18.9	15 6	2 8	44 6
Sum of PCB Congeners X 2	45 4	33 2	125 8	56 8	37 8	31 2	5 6	89 2
trans-Nonachlor	0.4 U	0.4 U	1 J	0 7 J	0 4 U	0 4 U	0 4 U	1 2
Metals (mg/kg)								
Aluminum	29667 J	32011 J	40750 J	37770 J	33977 J	37829 J	36058 J	92358 J
Arsenic	5 J	4 7 J	6 3 J	5 8 J	4 2 J	4 9 J	3 8 J	4 8 J
Cadmium	0 36	0 38	0 69	0 21	0 25	0 39	0 19	0 43
Chromium	48	44 1	73 6	55 6	52 5	52 9	47 8	53 2
Copper	23 9	26 4	83 5	30 3	19	22.7	18 3	44 7
Iron	24706 J	24564 J	31885 J	29787 J	28355 J	25993 J	28736 J	51703 J
Lead	61 2	71 4	190 4	56	40 6	46 2	21 7	74 2
Manganese	341.6	312 4	332 9	362 9	368 4	377 9	318 5	669 7
Mercury	0 208	0 225	0 562	0 299	0 171	0 112	0 111	0 387
Nickel	18 2	18 7	28 4	24	21	26 9	21 2	42 7
Silver	0 44 J	0 4 J	1 08 J	0.18 J	0 19 J	0 16 J	0 065 UJ	0 27 J
Zinc	50 9 U	125 7	248 3	166 3	108 5	143 9	39 15 U	306 2
AVS/SEM (µmole/g dry weight)								
Acid Volatile Sulfide	23 68	14 13	39	17 26	29 52	12 93	2.74	32 95
Cadmium	0 005	0 005	0.011	0 001	0 004	0 004	0.001	0 006
Copper	0 303	0 0555 U	0 22	0 232	0.285	0 0875 U	0 234	0 083 U
Lead	0 17	0 192	0 476	0 173	0 13	0.148	0 039	0 236
Nickel	0 0265 U	0 03 U	0.028 U	0 023 U	0 036 U	0 0455 U	0 0215 U	0 038 U
SEM-AVS	-22.08 J	-12 74 J	-36 14 J	-15 85 J	-27 9 J	-11 6 J	-1 43 J	-30 84 J
SEM/AVS	0 0874 J	0 0985 J	0 0733 J	0 082 J	0 055 J	0 1026 J	0 4783 J	0 064 J
Zinc	1 091	1 11	2.123	0 984	1.166	1 042	1 015	1 753
Total Organic Carbon (percent)								
Total Organic Carbon	2.6	2.6	4	2 9	2 3	2.3	1 3	2 7
Grain Size (percent)								
CLAY	3.9	2 3	2 7	2 5	2 4	2	0 6	1 3
SAND	3 3	46 2	6 9	49.4	59 3	50 9	91 5	54 6
SILT	92.8	51 6	90 4	48 1	38 3	47.2	8	44 1

Notes:
1/2 of the detection limit was used for all non-detected results

TABLE B-3.3
PORE WATER CONCENTRATIONS FOR ORGANICS AND METALS
ECOLOGICAL PRG DEVELOPMENT STEP 2
OLD FIRE FIGHTING TRAINING AREA
NSN, NEWPORT RHODE ISLAND

Sample Location / Sample Depth Interval	LogKow[1]	LogKoc[2]	Koc	OFF-1 0-15 cm	OFF-2 0-15 cm	OFF-3 0-15 cm	OFF-4 0-15 cm	OFF-5 0-15 cm	OFF-6 0-15 cm	OFF-7 0-15 cm	OFF-8 0-15 cm	OFF-9 0-15 cm	OFF-10 0-15 cm
Polyaromatic Hydrocarbons (ug/L)													
1-Methylnaphthalene	3 97	3 90	7994	1 03E-01 J	5 96E-01 J	8 64E-01 J	4 98E-01 J	3 48E+00 J	9 17E-01 J	2 28E-01	1 06E-01	1 77E-02 J	2 50E-02 J
1-Methylphenanthrene	5 08	4 99	98610	7 44E-02	3 36E-01	6 07E-01	3 18E-01	1 48E+00	3 83E-01	5 55E-02	1 72E-02	3 72E-03 J	2 77E-03 J
2,3,5-Trimethylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dimethylnaphthalene	4 61	4 53	34034	3 09E-02 J	2 75E-01 J	2 18E-01 J	1 75E-01 J	1 40E+00 J	2 42E-01 J	9 25E-02	5 54E-02	3 04E-02	2 40E-02 J
2-Methylnaphthalene	3 97	3 90	7994	1 81E-01 J	8 82E-01 J	1 24E+00 J	5 30E-01 J	4 13E+00 J	1.18E+00 J	3 61E-01	1 39E-01	3 23E-02 J	3 53E-02 J
Acenaphthene	3 92	3 85	7139	1 79E-01	1 12E+00	5 77E+00	8 40E-01	1 35E+01	2 68E+00	8 85E-01	3 66E-01	4 79E-02 J	3 18E-02 J
Acenaphthylene	4 05	3 98	9581	5 39E-01	4 63E+00	4 06E+00	4 92E+00	5 31E+00	1 13E+00	9 28E-01	1 49E-01	4 96E-02	3 89E-02 J
Anthracene	4 55	4 47	29712	4 77E-01 J	3 37E+00 J	5 46E+00 J	2 89E+00 J	9 46E+00 J	2 19E+00 J	6 96E-01	1 81E-01	3 17E-02	3 00E-02 J
Benzo(a)anthracene	5 7	5 60	401218	1 38E-02	8 16E-01	1 58E+00	6 31E-01	2 32E+00	5 88E-01	1 52E-01	4 10E-02	1 19E-02	7 98E-03
Benzo(a)pyrene	6 11	6 01	1014869	3 26E-02	2 16E-01	3 78E-01 J	2 29E-01	4 76E-01	1 09E-01	6 90E-02	1 65E-02	6 25E-03	4 04E-03
Benzo(b,j,k)fluoranthene	6 2	6 09	1244171	1 24E-01	5 63E-01	1 54E+00 J	3 13E-01	2 01E+00	4 19E-01	1 21E-01	2 54E-02	1 02E-02	6 91E-03
Benzo(e)pyrene	6 11	6 01	1014869	4 98E-02 J	2 12E-01 J	5 75E-01 J	1 43E-01 J	7 48E-01 J	1 79E-01 J	5 01E-02	1 22E-02	4 80E-03	3 70E-03 J
Benzo(g,h,i)Perylene	6 7	6 59	3858158	1 26E-02 J	5 94E-02 J	1 55E-01 J	3 72E-02 J	1 55E-01 J	3 79E-02 J	1 39E-02	2 81E-03	1 13E-03	9 54E-04 J
Biphenyl	3 96	3 89	7816	5 12E-02	2 57E-01	5 49E-01	9 38E-02	1 93E+00	3 32E-01	9 90E-02	3 15E-02 U	3 41E-02 U	1 40E-02 J
Chrysene/triphenylene	5 7	5 60	401218	1 09E-01	5 30E-01	1 26E+00	5 12E-01	1 82E+00	4 64E-01	6 81E-02 J	3 76E-02	1 24E-02	7 21E-03
Dibenzo(a,h)Anthracene	6 69	6 58	3771812	6 50E-03 J	3 11E-02 J	8 28E-02 J	1 04E-02 J	9 04E-02 J	2 05E-02 J	4 09E-03	8 46E-04	1 50E-04 U	2 07E-04 J
Fluoranthene	5 12	5 03	107954	1 00E+00	7 03E+00	1 50E+01	5 74E+00	1.78E+01	5 76E+00	1 07E+00	3 24E-01	9 03E-02	7 26E-02
Fluorene	4 21	4 14	13763	1 63E-01 J	2 00E+00 J	4 83E+00 J	1 43E+00 J	9 88E+00 J	1 58E+00 J	6 12E-01	1 94E-01	3 21E-02 J	1 85E-02 J
Indeno(1,2,3-cd)pyrene	6.65	6 54	3445323	1 63E-02	8 10E-02	2 12E-01 J	3 87E-02	2 14E-01	4 89E-02	1 48E-02	3 04E-03	1 16E-03	9 31E-04
Naphthalene	3 36	3 30	2010	8 82E-01	7 73E+00	8 24E+00	7 52E+00	1 28E+01	4 45E+00	1 83E+00	8 73E-01	1 78E-01	1 81E-01
Perylene	6 05	5 95	885992	1 41E-02	8 39E-02	1 87E-01 J	7 61E-02	1 65E-01	4 60E-02	2 16E-02	5 24E-03	2 01E-03	1 31E-03
Phenanthrene	4 55	4 47	29712	1 98E+00	1 72E+01	4 00E+01	1 13E+01	4 91E+01	1 77E+01	2 34E+00	6 76E-01	1 30E-01	9 58E-02
Pyrene	5 11	5 02	105538	9 37E-01	5 81E+00	1 13E+01	5 06E+00	1 60E+01	5 14E+00	1 06E+00	2 92E-01	8 05E-02	7 54E-02
Sum PAHs (6 High Molecular Weight)[3]	NA	NA	NA	2 10E+00	1 44E+01	2 96E+01	1 22E+01	3 85E+01	1 21E+01	2 42E+00	7 12E-01	2 02E-01	1 67E-01
Sum PAHs (7 Low Molecular Weight)[4]	NA	NA	NA	4 40E+00	3 69E+01	6 96E+01	2 95E+01	1 04E+02	3 09E+01	7 65E+00	2 58E+00	5 02E-01	4 31E-01
Sum PAHs (NOAA Status &Trends)[5]	NA	NA	NA	6 50E+00	5 13E+01	9 92E+01	4 17E+01	1 43E+02	4 30E+01	1 01E+01	3 29E+00	7 03E-01	5 99E-01
Pesticides/PCBs (ug/L)													
1a,2a,3b,4a,5a,6b-hexachlorocyclohexane (gamma-BHC)	3 81	3 75	5566	2 99E-03 U	4 90E-03 U	5 99E-03 U	5 99E-03 U	5 39E-03 U	7.99E-03 J	1 89E-03 J	4 15E-03 J	1 50E-03 J	4 90E-03 U
2,4'-DDE	6 76	6 65	4419366	3 14E-06 U	8 23E-06 U	1 01E-05 U	1 01E-05 U	9 05E-06 U	5 03E-06 U	4 76E-06 U	6 96E-06 U	7 54E-06 U	8 23E-06 U
2,4'-DDT	6 76	6 65	4419366	1 38E-05	3 70E-05	1 76E-05 J	6 54E-05	3 85E-05	1 76E-05	5 95E-06 U	8 70E-06 U	9 43E-06 U	1 03E-05 U
4,4'-DDD	6 1	6 00	992156	1 68E-04 J	1.28E-04 J	2 02E-04 J	2 69E-04 J	2 02E-04 J	2 13E-04 J	2 02E-04	6 20E-05 J	3 78E-05 U	3 67E-05 U
4,4'-DDE	6 76	6 65	4419366	1 57E-05 U	2 57E-05 U	2 77E-05 U	2 51E-05 U	3 39E-05 U	4 78E-05	3 69E-05	1 22E-05 J	8 49E-06 U	9 26E-06 U
4,4'-DDT	6 76	6 65	4419366	5 41E-05	2 06E-04	1 01E-04	2 89E-04	2 56E-04	1.23E-04	3 22E-05	1 91E-05	1 51E-05	1 44E-05
Aldrin	6 5	6 39	2453466	7 93E-06 U	1 30E-05 U	1 59E-05 U	1 59E-05 U	1 43E-05 U	7 93E-06 U	7 51E-06 U	3 14E-06 J	1 19E-05 U	1 30E-05 U
alpha-Chlordane	6 5	6 39	2453466	1 81E-05	2 59E-05 J	3 17E-05 J	5 43E-05	5 71E-05	1 36E-05 J	1 50E-05 J	3 14E-06 J	3 40E-06 J	1 48E-05 U
Heptachlor	6 5	6 39	2453466	5 66E-06 U	9 26E-06 U	1 13E-05 U	3 17E-05 U	1 02E-05 U	5 66E-06 U	6 44E-06 J	7 84E-06 U	8 49E-06 U	9 26E-06 U
Heptachlor Epoxide	6 5	6 39	2453466	5 66E-06 U	9 26E-06 U	1 13E-05 U	2 72E-05 J	1 02E-05 U	5 66E-06 U	5 36E-06 U	7 84E-06 U	8 49E-06 U	9 26E-06 U
Hexachlorobenzene	5.89	5 79	616808	1 80E-05 U	2 95E-05 U	3 60E-05 U	3 60E-05 U	4 05E-05 U	2 70E-05 U	1 71E-05 U	2 49E-05 U	2 70E-05 U	2 95E-05 U
Mirex	6.89	6 77	5931301	2 81E-06 J	4 60E-06 U	5 62E-06 U	5 62E-06 U	1 01E-05	4 68E-06 J	3 55E-06 J	3 89E-06 U	4 21E-06 U	4 60E-06 U
PCB 101/90	6 38	6.27	1869907	1 78E-05 U	5.10E-05 U	7 13E-05 U	1 72E-04	5 88E-05 U	2 97E-05 U	7 60E-05	2 26E-05 U	1 34E-05 U	1 70E-05 U
PCB 105	6 65	6 54	3445323	4 84E-06 U	1.58E-05 U	2.26E-05 U	1 13E-05 U	4 93E-05 J	5 64E-06 U	9 93E-06 UJ	6 70E-06 U	7 26E-06 U	3 96E-06 U
PCB 118	6 74	6 63	4223767	9 21E-06 J	4.52E-05	4 74E-05	3 42E-05	2 60E-05	2 10E-05	2 87E-05	2.00E-05	9 86E-06 J	1 51E-05 J
PCB 126	6 89	6 77	5931301	2 34E-06 U	1 38E-05 J	2 44E-05 J	3 18E-05 J	4 21E-05 J	2 34E-06 UJ	3 55E-06 U	3 24E-06 UJ	3 51E-06 U	3 83E-06 U
PCB 128	6.74	6 63	4223767	7 89E-06	1 29E-05 J	2 10E-05 J	5 52E-05	2 13E-05 J	2 37E-05 J	1 25E-05	5 46E-06 U	3 95E-06 UJ	5 38E-06 U
PCB 138/163/164	6 83	6 71	5178095	2 04E-05	1 88E-04 J	2 40E-04 J	2.45E-04	3 13E-04 J	3.22E-05 J	5.29E-05	3 57E-05	1 61E-05	2 11E-05
PCB 153	6 92	6 80	6348045	1 31E-05	3.58E-05	4 38E-05	3 33E-05	6 30E-05	2 36E-05	2 90E-05	2.42E-05	1 31E-05	1 58E-05
PCB 170	7 27	7 15	14018127	1 78E-06 U	2.27E-06 U	2.77E-06 U	1 43E-05	1 28E-05	7 13E-06 J	2 25E-06 U	2 47E-06 U	1 49E-06 UJ	2 27E-06 U
PCB 18	5 24	5 15	141645	5 10E-04 J	2.25E-04 U	1.33E-03	2 75E-04 U	9 88E-04	1 10E-03	2 23E-04 J	1 90E-04 U	2 06E-04 U	2 25E-04 U

TABLE B-3.3
PORE WATER CONCENTRATIONS FOR ORGANICS AND METALS
ECOLOGICAL PRG DEVELOPMENT STEP 2
OLD FIRE FIGHTING TRAINING AREA
NSN, NEWPORT RHODE ISLAND

Sample Location / Sample Depth Interval	LogKow[1]	LogKoc[1]	Koc	OFF-1 0-15 cm	OFF-2 0-15 cm	OFF-3 0-15 cm	OFF-4 0-15 cm	OFF-5 0-15 cm	OFF-6 0-15 cm	OFF-7 0-15 cm	OFF-8 0-15 cm	OFF-9 0-15 cm	OFF-10 0-15 cm
PCB 180	7 36	7.24	17185414	3 56E-06	7 93E-06	1 55E-05	1 29E-05	2 27E-05	6 79E-06 J	7 66E-06	5 37E-06	3 39E-06	3 17E-06
PCB 187/182/159	7 17	7 05	11178667	2 98E-06	5 69E-06	5 96E-06	2 78E-05	1 43E-05	9 44E-06 J	7 53E-06	3 10E-06 U	2 24E-06 U	4 88E-06
PCB 188	6 82	6 70	5062208	3 29E-06 U	5 39E-06 U	1 76E-05	6 58E-06 U	2 57E-05	2 85E-05	7 28E-06	7 60E-06 J	4 94E-06 U	5 39E-06 U
PCB 195	7 56	7 43	27024645	5 14E-07 U	1 01E-06 U	1 23E-06 U	4 93E-06	1.30E-05	6 17E-07 UJ	5 84E-07 U	8 54E-07 U	9 25E-07 U	1 01E-06 U
PCB 200	7.27	7 15	14018127	1 19E-06 J	7 78E-06	7 93E-06	1 43E-05	1 43E-05	4 36E-06 J	1 50E-06 J	2 19E-06 J	1 78E-06 J	2 59E-06 J
PCB 206	8 09	7 95	89691234	1 55E-07 U	2 53E-07 U	3 10E-07 U	1 49E-06 U	3 34E-07 U	1 86E-07 UJ	3 52E-07	6 86E-07	3 72E-07 J	6 59E-07 U
PCB 209	8 18	8 04	109956270	1 26E-07 U	2.07E-07 U	2 53E-07 U	2 53E-07 U	3 18E-07 U	2 07E-06 J	3 83E-07	5 60E-07	2 27E-07 J	2 89E-07 U
PCB 28/50	5 67	5 57	374878	1 04E-04	8 49E-05 U	1 78E-04 J	1 04E-04 U	4 80E-04	4 00E-04	1 40E-04	6 16E-05 J	1 11E-04 J	8 49E-05 U
PCB 29	5 6	5 51	319948	6 08E-05 U	9 94E-05 U	1.22E-04 U	1 22E-04 U	1 09E-04 U	6 08E-05 U	5 76E-05 U	8 41E-05 U	9 12E-05 U	9 94E-05 U
PCB 44	5 75	5 65	449293	7 42E-05 J	8 09E-05 J	3 46E-04 J	3 46E-04 J	3 12E-04 J	2 23E-04 J	2 23E-04	4 28E-05 U	4 64E-05 U	6 07E-05 J
PCB 50	5 63	5 53	342429	4 06E-05 U	6 64E-05 U	8 11E-05 U	8 11E-05 U	7 30E-05 U	4 06E-05 U	3 84E-05 U	5 62E-05 U	6 08E-05 U	6 64E-05 U
PCB 52	5 84	5 74	550808	4 03E-05 U	5 78E-05 U	1 01E-04 U	2 82E-04 J	3 27E-04 J	2 62E-04 J	1 34E-04	4 89E-05 U	5 30E-05 U	5 78E-05 U
PCB 66/95	6 2	6 09	1244171	4 91E-05	1 02E-04	1 79E-04	1 52E-04	3 13E-04	1 52E-04	1 40E-04	6 80E-05	1 67E-05 UJ	4 38E-05
PCB 8	5 07	4 98	96403	4 90E-03 J	1 41E-04 U	1 04E-03 J	1 73E-04 U	1 56E-04 U	3 46E-04	8 19E-05 U	1 20E-04 U	1 30E-04 U	1 41E-04 U
PCB 87	6 29	6 18	1525281	1 09E-05 UJ	5 36E-05 J	5 83E-05 J	5 10E-05 J	5 24E-05 J	5 83E-05 J	3 45E-05	1 51E-05 U	1 64E-05 U	1 79E-05 UJ
trans-Nonachlor	6 87	6 75	5668785	5 88E-06 J	6 41E-06 U	1 37E-05 J	7 84E-06 U	2 29E-05	3 92E-06 U	7 43E-06	2 71E-06 J	1 47E-06 J	6 41E-06 U
Sum of PCB Congeners				5 88E-03	1 30E-03	3 96E-03	2.25E-03	3 49E-03	2 84E-03	1 31E-03	8 27E-04	8 14E-04	8 99E-04
Sum of PCB Congeners X 2				1 18E-02	2.61E-03	7 92E-03	4 50E-03	6 98E-03	5 68E-03	2 62E-03	1 65E-03	1 63E-03	1 80E-03
Metals (ug/L)													
Aluminum				55 9	67.4	61.2	54 9	63 8	43 2	58 7	51.2	69 3	48 1
Arsenic				1 1	5 5	3 4	2.8	1	2 9	3 2	2 4	2 1	2 6
Barium				10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Cadmium				0 1 J	0 5	0 8	0 9	0 5	0 6	0 5	0 7	0 8	0 4
Chromium				28 6	19.2	18 6	22 4	21 8	15 4	19	20 1	23 9	22 3
Copper				26	21	23	28	84	19	15	19	31	30
Iron				610	310	120	200	170	220	120	280	410	340
Lead				18 22	16 43	14 62	18.66	18 24	15 83	16 41	15 8	12 4	15 71
Manganese				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury				R	R	R	R	R	R	R	R	R	R
Nickel				0 25 U	0 7	2	1 3	1 1	1 5	0 25 U	2 4	1 9	3 1
Silver				1 6	1.8	1.4	1 7	1 3	0 05 U	1 7	1 5	1 5	1 6
Zinc				170	140	100	130	260	420	170	180	200	270
Total Organic Carbon (percent)													
Total Organic Carbon				1 8	1 1	0 9	0 9	1	1.8	1 9	1 3	1 2	1 1

TABLE B-3.3
PORE WATER CONCENTRATIONS FOR ORGANICS AND METALS
ECOLOGICAL PRG DEVELOPMENT STEP 2
OLD FIRE FIGHTING TRAINING AREA
NSN, NEWPORT RHODE ISLAND

Sample Location	OFF-11	OFF-12	OFF-13	OFF-14	OFF-15	OFF-16	OFF-17	OFF-18	OFF-19	OFF-20	OFF-21	OFF-22	OFF-23
Sample Depth Interval	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm
Polyaromatic Hydrocarbons (ug/L)													
1-Methylnaphthalene	7 05E-02 J	3 94E-01 J	1 35E-01 J	5 88E-02	4 79E-02 J	8 47E-02 J	5 29E-02 J	9 82E-02 J	8 15E-02	2 38E-01 J	4 19E-02 J	1 92E-02 J	1 29E-01
1-Methylphenanthrene	1 36E-02	8 92E-02	4 49E-02 J	1 02E-02	9 63E-03	1.70E-02 J	9 87E-03	2 74E-02	7 06E-03	1 96E-02	8 51E-03	2 03E-03 J	1 87E-02
2,3,5-Trimethylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dimethylnaphthalene	4 94E-02 J	1 04E-01 J	4 05E-02 J	2 29E-02	1 79E-02 J	4 27E-02 J	2 50E-02 J	3 33E-02 J	5 50E-02	5 61E-02 J	1 75E-02 J	1 31E-02 J	4 20E-02
2-Methylnaphthalene	1 99E-01 J	5 85E-01 J	2 05E-01 J	9 69E-02	9 90E-02	1 15E-01 J	9 48E-02 J	2 00E-01 J	1 36E-01	2 20E-01 J	7 12E-02 J	2 98E-02 J	2 01E-01
Acenaphthene	3 55E-01	1 80E+00	3 85E-01 J	7 98E-02	5 95E-02 J	2 03E-01 J	1 38E-01	2 09E-01	2 12E-01	4 59E-01	5 72E-02	1 94E-02 J	4 64E-01
Acenaphthylene	8 54E-02	2 43E-01	4 07E-01 J	1 32E-01	1 03E-01	1 44E-01 J	1 65E-01	3 68E-01	1 46E-01	6 72E-02	8 30E-02	3 53E-02 J	3 00E-01
Anthracene	1 96E-01 J	7 70E-01 J	4 06E-01 J	8 72E-02	9 82E-02	1 14E-01 J	1 55E-01 J	2 86E-01 J	1 21E-01	3 18E-01 J	7 01E-02 J	2 46E-02 J	4 34E-01
Benzo(a)anthracene	3 81E-02	1 20E-01	7.23E-02 J	2 69E-02	2.20E-02	1 87E-02 J	2 41E-02	4 55E-02	2 72E-02	3 47E-02	1 64E-02	6 83E-03	5 69E-02
Benzo(a)pyrene	1 33E-02	5 60E-02	2 83E-02 J	1 26E-02	8.46E-03	8 34E-03 J	1 26E-02	2 37E-02	1 09E-02	1 10E-02	7 54E-03	2 94E-03	2 77E-02
Benzo(b,j,k)fluoranthene	2 08E-02	8 78E-02	4 88E-02 J	1 84E-02	2 45E-02	1 34E-02 J	2 02E-02	4 60E-02	1 71E-02	2 05E-02	1 31E-02	4 86E-03	4 58E-02
Benzo(e)pyrene	9 58E-03 J	4 26E-02 J	2 31E-02 J	1 05E-02	1 15E-02	7 09E-03 J	1 03E-02 J	2 37E-02 J	7 95E-03	8 44E-03 J	6 77E-03 J	3 74E-03 J	2 51E-02
Benzo(g,h,i)Perylene	2 24E-03 J	8 45E-03 J	4 82E-03 J	2 53E-03	2 16E-03	1 80E-03 J	2 69E-03 J	5 83E-03 J	1 80E-03	1 48E-03 J	1 50E-03 J	1 20E-03 J	6 72E-03
Biphenyl	4 30E-02 J	1 47E-01	6 56E-02 J	2 05E-02 U	3 41E-02 U	4 48E-02 J	2 76E-02 J	5 53E-02	8 03E-02	9.96E-02	3 28E-02 J	7 87E-03 J	6 07E-02
Chrysene/triphenylene	2 65E-02	9 95E-02	4 82E-02 J	2 37E-02	1 81E-02	1 45E-02 J	1 95E-02 J	3 93E-02	2 38E-02	3 21E-02	1 64E-02	5 12E-03	4 98E-02
Dibenzo(a,h)Anthracene	5 76E-04 J	2 97E-03 J	1 41E-03 J	6 92E-04	9 72E-04	5 06E-04 J	7 76E-04 J	1 81E-03 J	5 25E-04	5 80E-04 J	4 66E-04 J	2 49E-04 J	1 76E-03
Fluoranthene	3 27E-01	1 16E+00	6 02E-01 J	1 43E-01	1 43E-01	1 58E-01 J	1 88E-01 J	4 35E-01	1 73E-01	3 55E-01	1 17E-01	4 70E-02	5 35E-01
Fluorene	1 66E-01 J	7 88E-01 J	2 23E-01 J	6 25E-02	4 60E-02	9 53E-02 J	8 64E-02 J	1 36E-01 J	1 29E-01	2 93E-01 J	3 57E-02 J	1 34E-02 J	2 85E-01
Indeno(1,2,3-cd)pyrene	2 28E-03	9 02E-03	4 69E-03 J	2 50E-03	2 81E-03	1 74E-03 J	2 65E-03	5 70E-03	1 95E-03	1 89E-03	1 59E-03	7 57E-04	5 49E-03
Naphthalene	4 43E-01	2 55E+00	7 61E-01 J	5 12E-01	4 69E-01	3 81E-01 J	4 78E-01	8 47E-01	9 14E-01	8 67E-01	1 88E-01	1 22E-01 J	7 67E-01
Perylene	3 57E-03	1 16E-02	7 14E-03 J	4 48E-03	3 09E-03	2 73E-03 J	3 49E-03	7 79E-03	3 33E-03	3 11E-03	2 12E-03	1 12E-03	8 57E-03
Phenanthrene	7 28E-01	3 38E+00	1 21E+00 J	2 19E-01	2 45E-01	4 28E-01 J	3 51E-01	7 72E-01	3 41E-01	1 21E+00	1 84E-01	6 08E-02	9 60E-01
Pyrene	2 90E-01	1 14E+00	5 99E-01 J	1 63E-01	1 48E-01	1 87E-01 J	1 98E-01 J	4.29E-01	1 71E-01	3 09E-01	1 38E-01	5 04E-02	4 98E-01
Sum PAHs (6 High Molecular Weight)[3]	6 95E-01	2 58E+00	1 35E+00	3 69E-01	3 40E-01	3 87E-01	4 43E-01	9 74E-01	4 06E-01	7 43E-01	2 96E-01	1 13E-01	1 17E+00
Sum PAHs (7 Low Molecular Weight)[4]	2 17E+00	1 01E+01	3 60E+00	1 19E+00	1 12E+00	1 48E+00	1 47E+00	2 82E+00	2 00E+00	3 43E+00	6 90E-01	3 06E-01	3 41E+00
Sum PAHs (NOAA Status &Trends)[5]	2 87E+00	1 27E+01	4 95E+00	1 56E+00	1 46E+00	1 87E+00	1 91E+00	3 79E+00	2 40E+00	4 18E+00	9 85E-01	4 18E-01	4 58E+00
Pesticides/PCBs (ug/L)													
1a,2a,3b,4a,5a,6b-hexachlorocyclohexane (gamma-BHC)	4 90E-03 U	2 16E-03 U	1 35E-03 U	2 70E-03 U	7 49E-03 J	2.07E-03 U	2 07E-03 U	1 35E-03 U	5 58E-03	2 34E-03 U	2 34E-03 U	4 15E-03 U	2 00E-03 U
2,4'-DDE	8.23E-06 U	8 15E-06	2 26E-06 U	4 53E-06 U	7 54E-06 U	3 48E-06 U	3 48E-06 U	2 26E-06 U	3 12E-06 U	3 94E-06 U	3 94E-06 U	6 96E-06 U	3 35E-06 U
2,4'-DDT	1 03E-05 U	5 43E-06 J	6 79E-06	5 66E-06 U	9 43E-06 U	1 04E-05	6 09E-06 J	1 02E-05	3 90E-06 U	4 92E-06 U	4 92E-06 U	8 70E-06 U	6 70E-06
4,4'-DDD	3 67E-05 U	4 52E-04 J	4 96E-04 J	7 06E-05	5 04E-05 J	8 53E-05 J	5 00E-04 J	3 98E-04 J	3 82E-05	4 82E-05 J	1 05E-04 J	3 10E-05 U	2 73E-04
4,4'-DDE	9 26E-06 U	5 61E-05	6 11E-05	1.02E-05 J	9 43E-06 J	7.83E-06 U	1 00E-05 U	5 94E-05	9 36E-06	5 41E-06 U	8 85E-06 U	7 83E-06 U	2 68E-05
4,4'-DDT	3 29E-05	4 34E-05	6.17E-05	2 26E-05	1 51E-05	1 39E-05	3 57E-05	5 37E-05	1 40E-05	1 67E-05	2 07E-05	1 04E-05 J	3 44E-05
Aldrin	1 30E-05 U	5 71E-06 U	3 57E-06 U	7 13E-06 U	1 19E-05 U	5 49E-06 U	5 49E-06 U	3 57E-06 U	2 81E-06 J	6 20E-06 U	6 20E-06 U	1 10E-05 U	5 28E-06 U
alpha-Chlordane	1 48E-05 U	1 96E-05	1 43E-05	4 08E-06 J	3 40E-06 J	1 41E-05	6 27E-06 U	1.12E-05	1 12E-05	7 09E-06 U	7 09E-06 U	1 25E-05 U	1 21E-05 J
Heptachlor	9.26E-06 U	4 08E-06 U	6 62E-06 U	4 08E-06 J	3 40E-06 J	3 92E-06 U	3 92E-06 U	2 55E-06 U	3 51E-06 U	4 08E-06 U	4 43E-06 U	7 84E-06 U	3 77E-06 U
Heptachlor Epoxide	1 04E-04 J	3 91E-05 J	1 12E-05 J	5 09E-06 U	8 49E-06 U	3 92E-06 U	3 92E-06 U	1 02E-05 J	3 51E-06 U	4 43E-06 U	4 43E-06 U	7 84E-06 U	3 77E-06 U
Hexachlorobenzene	2.95E-05 U	2 59E-05 U	8 11E-06 U	1 62E-05 U	2 70E-05 U	1 25E-05 U	1.25E-05 U	8 11E-06 U	5 03E-05	1 41E-05 U	1 41E-05 U	2 49E-05 U	3 00E-05
Mirex	4 60E-06 U	2 02E-06 U	1.26E-06 U	3 37E-06 J	5 62E-06 J	1 95E-06 U	1 95E-06 U	1 26E-06 U	1.74E-06 U	2.20E-06 U	2 20E-06 U	3 89E-06 U	6 87E-06 J
PCB 101/90	5 35E-05 U	8 77E-05	7 89E-05	5 88E-05	2 01E-05 U	1 95E-05 U	2 16E-05 U	6 02E-05	3 32E-05	2 21E-05 U	2 56E-05 U	1 44E-05 U	5 74E-05
PCB 105	1 72E-05 U	1 97E-05 J	2 54E-05 J	6 53E-06 UJ	7 26E-06 U	5 02E-06 U	5 58E-06 U	1.74E-05 J	3 00E-06 U	3 79E-06 U	5 68E-06 U	2.23E-06 U	1 83E-05 J
PCB 118	4 30E-05	3 03E-05	3.91E-05	2 72E-05	1 58E-05	2 09E-05	1.55E-05	3.26E-05	1 14E-05	1.85E-05	2 06E-05	6 37E-06 U	2 37E-05
PCB 126	1 07E-05 J	1 21E-05 J	2 07E-05 J	9 27E-06	3 51E-06 UJ	7 78E-06 J	8 43E-06 J	7.59E-06 J	2 03E-06 U	8 06E-06 J	5 13E-06 J	3 24E-06 U	1 25E-05
PCB 128	1 29E-05	1.70E-05	2 37E-05	4 74E-06 U	3 95E-06 UJ	9 11E-06	8 20E-06	1.42E-05	2 04E-06 U	7 21E-06	9 26E-06	4 55E-06 U	2 02E-05
PCB 138/163/164	6 14E-05	5 95E-05	6 42E-05	2 99E-05	2 74E-05	3 64E-05	2 38E-05	5 89E-05	2 00E-05	3 44E-05	2 44E-05	1 34E-05	5 44E-05
PCB 153	4 73E-05	3 40E-05	3 66E-05	2 68E-05	2 23E-05	2.00E-05	1 70E-05	2 95E-05	1 30E-05	2 47E-05	1 85E-05	8 48E-06	2 45E-05
PCB 170	9 73E-06	1 08E-05	1.03E-05	1 61E-06 U	1 78E-06 U	4 12E-06	1 78E-06 U	5 17E-06	1 11E-06 U	4 65E-06	1 71E-06 U	1 37E-06 U	5 55E-06
PCB 18	2 25E-03	6 78E-04	8 82E-05 J	3 88E-04	2 06E-04 U	8.15E-05 J	9 50E-05 U	6 18E-05 U	3 16E-04 J	1 07E-04 U	1 07E-04 U	1 90E-04 U	9 15E-05 U

TABLE B-3.3
PORE WATER CONCENTRATIONS FOR ORGANICS AND METALS
ECOLOGICAL PRG DEVELOPMENT STEP 2
OLD FIRE FIGHTING TRAINING AREA
NSN, NEWPORT RHODE ISLAND

Sample Location Sample Depth Interval	OFF-11 0-15 cm	OFF-12 0-15 cm	OFF-13 0-15 cm	OFF-14 0-15 cm	OFF-15 0-15 cm	OFF-16 0-15 cm	OFF-17 0-15 cm	OFF-18 0-15 cm	OFF-19 0-15 cm	OFF-20 0-15 cm	OFF-21 0-15 cm	OFF-22 0-15 cm	OFF-23 0-15 cm
PCB 180	1 69E-05	1 49E-05	1 35E-05	4 66E-06	5 33E-06	3 80E-06	2 91E-06	7 56E-06	3 61E-06	4 81E-06	3 29E-06	1 34E-06 J	7 33E-06
PCB 187/182/159	1 63E-05	1 32E-05	1 23E-05	8 05E-06	2 61E-06 U	5 85E-06	4 47E-06	8 50E-06	3 39E-06	5 45E-06	5 83E-06 J	3 44E-06	1 03E-05
PCB 188	1 08E-05 J	7 90E-06	7 90E-06	7 90E-06	4 94E-06 U	7 60E-06	2 28E-06 U	7 41E-06	3 41E-06 J	5 15E-06	5 15E-06	4 56E-06 U	7 32E-06
PCB 195	2 35E-06	1 18E-06 J	3 42E-06	5 55E-07 U	9 25E-07 U	4 27E-07 U	4 27E-07 U	2 78E-07 U	3 83E-07 U	4 83E-07 U	4 83E-07 U	8 54E-07 U	1 03E-06 UJ
PCB 200	2 59E-06 J	4 57E-06	4 46E-07 U	1 43E-06 J	2 38E-06 J	6 86E-07 U	8 23E-07 J	2 14E-06	1 48E-06	1.24E-06 J	9 30E-07 J	1 10E-06 J	2 91E-06
PCB 206	7 60E-07 U	4 24E-07 U	1 11E-06	5 57E-07	6 50E-07	1 29E-07 U	3 22E-07 U	3 21E-07 U	3 08E-07	2 42E-07 U	2 67E-07 U	4 29E-07 U	4 96E-07
PCB 209	2 07E-07 U	8 00E-07	6 82E-07	5 46E-07	4 55E-07	1 40E-07 U	4 90E-07	5 91E-07	2 82E-07	1 98E-07 U	1 38E-07 U	1 75E-07 U	5 05E-07
PCB 28/50	1 79E-03	4 48E-04	8 67E-05	1 20E-04	6 67E-05 J	3 59E-05 U	3 59E-05 U	4 67E-05	3 68E-05 J	4 06E-05 U	4 06E-05 U	7 18E-05 U	1 48E-04
PCB 29	9 94E-05 U	4 38E-05 U	2 73E-05 U	5 47E-05 U	9 12E-05 U	4 21E-05 U	4.21E-05 U	2 73E-05 U	3 77E-05 U	4 76E-05 U	4 76E-05 U	8 41E-05 U	4 05E-05 U
PCB 44	6 68E-04 J	1 78E-04 J	1 34E-04 J	6 68E-05	4 64E-05 U	6 85E-05 J	4.28E-05 J	6 68E-05 J	8 44E-05 J	3 87E-05 J	4 84E-05 J	3 42E-05 J	9 07E-05
PCB 50	6 64E-05 U	2 92E-05 U	1 83E-05 U	3 65E-05 U	6 08E-05 U	2 81E-05 U	2 81E-05 U	1 83E-05 U	2 52E-05 U	3 17E-05 U	3 17E-05 U	5 62E-05 U	2 70E-05 U
PCB 52	5 61E-04 J	2 32E-04 J	1 32E-04 J	9 99E-05	5 30E-05 U	2 79E-05 U	2 44E-05 U	5 45E-05 J	2 82E-05 UJ	2 76E-05 U	3 55E-05 U	4 89E-05 U	9 41E-05
PCB 66/95	4 75E-04	1 61E-04	9 24E-05	8 84E-05	3 01E-05 U	5.26E-05	4 02E-05	7 84E-05	6 37E-05	4 89E-05	5 59E-05	3 09E-05 U	8 04E-05
PCB 8	7 54E-04	6 22E-04	2 33E-04	1 30E-04 U	1 30E-04 U	2.39E-04	5 98E-05 U	2 07E-04	3 04E-03	6 77E-05 U	6 77E-05 U	1 20E-04 U	1 15E-04 U
PCB 87	4 77E-05 J	4.20E-05 J	4 10E-05 J	9 83E-06 U	1.64E-05 U	1.77E-05 J	1 51E-05 J	2 62E-05 J	1 13E-05 J	8 55E-06 UJ	1 71E-05 J	1 51E-05 UJ	2 67E-05
trans-Nonachlor	6 41E-06 U	4.23E-06 J	4 41E-06 J	3 53E-06 J	2 94E-06 J	2 71E-06 U	2 71E-06 U	4 41E-06 J	4 26E-06 J	3 07E-06 U	3 07E-06 U	5 43E-06 U	7 84E-06
Sum of PCB Congeners	7 02E-03	2 75E-03	1 19E-03	1.18E-03	8 19E-04	7.35E-04	4 97E-04	8 40E-04	3 74E-03	5 60E-04	5 79E-04	7 17E-04	9 61E-04
Sum of PCB Congeners X 2	1 40E-02	5 50E-03	2.38E-03	2.37E-03	1 64E-03	1.47E-03	9.94E-04	1 68E-03	7 49E-03	1 12E-03	1 16E-03	1 43E-03	1.92E-03
Metals (ug/L)													
Aluminum	53 8	54 2	47 3	52 7	59 6	49 2	58 7	63 4	51 3	49 8	65.1	49 2	59 7
Arsenic	2	2 6	2 7	2 8	3 4	2.9	3 9	1 5	3	2 4	3	2 6	1 8
Barium	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Cadmium	0 4	0 7	0 8	0 7	0 6	0 9	0 6	0 7	0 8	0.9	0.4	0 9	0 4
Chromium	20 8	14 7	19 6	18 6	21 3	23 8	17 3	19.5	17 4	18 5	25 6	17 2	19 7
Copper	31	17	21	18	26	19	24	28	20	21	18	18	11
Iron	470	210	230	160	230	340	180	270	290	110	530	250	390
Lead	13 24	21 4	18 5	19 9	14 3	12	18 1	12 5	11 7	15 9	11 3	17 14	27 9
Manganese	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	R	R	R	R	R	R	R	R	R	R	R	R	R
Nickel	0 9	1 3	1 7	2 1	2 5	1 5	1	1 9	1 3	1 4	1 3	1 5	1 6
Silver	1 4	1 3	1 9	1 4	1.2	1 6	1 2	1 8	1.5	1 6	1 4	1 2	1 8
Zinc	260	140	160	110	190	210	240	180	150	150	220	200	160
Total Organic Carbon (percent)													
Total Organic Carbon	1.1	2.5	4	2	1 2	2 6	2 6	4	2 9	2 3	2 3	1 3	2 7

Notes:

1/2 of the detection limit was used for all non-detected results

The pore water concentrations for the organic constituents is calculated using the following equation [PW] = [SD]/(Koc*foc)

Where: [PW] = Pore water concentration
[SD] = Sediment concentration
Koc = Organic carbon partitioning coefficient
foc = Fraction of organic carbon = Total Organic Carbon/100

The pore water concentrations for the metals were measured

Footnotes:

1 - Sources of LogKow values are Karickhoff and Long, 1995 or Karickhoff et al , 1989

2 - LogKoc value is calculated using the following equantion from Karickhoff et al , 1989 $Log_{10}(koc) = 0\ 00028 + 0\ 983*log_{10}(Kow)$

3 - The pore water concentrations for HMW PAHs were calculated by summing the pore water concentrations for the following individual PAHs [benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, and pyrene]

4 - The pore water concentrations for LMW PAHs were calculated by summing the pore water concentrations for the following individual PAHs (2-methylnaphthalene, acenaphthalene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene)

5 - The pore water concentrations for total PAHs were calculated by summing the pore water concentrations for HMW and LMW PAHs

TABLE B-3.4
SUMMARY OF TOXIC AND NON-TOXIC PORE WATER AND SEDIMENT SAMPLES
ECOLOGICAL PRG DEVELOPMENT STEP 3
OLD FIRE FIGHTING TRAINING CENTER, NETC
NEWPORT, RHODE ISLAND

Station	Sea Urchin Development Test with Pore Water Samples					Amphipod Test with Sediment Samples	
	Mean Number of Normal Larvae				Toxic	Mean	Toxic
	100%[1]	50%[1]	10%[1]	EC50[2]	Samples[3]	Survival	Samples[3]
Site Stations							
OF-1	0	7	84	30	Toxic	95	
OF-2	0	13	88	33	Toxic	87	
OF-3	4	73	88	71		92	
OF-4	85	83	90	>100		90	
OF-5	0	1	19	6	Toxic	72	Toxic
OF-6	6	79	85	74		94	
OF-7	1	81	88	73		94	
OF-8	0	71	80	72		100	
OF-9	3	0	74	29	Toxic	95	
OF-10	0	74	91	69		100	
OF-11	9	95	94	78		98	
OF-12	0	1	93	30	Toxic	100	
OF-13	0	0	93	30	Toxic	99	
OF-14	54	81	79	>100		99	
OF-15	0	41	87	49	Toxic	98	
OF-16	0	93	90	75		97	
OF-17	17	94	94	81		98	
OF-18	1	0	94	30	Toxic	96	
OF-19	0	33	85	43	Toxic	98	
OF-20	2	89	93	75		100	
OF-21	7	88	91	76		98	
Reference Stations							
OF-22	2	82	91	73		90	
OF-23	0	0	89	30	Toxic	95	

Notes:
1 - Value is the percentage of pore water used in the toxicity test.
2 - The EC50 value is the percentage of pore water that causes 50% of the larvae to development abnormally.
3 - Samples with EC50 values of greater than ~70% are considered non-toxic.

NA - Not Applicable because the sample is a control sample
Source of data is Technical Support Document for the Marine Ecological Risk Assessment for OFFTA (TtNUS, 1998)

TABLE B-3.5
PORE WATER SUMMARY STATISTICS
ECOLOGICAL PRG DEVELOPMENT STEP 4
OLD FIRE FIGHTING TRAINING CENTER, NSN
NEWPORT, RHODE ISLAND

PARAMETER	Non-Toxic Sea Urchin Samples[1]					
	Frequency of Detection	Maximum Detection	Location of Maximum Detection	Data Distribution	Statistic Selected[5]	Selected Pore Water Concentration
Metals (ug/L)						
Aluminum	12 / 12	6.51E+01	OFF-21-PW	Lognormal	95% UCL-T	5.74E+01
Arsenic	12 / 12	3.90E+00	OFF-17-PW	Lognormal	95% UCL-T	3.15E+00
Cadmium	12 / 12	9.00E-01	OFF-16-PW, OFF-20-PW, OFF-4-PW	Normal	95% UCL-N	7.53E-01
Chromium	12 / 12	2.56E+01	OFF-21-PW	Lognormal	95% UCL-T	2.19E+01
Copper	12 / 12	3.10E+01	OFF-11-PW	Lognormal	95% UCL-T	2.51E+01
Iron	12 / 12	5.30E+02	OFF-21-PW	Lognormal	95% UCL-T	3.68E+02
Lead	12 / 12	1.99E+01	OFF-14-PW	Normal	95% UCL-N	1.70E+01
Nickel	11 / 12	3.10E+00	OFF-10-PW	Normal	95% UCL-N	1.96E+00
Silver	11 / 12	1.70E+00	OFF-4-PW, OFF-7-PW	Undefined	Max	1.70E+00
Zinc	12 / 12	4.20E+02	OFF-6-PW	Lognormal	95% UCL-T	2.66E+02
SEM and AVS (umol/g)						
SEM-AVS	11 / 12	4.89E-01 J	OFF-3-PW	Undefined	Max	4.89E-01
PAHs (ug/L)						
1-Methylnaphthalene	12 / 12	9.17E-01 J	OFF-6-PW	Lognormal	Max	9.17E-01
1-Methylphenanthrene	12 / 12	6 07E-01	OFF-3-PW	Lognormal	Max	6.07E-01
2,6-Dimethylnaphthalene	12 / 12	2.42E-01 J	OFF-6-PW	Lognormal	95% UCL-T	1.86E-01
2-Methylnaphthalene	12 / 12	1.24E+00 J	OFF-3-PW	Lognormal	95% UCL-T	1.04E+00
Acenaphthene	12 / 12	5.77E+00	OFF-3-PW	Lognormal	Max	5.77E+00
Acenaphthylene	12 / 12	4.92E+00	OFF-4-PW	Lognormal	Max	4.92E+00
Anthracene	12 / 12	5.46E+00 J	OFF-3-PW	Lognormal	Max	5.46E+00
Benzo(a)anthracene	12 / 12	1.58E+00	OFF-3-PW	Lognormal	Max	1.58E+00
Benzo(a)pyrene	12 / 12	3.78E-01 J	OFF-3-PW	Lognormal	Max	3.78E-01
Benzo(b,j,k)fluoranthene	12 / 12	1.54E+00 J	OFF-3-PW	Undefined	Max	1.54E+00
Benzo(e)pyrene	12 / 12	5.75E-01 J	OFF-3-PW	Undefined	Max	5.75E-01
Benzo(g,h,i)Perylene	12 / 12	1.55E-01 J	OFF-3-PW	Undefined	Max	1.55E-01
Biphenyl	10 / 12	5.49E-01	OFF-3-PW	Lognormal	95% UCL-T	3.16E-01
Chrysene/triphenylene	12 / 12	1.26E+00	OFF-3-PW	Lognormal	Max	1.26E+00
Dibenzo(a,h)Anthracene	12 / 12	8.28E-02 J	OFF-3-PW	Undefined	Max	8.28E-02
Fluoranthene	12 / 12	1.50E+01	OFF-3-PW	Lognormal	Max	1.50E+01
Fluorene	12 / 12	4.83E+00 J	OFF-3-PW	Lognormal	Max	4.83E+00
Indeno(1,2,3-cd)pyrene	12 / 12	2.12E-01 J	OFF-3-PW	Undefined	Max	2.12E-01
Naphthalene	12 / 12	8.24E+00	OFF-3-PW	Lognormal	Max	8.24E+00
Perylene	12 / 12	1.87E-01 J	OFF-3-PW	Lognormal	Max	1.87E-01
Phenanthrene	12 / 12	4.00E+01	OFF-3-PW	Lognormal	Max	4.00E+01
Pyrene	12 / 12	1.13E+01	OFF-3-PW	Undefined	Max	1.13E+01
Sum PAHs (6 High Molecular Weight)	12 / 12	2.96E+01	OFF-3-PW	Lognormal	Max	2.96E+01
Sum PAHs (7 Low Molecular Weight)	12 / 12	6.96E+01	OFF-3-PW	Lognormal	Max	6.96E+01
Sum PAHs (NOAA Status &Trends)	12 / 12	9.92E+01	OFF-3-PW	Lognormal	Max	9.92E+01
Pesticides (ug/L)						
2,4'-DDE	0 / 12	0.00E+00	None	Lognormal	Max	0.00E+00
2,4'-DDT	5 / 12	6.54E-05	OFF-4-PW	Undefined	95% UCL-T	2.28E-05
4,4'-DDD	10 / 12	5.00E-04 J	OFF-17-PW	Lognormal	95% UCL-T	3.10E-04
4,4'-DDE	4 / 12	4.78E-05	OFF-6-PW	Lognormal	95% UCL-T	2 90E-05
4,4'-DDT	12 / 12	2.89E-04	OFF-4-PW	Undefined	95% UCL-T	1.29E-04
Aldrin	1 / 12	3.14E-06 J	OFF-8-PW	Lognormal	Max	3.14E-06
Alpha-Chlordane	7 / 12	5 43E-05	OFF-4-PW	Lognormal	95% UCL-T	2.98E-05
Gamma-BHC	3 / 12	7.99E-03 J	OFF-6-PW	Lognormal	95% UCL-T	5 54E-03
Heptachlor	2 / 12	6.44E-06 J	OFF-7-PW	Undefined	Max	6.44E-06

TABLE B-3.5
PORE WATER SUMMARY STATISTICS
ECOLOGICAL PRG DEVELOPMENT STEP 4
OLD FIRE FIGHTING TRAINING CENTER, NSN
NEWPORT, RHODE ISLAND

PARAMETER	Non-Toxic Sea Urchin Samples[1]					
	Frequency of Detection	Maximum Detection	Location of Maximum Detection	Data Distribution	Statistic Selected[5]	Selected Pore Water Concentration
Heptachlor Epoxide	2 / 12	1.04E-04 J	OFF-11-PW	Undefined	95% UCL-T	3.08E-05
Hexachlorobenzene	0 / 12	0 00E+00	None	Lognormal	Max	0.00E+00
Mirex	3 / 12	4.68E-06 J	OFF-6-PW	Normal	95% UCL-N	4.40E-06
PCBs (ug/L)						
PCB 101/90	3 / 12	1.72E-04	OFF-4-PW	Lognormal	95% UCL-T	8.24E-05
PCB 105	0 / 12	0.00E+00	None	Lognormal	Max	0.00E+00
PCB 118	12 / 12	4.74E-05	OFF-3-PW	Lognormal	95% UCL-T	3.27E-05
PCB 126	8 / 12	3.18E-05 J	OFF-4-PW	Lognormal	95% UCL-T	1.83E-05
PCB 128	9 / 12	5.52E-05	OFF-4-PW	Lognormal	95% UCL-T	2.42E-05
PCB 138/163/164	12 / 12	2.45E-04	OFF-4-PW	Undefined	95% UCL-T	1.26E-04
PCB 153	12 / 12	4.73E-05	OFF-11-PW	Lognormal	95% UCL-T	3.33E-05
PCB 170	5 / 12	1.43E-05	OFF-4-PW	Lognormal	95% UCL-T	7.74E-06
PCB 18	6 / 12	2.25E-03	OFF-11-PW	Lognormal	95% UCL-T	1.50E-03
PCB 180	12 / 12	1.69E-05	OFF-11-PW	Lognormal	95% UCL-T	1.13E-05
PCB 187/182/159	11 / 12	2.78E-05	OFF-4-PW	Lognormal	95% UCL-T	1.29E-05
PCB 188	9 / 12	2.85E-05	OFF-6-PW	Lognormal	95% UCL-T	1.46E-05
PCB 195	2 / 12	4 93E-06	OFF-4-PW	Undefined	95% UCL-T	1.95E-06
PCB 200	11 / 12	1.43E-05	OFF-4-PW	Lognormal	95% UCL-T	7.17E-06
PCB 206	3 / 12	6.86E-07	OFF-8-PW	Lognormal	Max	6.86E-07
PCB 209	5 / 12	2.07E-06 J	OFF-6-PW	Lognormal	95% UCL-T	7.73E-07
PCB 28/50	6 / 12	1.79E-03	OFF-11-PW	Lognormal	95% UCL-T	6 41E-04
PCB 44	11 / 12	6.68E-04 J	OFF-11-PW	Undefined	95% UCL-T	4.56E-04
PCB 52	5 / 12	5.61E-04 J	OFF-11-PW	Lognormal	95% UCL-T	3 60E-04
PCB 66/95	12 / 12	4.75E-04	OFF-11-PW	Lognormal	95% UCL-T	2.14E-04
PCB 8	4 / 12	1.04E-03 J	OFF-3-PW	Lognormal	95% UCL-T	5.80E-04
PCB 87	8 / 12	5.83E-05 J	OFF-3-PW, OFF-6-PW	Lognormal	95% UCL-T	4.98E-05
Sum of PCB Congeners	12 / 12	7.02E-03	OFF-11-PW	Lognormal	95% UCL-T	3.70E-03
Sum of PCB Congeners X 2	12 / 12	1 40E-02	OFF-11-PW	Lognormal	95% UCL-T	7.40E-03
Trans-Nonachlor	4 / 12	1.37E-05 J	OFF-3-PW	Lognormal	95% UCL-T	7.56E-06

TABLE B-3.5
PORE WATER SUMMARY STATISTICS
ECOLOGICAL PRG DEVELOPMENT STEP 4
OLD FIRE FIGHTING TRAINING CENTER, NSN
NEWPORT, RHODE ISLAND

PARAMETER	Toxic Sea Urchin Samples[2]					
	Frequency of Detection	Maximum Detection	Location of Maximum Detection	Data Distribution[6]	Statistic Selected	Selected Pore Water Concentration
Metals (ug/L)						
Aluminum	8 / 8	6.93E+01	OFF-9-PW	< 11 Samples	Max	6.93E+01
Arsenic	9 / 9	5.50E+00	OFF-2-PW	< 11 Samples	Max	5.50E+00
Cadmium	9 / 9	8.00E-01	OFF-13-PW, OFF-19-PW, OFF-9-PW	< 11 Samples	Max	8.00E-01
Chromium	9 / 9	2.86E+01	OFF-1-PW	< 11 Samples	Max	2.86E+01
Copper	9 / 9	8.40E+01	OFF-5-PW	< 11 Samples	Max	8.40E+01
Iron	9 / 9	6.10E+02	OFF-1-PW	< 11 Samples	Max	6.10E+02
Lead	9 / 9	2.14E+01	OFF-12-PW	< 11 Samples	Max	2.14E+01
Nickel	8 / 9	2.50E+00	OFF-15-PW	< 11 Samples	Max	2.50E+00
Silver	9 / 9	1.90E+00	OFF-13-PW	< 11 Samples	Max	1.90E+00
Zinc	9 / 9	2.60E+02	OFF-5-PW	< 11 Samples	Max	2.60E+02
SEM and AVS (umol/g)						
SEM-AVS	7 / 7	-3.65E+00 J	OFF-15-PW	< 11 Samples	Max	-3.65E+00
PAHs (ug/L)						
1-Methylnaphthalene	9 / 9	3.48E+00 J	OFF-5-PW	< 11 Samples	Max	3.48E+00
1-Methylphenanthrene	9 / 9	1.48E+00	OFF-5-PW	< 11 Samples	Max	1.48E+00
2,6-Dimethylnaphthalene	9 / 9	1.40E+00 J	OFF-5-PW	< 11 Samples	Max	1.40E+00
2-Methylnaphthalene	9 / 9	4.13E+00 J	OFF-5-PW	< 11 Samples	Max	4.13E+00
Acenaphthene	9 / 9	1.35E+01	OFF-5-PW	< 11 Samples	Max	1.35E+01
Acenaphthylene	9 / 9	5.31E+00	OFF-5-PW	< 11 Samples	Max	5.31E+00
Anthracene	9 / 9	9 46E+00 J	OFF-5-PW	< 11 Samples	Max	9.46E+00
Benzo(a)anthracene	9 / 9	2.32E+00	OFF-5-PW	< 11 Samples	Max	2.32E+00
Benzo(a)pyrene	9 / 9	4.76E-01	OFF-5-PW	< 11 Samples	Max	4.76E-01
Benzo(b,j,k)fluoranthene	9 / 9	2.01E+00	OFF-5-PW	< 11 Samples	Max	2.01E+00
Benzo(e)pyrene	9 / 9	7.48E-01 J	OFF-5-PW	< 11 Samples	Max	7.48E-01
Benzo(g,h,i)Perylene	9 / 9	1.55E-01 J	OFF-5-PW	< 11 Samples	Max	1.55E-01
Biphenyl	7 / 9	1.93E+00	OFF-5-PW	< 11 Samples	Max	1.93E+00
Chrysene/triphenylene	9 / 9	1.82E+00	OFF-5-PW	< 11 Samples	Max	1.82E+00
Dibenzo(a,h)Anthracene	8 / 9	9 04E-02 J	OFF-5-PW	< 11 Samples	Max	9.04E-02
Fluoranthene	9 / 9	1.78E+01	OFF-5-PW	< 11 Samples	Max	1.78E+01
Fluorene	9 / 9	9.88E+00 J	OFF-5-PW	< 11 Samples	Max	9.88E+00
Indeno(1,2,3-cd)pyrene	9 / 9	2.14E-01	OFF-5-PW	< 11 Samples	Max	2.14E-01
Naphthalene	9 / 9	1.28E+01	OFF-5-PW	< 11 Samples	Max	1.28E+01
Perylene	9 / 9	1.65E-01	OFF-5-PW	< 11 Samples	Max	1.65E-01
Phenanthrene	9 / 9	4.91E+01	OFF-5-PW	< 11 Samples	Max	4.91E+01
Pyrene	9 / 9	1.60E+01	OFF-5-PW	< 11 Samples	Max	1.60E+01
Sum PAHs (6 High Molecular Weight)	9 / 9	3.85E+01	OFF-5-PW	< 11 Samples	Max	3.85E+01
Sum PAHs (7 Low Molecular Weight)	9 / 9	1.04E+02	OFF-5-PW	< 11 Samples	Max	1.04E+02
Sum PAHs (NOAA Status &Trends)	9 / 9	1.43E+02	OFF-5-PW	< 11 Samples	Max	1.43E+02
Pesticides (ug/L)						
2,4'-DDE	1 / 9	8.15E-06	OFF-12-PW	< 11 Samples	Max	8.15E-06
2,4'-DDT	6 / 9	3.85E-05	OFF-5-PW	< 11 Samples	Max	3.85E-05
4,4'-DDD	8 / 9	4.96E-04 J	OFF-13-PW	< 11 Samples	Max	4.96E-04
4,4'-DDE	5 / 9	6.11E-05	OFF-13-PW	< 11 Samples	Max	6.11E-05
4,4'-DDT	9 / 9	2.56E-04	OFF-5-PW	< 11 Samples	Max	2.56E-04
Aldrin	1 / 9	2 81E-06 J	OFF-19-PW	< 11 Samples	Max	2.81E-06
Alpha-Chlordane	9 / 9	5.71E-05	OFF-5-PW	< 11 Samples	Max	5.71E-05
Gamma-BHC	3 / 9	7.49E-03 J	OFF-15-PW	< 11 Samples	Max	7.49E-03
Heptachlor	1 / 9	3 40E-06 J	OFF-15-PW	< 11 Samples	Max	3.40E-06

TABLE B-3.5
PORE WATER SUMMARY STATISTICS
ECOLOGICAL PRG DEVELOPMENT STEP 4
OLD FIRE FIGHTING TRAINING CENTER, NSN
NEWPORT, RHODE ISLAND

PARAMETER	Toxic Sea Urchin Samples[2]					
	Frequency of Detection	Maximum Detection	Location of Maximum Detection	Data Distribution[6]	Statistic Selected	Selected Pore Water Concentration
Heptachlor Epoxide	3 / 9	3 91E-05 J	OFF-12-PW	< 11 Samples	Max	3.91E-05
Hexachlorobenzene	1 / 9	5.03E-05	OFF-19-PW	< 11 Samples	Max	5.03E-05
Mirex	3 / 9	1.01E-05	OFF-5-PW	< 11 Samples	Max	1.01E-05
PCBs (ug/L)						
PCB 101/90	4 / 9	8.77E-05	OFF-12-PW	< 11 Samples	Max	8.77E-05
PCB 105	4 / 9	4 93E-05 J	OFF-5-PW	< 11 Samples	Max	4.93E-05
PCB 118	9 / 9	4.52E-05	OFF-2-PW	< 11 Samples	Max	4.52E-05
PCB 126	5 / 9	4.21E-05 J	OFF-5-PW	< 11 Samples	Max	4.21E-05
PCB 128	6 / 9	2.37E-05	OFF-13-PW	< 11 Samples	Max	2.37E-05
PCB 138/163/164	9 / 9	3.13E-04 J	OFF-5-PW	< 11 Samples	Max	3.13E-04
PCB 153	9 / 9	6.30E-05	OFF-5-PW	< 11 Samples	Max	6.30E-05
PCB 170	4 / 9	1.28E-05	OFF-5-PW	< 11 Samples	Max	1.28E-05
PCB 18	5 / 9	9.88E-04	OFF-5-PW	< 11 Samples	Max	9.88E-04
PCB 180	9 / 9	2.27E-05	OFF-5-PW	< 11 Samples	Max	2.27E-05
PCB 187/182/159	7 / 9	1.43E-05	OFF-5-PW	< 11 Samples	Max	1.43E-05
PCB 188	5 / 9	2.57E-05	OFF-5-PW	< 11 Samples	Max	2.57E-05
PCB 195	3 / 9	1.30E-05	OFF-5-PW	< 11 Samples	Max	1.30E-05
PCB 200	8 / 9	1.43E-05	OFF-5-PW	< 11 Samples	Max	1.43E-05
PCB 206	4 / 9	1.11E-06	OFF-13-PW	< 11 Samples	Max	1.11E-06
PCB 209	6 / 9	8.00E-07	OFF-12-PW	< 11 Samples	Max	8.00E-07
PCB 28/50	8 / 9	4.80E-04	OFF-5-PW	< 11 Samples	Max	4.80E-04
PCB 44	7 / 9	3.12E-04 J	OFF-5-PW	< 11 Samples	Max	3.12E-04
PCB 52	4 / 9	3.27E-04 J	OFF-5-PW	< 11 Samples	Max	3.27E-04
PCB 66/95	7 / 9	3.13E-04	OFF-5-PW	< 11 Samples	Max	3.13E-04
PCB 8	5 / 9	4.90E-03 J	OFF-1-PW	< 11 Samples	Max	4.90E-03
PCB 87	6 / 9	5.36E-05 J	OFF-2-PW	< 11 Samples	Max	5.36E-05
Sum of PCB Congeners	9 / 9	5.88E-03	OFF-1-PW	< 11 Samples	Max	5.88E-03
Sum of PCB Congeners X 2	9 / 9	1.18E-02	OFF-1-PW	< 11 Samples	Max	1.18E-02
Trans-Nonachlor	8 / 9	2.29E-05	OFF-5-PW	< 11 Samples	Max	2.29E-05

TABLE B-3.5
PORE WATER SUMMARY STATISTICS
ECOLOGICAL PRG DEVELOPMENT STEP 4
OLD FIRE FIGHTING TRAINING CENTER, NSN
NEWPORT, RHODE ISLAND

PARAMETER	Non-Toxic Amphipod Samples[3,4]					
	Frequency of Detection	Maximum Detection	Location of Maximum Detection	Data Distribution	Statistic Selected	Selected Pore Water Concentration
Metals (ug/L)						
Aluminum	19 / 19	6.93E+01	OFF-9-PW	Lognormal	95% UCL-T	5.88E+01
Arsenic	20 / 20	5.50E+00	OFF-2-PW	Lognormal	95% UCL-T	3.26E+00
Cadmium	20 / 20	9.00E-01	OFF-16-PW, OFF-20-PW, OFF-4-PW	Normal	95% UCL-N	7.21E-01
Chromium	20 / 20	2 86E+01	OFF-1-PW	Lognormal	95% UCL-T	2.17E+01
Copper	20 / 20	3.10E+01	OFF-11-PW, OFF-9-PW	Lognormal	95% UCL-T	2.49E+01
Iron	20 / 20	6.10E+02	OFF-1-PW	Lognormal	95% UCL-T	3.54E+02
Lead	20 / 20	2.14E+01	OFF-12-PW	Normal	95% UCL-N	1.68E+01
Nickel	18 / 20	3.10E+00	OFF-10-PW	Normal	95% UCL-N	1.79E+00
Silver	19 / 20	1.90E+00	OFF-13-PW	Undefined	Max	1.90E+00
Zinc	20 / 20	4.20E+02	OFF-6-PW	Lognormal	95% UCL-T	2.18E+02
SEM and AVS (umol/g)						
SEM-AVS	17 / 20	4 89E-01 J	OFF-3-PW	Undefined	Max	4.89E-01
PAHs (ug/L)						
1-Methylnaphthalene	20 / 20	9 17E-01 J	OFF-6-PW	Lognormal	95% UCL-T	5.03E-01
1-Methylphenanthrene	20 / 20	6.07E-01	OFF-3-PW	Lognormal	95% UCL-T	3.96E-01
2,6-Dimethylnaphthalene	20 / 20	2.75E-01 J	OFF-2-PW	Lognormal	95% UCL-T	1.29E-01
2-Methylnaphthalene	20 / 20	1.24E+00 J	OFF-3-PW	Lognormal	95% UCL-T	6.42E-01
Acenaphthene	20 / 20	5.77E+00	OFF-3-PW	Lognormal	95% UCL-T	2.34E+00
Acenaphthylene	20 / 20	4.92E+00	OFF-4-PW	Undefined	95% UCL-T	2.71E+00
Anthracene	20 / 20	5 46E+00 J	OFF-3-PW	Lognormal	95% UCL-T	3.04E+00
Benzo(a)anthracene	20 / 20	1.58E+00	OFF-3-PW	Undefined	95% UCL-T	6.55E-01
Benzo(a)pyrene	20 / 20	3.78E-01 J	OFF-3-PW	Lognormal	95% UCL-T	1.50E-01
Benzo(b,j,k)fluoranthene	20 / 20	1 54E+00 J	OFF-3-PW	Undefined	95% UCL-T	4.86E-01
Benzo(e)pyrene	20 / 20	5.75E-01 J	OFF-3-PW	Undefined	95% UCL-T	1.78E-01
Benzo(g,h,i)Perylene	20 / 20	1.55E-01 J	OFF-3-PW	Undefined	95% UCL-T	4.73E-02
Biphenyl	16 / 20	5.49E-01	OFF-3-PW	Lognormal	95% UCL-T	1.75E-01
Chrysene/triphenylene	20 / 20	1.26E+00	OFF-3-PW	Undefined	95% UCL-T	4.47E-01
Dibenzo(a,h)Anthracene	19 / 20	8 28E-02 J	OFF-3-PW	Lognormal	95% UCL-T	3.18E-02
Fluoranthene	20 / 20	1.50E+01	OFF-3-PW	Undefined	95% UCL-T	6.79E+00
Fluorene	20 / 20	4 83E+00 J	OFF-3-PW	Lognormal	95% UCL-T	2.20E+00
Indeno(1,2,3-cd)pyrene	20 / 20	2.12E-01 J	OFF-3-PW	Undefined	95% UCL-T	6.42E-02
Naphthalene	20 / 20	8.24E+00	OFF-3-PW	Lognormal	95% UCL-T	4.55E+00
Perylene	20 / 20	1.87E-01 J	OFF-3-PW	Undefined	95% UCL-T	6.14E-02
Phenanthrene	20 / 20	4.00E+01	OFF-3-PW	Lognormal	95% UCL-T	2.37E+01
Pyrene	20 / 20	1.13E+01	OFF-3-PW	Undefined	95% UCL-T	5.18E+00
Sum PAHs (6 High Molecular Weight)	20 / 20	2.96E+01	OFF-3-PW	Undefined	95% UCL-T	1.30E+01
Sum PAHs (7 Low Molecular Weight)	20 / 20	6.96E+01	OFF-3-PW	Lognormal	95% UCL-T	3.23E+01
Sum PAHs (NOAA Status &Trends)	20 / 20	9.92E+01	OFF-3-PW	Lognormal	95% UCL-T	4.49E+01
Pesticides (ug/L)						
2,4'-DDE	1 / 20	8 15E-06	OFF-12-PW	Lognormal	95% UCL-T	7.25E-06
2,4'-DDT	10 / 20	6.54E-05	OFF-4-PW	Undefined	95% UCL-T	1.78E-05
4,4'-DDD	17 / 20	5.00E-04 J	OFF-17-PW	Lognormal	95% UCL-T	3.22E-04
4,4'-DDE	9 / 20	6.11E-05	OFF-13-PW	Undefined	95% UCL-T	3.47E-05
4,4'-DDT	20 / 20	2.89E-04	OFF-4-PW	Undefined	95% UCL-T	9.58E-05
Aldrin	2 / 20	3.14E-06 J	OFF-8-PW	Lognormal	Max	3.14E-06
Alpha-Chlordane	15 / 20	5.43E-05	OFF-4-PW	Lognormal	95% UCL-T	2.27E-05
Gamma-BHC	6 / 20	7.99E-03 J	OFF-6-PW	Lognormal	95% UCL-T	4.98E-03
Heptachlor	3 / 20	6.44E-06 J	OFF-7-PW	Undefined	Max	6.44E-06

TABLE B-3.5
PORE WATER SUMMARY STATISTICS
ECOLOGICAL PRG DEVELOPMENT STEP 4
OLD FIRE FIGHTING TRAINING CENTER, NSN
NEWPORT, RHODE ISLAND

PARAMETER	Non-Toxic Amphipod Samples[3,4]					
	Frequency of Detection	Maximum Detection	Location of Maximum Detection	Data Distribution	Statistic Selected	Selected Pore Water Concentrati n
Heptachlor Epoxide	5 / 20	1.04E-04 J	OFF-11-PW	Undefined	95% UCL-T	2.00E-05
Hexachlorobenzene	1 / 20	5.03E-05	OFF-19-PW	Lognormal	95% UCL-T	2.96E-05
Mirex	5 / 20	5.62E-06 J	OFF-15-PW	Normal	95% UCL-N	3.97E-06
PCBs (ug/L)						
PCB 101/90	7 / 20	1.72E-04	OFF-4-PW	Lognormal	95% UCL-T	6.78E-05
PCB 105	3 / 20	2.54E-05 J	OFF-13-PW	Lognormal	95% UCL-T	1.42E-05
PCB 118	20 / 20	4.74E-05	OFF-3-PW	Lognormal	95% UCL-T	3.21E-05
PCB 126	12 / 20	3 18E-05 J	OFF-4-PW	Lognormal	95% UCL-T	1.44E-05
PCB 128	14 / 20	5.52E-05	OFF-4-PW	Lognormal	95% UCL-T	1.97E-05
PCB 138/163/164	20 / 20	2.45E-04	OFF-4-PW	Undefined	95% UCL-T	9.47E-05
PCB 153	20 / 20	4.73E-05	OFF-11-PW	Lognormal	95% UCL-T	3.12E-05
PCB 170	8 / 20	1.43E-05	OFF-4-PW	Undefined	95% UCL-T	6.71E-06
PCB 18	10 / 20	2 25E-03	OFF-11-PW	Lognormal	95% UCL-T	7.48E-04
PCB 180	20 / 20	1.69E-05	OFF-11-PW	Undefined	95% UCL-T	9.85E-06
PCB 187/182/159	17 / 20	2.78E-05	OFF-4-PW	Lognormal	95% UCL-T	1.07E-05
PCB 188	13 / 20	2.85E-05	OFF-6-PW	Lognormal	95% UCL-T	1.01E-05
PCB 195	4 / 20	4.93E-06	OFF-4-PW	Lognormal	95% UCL-T	1.60E-06
PCB 200	18 / 20	1.43E-05	OFF-4-PW	Lognormal	95% UCL-T	5.01E-06
PCB 206	7 / 20	1.11E-06	OFF-13-PW	Lognormal	95% UCL-T	6.54E-07
PCB 209	11 / 20	2.07E-06 J	OFF-6-PW	Lognormal	95% UCL-T	6.18E-07
PCB 28/50	13 / 20	1.79E-03	OFF-11-PW	Undefined	95% UCL-T	2 97E-04
PCB 44	17 / 20	6.68E-04 J	OFF-11-PW	Undefined	95% UCL-T	2.19E-04
PCB 52	8 / 20	5.61E-04 J	OFF-11-PW	Lognormal	95% UCL-T	1.86E-04
PCB 66/95	18 / 20	4.75E-04	OFF-11-PW	Lognormal	95% UCL-T	1.53E-04
PCB 8	9 / 20	4.90E-03 J	OFF-1-PW	Undefined	95% UCL-T	1.19E-03
PCB 87	13 / 20	5.83E-05 J	OFF-3-PW, OFF-6-PW	Undefined	95% UCL-T	3.99E-05
Sum of PCB Congeners	20 / 20	7.02E-03	OFF-11-PW	Lognormal	95% UCL-T	3.05E-03
Sum of PCB Congeners X 2	20 / 20	1.40E-02	OFF-11-PW	Lognormal	95% UCL-T	6.10E-03
Trans-Nonachlor	11 / 20	1.37E-05 J	OFF-3-PW	Lognormal	95% UCL-T	6.16E-06

Footnotes:

1 - Samples were considered non-toxic for the sea urchin toxicity test (see Table 4)
2 - Samples were considered toxic for the sea urchin toxicity test (see Table 4)
3 - Samples were considered non-toxic for the amphipod toxicity test (see Table 4)
4 - The summary statistics for the toxic sediment samples are not presented because only one sediment sample (OFF-5) was toxic
5 - The selected statistic is based on the data distribution.
- The Maximum (Max) value was selected when the 95% Upper Confidence Level (UCL) exceeded the maximum detection
- The Log-normal 95% UCL (95% UCL-T) was selected when the data was lognormally distributed
- The Normal 95% UCL (95% UCL-N) was selected when the data was normally distributed
6 - There were not enough samples to accurately calculate a 95% UCL

TABLE B-3.6
TOXICITY EFFECT LEVEL CALCULATION
ECOLOGICAL PRG DEVELOPMENT STEP 5
OLD FIRE FIGHTING TRAINING CENTER, NSN
NEWPORT, RHODE ISLAND

PARAMETER	WQSV[1]	Sea Urchin Samples		Sea Urchin NOEC[4]	Amphipod Samples		Amphipod NOEC[4]	Aquatic NOEC[5]
		Non-Toxic Concentration[2]	Toxic Concentration[3]		Non-Toxic Concentration[2]	Toxic Concentration[3]		
M tals (ug/L)								
Aluminum	87	57	69		59	64		
Arsenic	36	3.2	5.5		3.3	1.0		
Cadmium	9.4	0.8	0.8		0.7	0.5		
Chromium	50	22	29		22	22		
Copper	3.7	25	84	25	25	84	25	24.9
Iron	1000	368	610		354	170		
Lead	8.5	17	21	17	17	18	17	16.8
Nickel	8.3	2.0	2.5		1.8	1.1		
Silver	0.28	1.7	1.9	1.7	1.9	1.3		1.7
Zinc	86	266	260		218	260	218	218
SEM and AVS (umol/g)								
SEM-AVS	5	0.49	0.21		0.5	-22.2		
PAHs (ug/L)								
2-Methylnaphthalene	0.88	1.0	4.1	1.0	0.64	4.1	0.88	0.88
Acenaphthene	710	5.8	14		2.3	14		
Acenaphthylene	0.46	4.9	5.3	4.9	2.7	5.3	2.7	2.7
Anthracene	0.29	5.5	9.5	5.5	3.0	9.5	3.0	3.0
Benzo(a)anthracene	0.065	1.6	2.3	1.6	0.65	2.3	0.65	0.65
Benzo(a)pyrene	0.042	0.38	0.48	0.4	0.15	0.48	0.15	0.15
Benzo(b,j,k)fluoranthene	0.14	1.5	2.0	1.5	0.49	2.0	0.49	0.49
Benzo(g,h,i)Perylene	0.02	0.15	0.16	0.15	0.047	0.16	0.05	0.05
Biphenyl	14	0.32	1.9		0.17	1.93		
Chrysene/triphenylene	0.10	1.3	1.8	1.3	0.45	1.8	0.45	0.45
Dibenzo(a,h)Anthracene	0.0017	0.083	0.09	0.08	0.032	0.09	0.032	0.032
Fluoranthene	16	15	18	16	6.8	18	16	16
Fluorene	0.14	4.8	10	4.8	2.2	10	2.2	2.2
Indeno(1,2,3-cd)pyrene	0.020	0.21	0.21	0.21	0.064	0.21	0.06	0.06
Naphthalene	294	8.2	13		4.6	13		
Phenanthrene	4.6	40	49	40	24	49	24	24
Pyrene	0.63	11	16	11	5.2	16	5.2	5.2
Sum PAHs (6 High Molecular Weight)	0.17	30	39	30	13	39	13	13

TABLE B-3.6
TOXICITY EFFECT LEVEL CALCULATION
ECOLOGICAL PRG DEVELOPMENT STEP 5
OLD FIRE FIGHTING TRAINING CENTER, NSN
NEWPORT, RHODE ISLAND

PARAMETER	WQSV[1]	Sea Urchin Samples		Sea Urchin NOEC[4]	Amphipod Samples		Amphipod NOEC[4]	Aquatic NOEC[5]
		Non-Toxic Concentration[2]	Toxic Concentration[3]		Non-Toxic Concentration[2]	Toxic Concentration[3]		
Sum PAHs (7 Low Molecular Weight)	4.8	70	104	70	32	104	32	32
Sum PAHs (NOAA Status &Trends)	3.7	99	143	99	45	143	45	45
Pesticides (ug/L)								
2,4'-DDE	1.00E-03	0.00E+00	8.15E-06		7.25E-06	9.05E-06		
2,4'-DDT	1.00E-03	2.28E-05	3.85E-05		1.78E-05	3.85E-05		
4,4'-DDD	1.00E-03	3.10E-04	4.96E-04		3.22E-04	2.02E-04		
4,4'-DDE	1.00E-03	2.90E-05	6.11E-05		3.47E-05	3.39E-05		
4,4'-DDT	1.00E-03	1.29E-04	2.56E-04		9.58E-05	2.56E-04		
Aldrin	1.63E-01	3.14E-06	2.81E-06		3.14E-06	1.43E-05		
Alpha-Chlordane	4.00E-03	2.98E-05	5.71E-05		2.27E-05	5.71E-05		
Gamma-BHC	2.00E-02	5.54E-03	7.49E-03		4.98E-03	5.39E-03		
Heptachlor	3.60E-03	6.44E-06	3.40E-06		6.44E-06	1.02E-05		
Heptachlor Epoxide	3.60E-03	3.08E-05	3.91E-05		2.00E-05	1.02E-05		
Hexachlorobenzene	3.57E-03	0.00E+00	5.03E-05		2.96E-05	4.05E-05		
Mirex	1.00E-03	4.40E-06	1.01E-05		3.97E-06	1.01E-05		
PCBs (ug/L)								
Sum of PCB Congeners X 2	3.00E-02	7.40E-03	1.18E-02		6.10E-03	6.98E-03		

Notes:
WQSV - Water Quality Screening Value
NOEC - No Observed Effects Concentration
This table only includes constituents that have WQSVs

Footnotes:
1 - The sources of the Water Quality Screening Values (WQSVs) are presented in Table 1
2 - The cells in this column are shaded if the chemical concentrations exceed the WQSV
3 - The cells in this column are shaded if the chemical concentrations in the toxic samples exceed the chemical concentrations in the non-toxic samples **and** the WQSV
4 - This column only lists chemicals if the concentration in the non-toxic sample exceeds the WQSV **and** the ch mical concentration in the toxic samples exc eds the chemical concentration in the non-toxic samples
5 - The concentration in this column is the lower of the two NOEC values and is named the Aquatic NOEC

TABLE B-3.7
SEM-AVS RESULTS
ECOLOGICAL PRG DEVELOPMENT STEP 5
OLD FIRE FIGHTING TRAINING AREA, NSN, NEWPORT RHODE ISLAND

Sample Location	Bulk Chemistry Sediment Results (from Table B-3.2)						SEM-AVS	TOC	TOC Normalized SEM-AVS[2]
	Cadmium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Nickel (mg/kg)	Silver (mg/kg)	Zinc (mg/kg)			
OFF-1	0.31	58	131	34	0.46 J	156	1.23[1]	1.8	68
OFF-2	0.14	24	90	26	0.065 UJ	315	0.79[1]	1.1	72
OFF-3	0.18	12	60	22	0.065 UJ	50 U	0.49	0.9	54
OFF-4	0.06	31	96	20	0.065 UJ	106	1.51[1]	0.9	168
OFF-5	0.23	17	139	19	0.065 UJ	40 U	-22	1	-2222
OFF-6	0.15	11	47	19	0.065 UJ	53 U	-25	1.8	-1387
OFF-7	0.29	33	294	28	0.18 J	156	-37	1.9	-1969
OFF-8	0.19	11	38	16	0.17 J	47 U	-4.7	1.3	-360
OFF-9	0.11	6.9	25	18	0.065 UJ	40 U	-3.6	1.2	-304
OFF-10	0.15	10	27	13	0.065 UJ	27 U	-6.4	1.1	-581
OFF-11	0.22	9.1	39	5.5 U	0.17 J	28 U	-12	1.1	-1104
OFF-12	0.53	37	114	21	0.48 J	147	-23	2.5	-923
OFF-13	0.80	81	202	30	1.06 J	263	-47	4	-1168
OFF-14	0.12	19	45	16	0.23 J	48 U	-8.4	2	-420
OFF-15	0.18	12	33	14	0.19 J	37 U	-5.6	1.2	-466
OFF-16	0.36	24	61	18	0.44 J	51 U	-22	2.6	-849
OFF-17	0.38	26	71	19	0.4 J	126	-13	2.6	-490
OFF-18	0.69	84	190	28	1.08 J	248	-36	4	-904
OFF-19	0.21	30	56	24	0.18 J	166	-16	2.9	-546
OFF-20	0.25	19	41	21	0.19 J	109	-28	2.3	-1213
OFF-21	0.39	23	46	27	0.16 J	144	-12	2.3	-504
OFF-22	0.19	18	22	21	0.065 UJ	39 U	-1.4	1.3	-110
OFF-23	0.43	45	74	43	0.27 J	306	-31	2.7	-1142

Notes:
SEM - Simultaneous Extracted Metals
AVS - Acid Volatile Sulfide
TOC - Total Organic Carbon
1 - AVS was not detected in these samples
2 - This value is calculated using the following equation: TOC Normalized SEM-AVS = (SEM-AVS)/(TOC/100)

TABLE B-3.8
TOXICITY EFFECTS LEVEL CALCULATION
ECOLOGICAL PRG DEVELOPMENT, STEP 6
OLD FIRE FIGHTING TRAINING CENTER, NSN
NEWPORT, RHODE ISLAND

PARAMETER	Aquatic NOEC[1]	Reference Stations		Toxicity Effects Level[2]
		OFF-22	OFF-23	
2-Methylnaphthalene	0.88	0.030	0.20	0.88
Acenaphthylene	2.7	0.035	0.30	2.7
Anthracene	3.0	0.025	0.43	3.0
Benzo(a)anthracene	0.65	0.0068	0.057	0.65
Benzo(a)pyrene	0.15	0.0029	0.028	0.15
Benzo(b,j,k)fluoranthene	0.49	0.0049	0.046	0.49
Benzo(g,h,i)Perylene	0.047	0.0012	0.0067	0.047
Chrysene/triphenylene	0.45	0.005	0.05	0.45
Dibenzo(a,h)Anthracene	0.032	0.00025	0.0018	0.032
Fluoranthene	16	0.047	0.54	16
Fluorene	2.2	0.013	0.29	2.2
Indeno(1,2,3-cd)pyrene	0.06	0.00076	0.0055	0.06
Phenanthrene	24	0.061	0.96	24
Pyrene	5.2	0.050	0.50	5.2
Sum PAHs (6 High Molecular Weight)	13	0.11	1.2	13
Sum PAHs (7 Low Molecular Weight)	32	0.31	3.4	32
Sum PAHs (NOAA Status &Trends)	45	0.42	4.6	45

Notes:
NOEC - No Observed Effects Concentration
This table only includes constituents that were retained as Aquatic NOECs
Footnotes:
1 - The Aquatic NOEC was obtained from Table 6
2 - The TEV is the higher of the reference concentration or the Aquatic NOEC

TABLE B-3.9
LIMITING COCS CALCULATION
ECOLOGICAL PRG DEVELOPMENT STEP 7
OLD FIRE FIGHTING TRAINING AREA
NAVAL STATION NEWPORT, NEWPORT RHODE ISLAND

Sample Location / Sample Depth Interval	TEV[1]	OFF-1 0-15 cm	OFF-2 0-15 cm	OFF-3 0-15 cm	OFF-4 0-15 cm	OFF-5 0-15 cm	OFF-6 0-15 cm	OFF-7 0-15 cm	OFF-8 0-15 cm	OFF-9 0-15 cm	OFF-10 0-15 cm	OFF-11 0-15 cm
Polyaromatic Hydrocarbons												
2-Methylnaphthalene	0 88	2 06E-01 J	1 01E+00 J	1 42E+00 J	6 05E-01 J	4.71E+00 J	1.35E+00 J	4 13E-01	1 58E-01	3 69E-02 J	4 03E-02 J	2 27E-01 J
Acenaphthylene	2 71	1 99E-01	1.71E+00	1 50E+00	1.81E+00	1 96E+00	4 17E-01	3 42E-01	5 47E-02	1 83E-02	1 43E-02 J	3 15E-02
Anthracene	3 04	1 57E-01 J	1 11E+00 J	1 80E+00 J	9 52E-01 J	3 11E+00 J	7 19E-01 J	2 29E-01	5 97E-02	1 04E-02	9 86E-03 J	6 44E-02 J
Benzo(a)anthracene	0 65	2 11E-02	1 25E+00	2 41E+00	9 64E-01	3 54E+00	8 99E-01	2 32E-01	6 27E-02	1 82E-02	1 22E-02	5 81E-02
Benzo(a)pyrene	0 15	2 18E-01	1 44E+00	2.52E+00 J	1 53E+00	3 18E+00	7 28E-01	4.61E-01	1 10E-01	4 18E-02	2 70E-02	8 86E-02
Benzo(b,j,k)fluoranthene	0 49	2 55E-01	1 16E+00	3 18E+00 J	6 43E-01	4 13E+00	8 63E-01	2 48E-01	5 23E-02	2 09E-02	1 42E-02	4 27E-02
Benzo(g,h,i)Perylene	0 05	2.67E-01 J	1 26E+00 J	3.27E+00 J	7 86E-01 J	3 28E+00 J	8 01E-01 J	2 94E-01	5 95E-02	2 40E-02	2 02E-02 J	4 75E-02 J
Chrysene/triphenylene	0 45	2 45E-01	1 19E+00	2 83E+00	1.15E+00	4 07E+00	1 04E+00	1 52E-01 J	8 41E-02	2 77E-02	1 61E-02	5 93E-02
Dibenzo(a,h)Anthracene	0 03	2 05E-01 J	9 79E-01 J	2 61E+00 J	3 27E-01 J	2 85E+00 J	6 45E-01 J	1 29E-01	2 67E-02	4 73E-03 U	6 53E-03 J	1 81E-02 J
Fluoranthene	16.00	6 27E-02	4 39E-01	9 39E-01	3 59E-01	1 11E+00	3 60E-01	6 67E-02	2 03E-02	5 64E-03	4 54E-03	2 04E-02
Fluorene	2 20	7 39E-02 J	9 09E-01 J	2 19E+00 J	6 49E-01 J	4 49E+00 J	7 19E-01 J	2 78E-01	8 81E-02	1 46E-02 J	8 40E-03 J	7 53E-02 J
Indeno(1,2,3-cd)pyrene	0 06	2 54E-01	1 26E+00	3.29E+00 J	6 03E-01	3 34E+00	7 61E-01	2 30E-01	4 73E-02	1 81E-02	1 45E-02	3 55E-02
Phenanthrene	23 69	8 37E-02	7 25E-01	1 69E+00	4 78E-01	2 07E+00	7 47E-01	9.87E-02	2 85E-02	5 48E-03	4 04E-03	3 07E-02
Pyrene	5 18	1 81E-01	1 12E+00	2 18E+00	9.78E-01	3 09E+00	9 93E-01	2 04E-01	5 65E-02	1 56E-02	1 46E-02	5 61E-02
Sum PAHs (6 High Molecular Weight)	13 00	1 62E-01	1 11E+00	2 28E+00	9.38E-01	2 96E+00	9 30E-01	1 86E-01	5 48E-02	1 55E-02	1 29E-02	5 35E-02
Sum PAHs (7 Low Molecular Weight)	32 31	1 36E-01	1 14E+00	2 15E+00	9.12E-01	3 23E+00	9 57E-01	2 37E-01	7 98E-02	1 55E-02	1 33E-02	6 72E-02
Sum PAHs (NOAA Status &Trends)	44 94	1 45E-01	1 14E+00	2 21E+00	9 27E-01	3 18E+00	9 57E-01	2 24E-01	7.32E-02	1 56E-02	1 33E-02	6 38E-02
SUM TEV_{HQ}[2]		2 43E+00	1 55E+01	3 18E+01	1 18E+01	4 49E+01	1.10E+01	3 38E+00	9 09E-01	2 62E-01	2 07E-01	8 55E-01
MAX TEV_{HQ}		2 67E-01	1 71E+00	3 29E+00	1.81E+00	4 71E+00	1.35E+00	4 61E-01	1.58E-01	4 18E-02	4 03E-02	2 27E-01
Limiting COC[3]		Benzo(g,h,i)Perylene	Acenaphthylene	Indeno(1,2,3-cd)pyrene	Acenaphthylene	2-Methylnaphthalene	2-Methylnaphthalene	Benzo(a)pyrene	NA	NA	NA	NA

TABLE B-3.9
LIMITING COCS CALCULATION
ECOLOGICAL PRG DEVELOPMENT STEP 7
OLD FIRE FIGHTING TRAINING AREA
NAVAL STATION NEWPORT, NEWPORT RHODE ISLAND

Sample Location Sample Depth Interval	OFF-12 0-15 cm	OFF-13 0-15 cm	OFF-14 0-15 cm	OFF-15 0-15 cm	OFF-16 0-15 cm	OFF-17 0-15 cm	OFF-18 0-15 cm	OFF-19 0-15 cm	OFF-20 0-15 cm	OFF-21 0-15 cm
Polyaromatic Hydrocarbons										
2-Methylnaphthalene	6.69E-01 J	2.34E-01 J	1 11E-01	1 13E-01	1 31E-01 J	1 08E-01 J	2.28E-01 J	1 55E-01	2 51E-01 J	8 14E-02 J
Acenaphthylene	8 97E-02	1 50E-01 J	4 85E-02	3 81E-02	5 29E-02 J	6 08E-02	1 36E-01	5 38E-02	2 47E-02	3 06E-02
Anthracene	2 53E-01 J	1.33E-01 J	2 87E-02	3 23E-02	3 75E-02 J	5 11E-02 J	9 41E-02 J	3 97E-02	1 04E-01 J	2 31E-02 J
Benzo(a)anthracene	1 83E-01	1 10E-01 J	4 11E-02	3 36E-02	2 85E-02 J	3 67E-02	6 95E-02	4 15E-02	5 30E-02	2 50E-02
Benzo(a)pyrene	3 74E-01	1 89E-01 J	8 40E-02	5 65E-02	5 57E-02 J	8 43E-02	1 59E-01	7 31E-02	7 36E-02	5 04E-02
Benzo(b,j,k)fluoranthene	1 81E-01	1 00E-01 J	3 78E-02	5 04E-02	2 77E-02 J	4 16E-02	9 47E-02	3 52E-02	4 23E-02	2 70E-02
Benzo(g,h,i)Perylene	1 79E-01 J	1 02E-01 J	5.35E-02	4 57E-02	3 82E-02 J	5 69E-02 J	1 23E-01 J	3 80E-02	3 12E-02 J	3 17E-02 J
Chrysene/triphenylene	2 23E-01	1 08E-01 J	5 30E-02	4 06E-02	3 24E-02 J	4 35E-02 J	8 80E-02	5 33E-02	7 18E-02	3 66E-02
Dibenzo(a,h)Anthracene	9 35E-02 J	4 45E-02 J	2 18E-02	3.06E-02	1 59E-02 J	2 44E-02 J	5 70E-02 J	1 65E-02	1 83E-02 J	1 47E-02 J
Fluoranthene	7 23E-02	3 76E-02 J	8 92E-03	8 93E-03	9 89E-03 J	1 18E-02 J	2 72E-02	1 08E-02	2 22E-02	7 32E-03
Fluorene	3 58E-01 J	1 01E-01 J	2 84E-02	2 09E-02	4 33E-02 J	3 92E-02 J	6 17E-02 J	5 84E-02	1 33E-01 J	1 62E-02 J
Indeno(1,2,3-cd)pyrene	1 40E-01	7 30E-02 J	3 89E-02	4 37E-02	2 71E-02 J	4 12E-02	8 87E-02	3 04E-02	2 95E-02	2 48E-02
Phenanthrene	1 43E-01	5 11E-02 J	9 23E-03	1 03E-02	1 81E-02 J	1 48E-02	3 26E-02	1 44E-02	5 11E-02	7 78E-03
Pyrene	2.21E-01	1.16E-01 J	3 15E-02	2 85E-02	3 61E-02 J	3 83E-02 J	8 28E-02	3 30E-02	5 98E-02	2 66E-02
Sum PAHs (6 High Molecular Weight)	1 98E-01	1.04E-01	2 84E-02	2 62E-02	2 98E-02	3 41E-02	7 50E-02	3 13E-02	5 71E-02	2 27E-02
Sum PAHs (7 Low Molecular Weight)	3 13E-01	1 11E-01	3 68E-02	3 47E-02	4 58E-02	4 54E-02	8 72E-02	6 18E-02	1 06E-01	2 14E-02
Sum PAHs (NOAA Status &Trends)	2 82E-01	1 10E-01	3.47E-02	3 25E-02	4 15E-02	4 25E-02	8 44E-02	5 35E-02	9 30E-02	2.19E-02
SUM TEV_{HQ} (2)	3 18E+00	1 55E+00	5 96E-01	5 53E-01	5 55E-01	6 53E-01	1 34E+00	6 53E-01	9 66E-01	4 03E-01
MAX TEV_{HQ}	6 69E-01	2 34E-01	1 11E-01	1 13E-01	1 31E-01	1 08E-01	2 28E-01	1 55E-01	2 51E-01	8 14E-02
Limiting COC (3)	2-Methylnaphthalene	2-Methylnaphthalene	NA	NA	NA	NA	2-Methylnaphthalene	NA	NA	NA

Notes:

1 - Source of TEV is presented in Table B-3 8

2 - The SUM TEV_{HQs} does not include the Sum PAHs because they are already counted as individual PAHs

3 - Limiting COCs are the cells with the maximim TEV_{HQs} at each station (shaded cells)

The values in this table are calculated using the following equation TEV_{HQ} = [PW]/TEV

Where TEV_{HQ} = Toxicity Effects Value Hazard Quotient

[PW] = Pore Water Concentration (ug/L) (from Table B-3 3)

TEV = Toxicity Effects Level (ug/L) (From Table B-3 8)

TABLE 10
PRG CALCULATION
ECOLOGICAL PRG DEVELOPMENT STEP 8
OLD FIRE FIGHTING TRAINING AREA, NSN
NEWPORT RHODE ISLAND

Sample Location	OFF-1	OFF-2	OFF-3	OFF-4	OFF-5	OFF-6	OFF-7	OFF-8	OFF-9	OFF-10	OFF-11	OFF-12
Sample Depth Interval	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm
Date Sampled	3/27/98	3/27/98	3/27/98	3/27/98	3/27/98	3/27/98	3/27/98	4/7/98	4/7/98	4/3/98	4/3/98	4/3/98
	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
Polyaromatic Hydrocarbons (ug/kg)												
2-Methylnaphthalene	1 26E+02	7 70E+01	6.30E+01	6 30E+01	7.00E+01	1.26E+02	1.33E+02	9.10E+01	8.40E+01	7 70E+01	7 70E+01	1 75E+02
Acenaphthylene	4 68E+02	2.86E+02	2.34E+02	2.34E+02	2.60E+02	4 68E+02	4.94E+02	3.38E+02	3 12E+02	2 86E+02	2 86E+02	6.50E+02
Indeno(1,2,3-cd)pyrene	3 98E+03	2.43E+03	1.99E+03	1 99E+03	2 21E+03	3 98E+03	4 20E+03	2.88E+03	2.65E+03	2 43E+03	2 43E+03	5.53E+03
Benzo(g,h,i)Perylene	3 28E+03	2 01E+03	1.64E+03	1 64E+03	1 82E+03	3.28E+03	3 47E+03	2 37E+03	2 19E+03	2 01E+03	2.01E+03	4 56E+03
Benzo(a)pyrene	2 73E+03	1.67E+03	1.37E+03	1 37E+03	1 52E+03	2 73E+03	2.89E+03	1.97E+03	1.82E+03	1.67E+03	1 67E+03	3 80E+03

TABLE 10
PRG CALCULATION
ECOLOGICAL PRG DEVELOPMENT STEP 8
OLD FIRE FIGHTING TRAINING AREA, NSN
NEWPORT RHODE ISLAND

Sample Location Sample Depth Interval Date Sampled	OFF-13 0-15 cm 4/3/98 SEDIMENT	OFF-14 0-15 cm 4/7/98 SEDIMENT	OFF-15 0-15 cm 4/7/98 SEDIMENT	OFF-16 0-15 cm 4/3/98 SEDIMENT	OFF-17 0-15 cm 4/3/98 SEDIMENT	OFF-18 0-15 cm 4/3/98 SEDIMENT	OFF-19 0-15 cm 4/7/98 SEDIMENT	OFF-20 0-15 cm 4/3/98 SEDIMENT	OFF-21 0-15 cm 4/3/98 SEDIMENT	Average PRG(1)
Polyaromatic Hydrocarbons (ug/kg)										
2-Methylnaphthalene	2 80E+02	1 40E+02	8 40E+01	1 82E+02	1 82E+02	2 80E+02	2 03E+02	1 61E+02	1.61E+02	135
Acenaphthylene	1 04E+03	5 20E+02	3 12E+02	6 76E+02	6 76E+02	1.04E+03	7.54E+02	5.98E+02	5 98E+02	502
Indeno(1,2,3-cd)pyrene	8.85E+03	4.42E+03	2.65E+03	5 75E+03	5.75E+03	8 85E+03	6.42E+03	5.09E+03	5 09E+03	4266
Benzo(g,h,i)Perylene	7.30E+03	3.65E+03	2 19E+03	4.74E+03	4.74E+03	7.30E+03	5 29E+03	4 19E+03	4 19E+03	3518
Benzo(a)pyrene	6.07E+03	3.04E+03	1.82E+03	3 95E+03	3.95E+03	6 07E+03	4 40E+03	3.49E+03	3.49E+03	2929

Notes:

The values in this table are calculated using the following equation: PRG = [SD]/TEV_{HQ}

Where: PRG = Preliminary Remediation Goal

[SD] = Sediment Concentration (ug/kg or mg/kg) (from Table 2)

TEV_{HQ} = Toxicity Effects Level Hazard Quotient (unitless) (from Table 9)

1 - Average PRG is the arithmetic average of all the PRGs across each station

TABLE B-3.11
SEDIMENT HAZARD QUOTIENTS
ECOLOGICAL PRG DEVELOPMENT STEP 8
OLD FIRE FIGHTING TRAINING AREA
NSN, NEWPORT RHODE ISLAND

Sample Location Sample Depth Interval Date Sampled	PRG(1)	OFF-1 0-15 cm 3/27/98	OFF-2 0-15 cm 3/27/98	OFF-3 0-15 cm 3/27/98	OFF-4 0-15 cm 3/27/98	OFF-5 0-15 cm 3/27/98	OFF-6 0-15 cm 3/27/98	OFF-7 0-15 cm 3/27/98	OFF-8 0-15 cm 4/7/98	OFF-9 0-15 cm 4/7/98	OFF-10 0-15 cm 4/3/98
Polyaromatic Hydrocarbons (ug/kg)											
2-Methylnaphthalene	135	0.19 J	0 57 J	0.66 J	0 28 J	2.4 J	1.3 J	0 41	0.11	0 02 J	0 02 J
Acenaphthylene	502	0.19	0.97	0 70	0.85	1.0	0.39	0 34	0 04	0.01	0 01 J
Benzo(a)pyrene	2929	0.20	0 82	1.2	0 71	1.6	0.68	0 45	0 07	0 03	0 02 J
Benzo(g,h,i)Perylene	3518	0.30 J	0 86 J	1.8 J	0.44 J	2.0 J	0.90 J	0 35	0 05	0 02	0 01 J
Indeno(1,2,3-cd)pyrene	4266	0.24	0.72	1.5 J	0.28	1.7	0.71	0.23	0.03	0 01	0.01
Sum PRG_{HQ}(2)		1.1	4.0	5 9	2.6	8.9	3 9	1.8	0 30	0.090	0 069
Max PRG_{HQ}(2)		0 3	0.97	1.8	0.85	2.4	1 3	0 5	0 11	0.026	0 023
Max CoC(3)		NA	NA	Benzo(g,h,i)Perylene	NA	2-methylnaphthalene	2-methylnaphthalene	NA	NA	NA	NA

TABLE B-3.11
SEDIMENT HAZARD QUOTIENTS
ECOLOGICAL PRG DEVELOPMENT STEP 8
OLD FIRE FIGHTING TRAINING AREA
NSN, NEWPORT RHODE ISLAND

Sample Location	OFF-11	OFF-12	OFF-13	OFF-14	OFF-15	OFF-16	OFF-17	OFF-18	OFF-19	OFF-20	OFF-21	OFF-22	OFF-23
Sample Depth Interval	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm
Date Sampled	4/3/98	4/3/98	4/3/98	4/7/98	4/7/98	4/3/98	4/3/98	4/3/98	4/7/98	4/3/98	4/3/98	3/27/98	4/3/98
Polyaromatic Hydrocarbons													
2-Methylnaphthalene	0.13 J	0 87 J	0 49 J	0 11	0 07	0.18 J	0 15 J	0.47 J	0.23	0 30 J	0 10 J	0 02 J	0.32
Acenaphthylene	0 02	0 12	0 31 J	0.05	0.02	0 07 J	0.08	0 28	0.08	0 03	0 04	0 01 J	0.15
Benzo(a)pyrene	0.05	0 48	0 39 J	0 09	0 04	0 08 J	0 11	0.33	0 11	0 09	0 06	0 01 J	0.26
Benzo(g,h,i)Perylene	0.03 J	0 28 J	0 25 J	0.07	0 03	0 06 J	0 09 J	0.31 J	0.07	0.04 J	0.05 J	0 02 J	0 24
Indeno(1,2,3-cd)pyrene	0 02	0.18	0 15 J	0.04	0.03	0 04 J	0 06	0.18	0 05	0.04	0.03	0 01	0 12
Sum PRG_{HQ} (2)	0.25	1.93	1.60	0 36	0 19	0.42	0.49	1.57	0.54	0 50	0.27	0 07	1 09
Max PRG_{HQ} (2)	0 13	0 87	0.49	0.11	0.070	0 18	0 15	0 47	0.23	0 30	0 097	0 023	0 32
Max CoC (3)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

Shaded cells are parameters with PRG_{HQ} that are greater than 1.0

1 - Source of PRG is presented in Table 10

2 - The values in this table are calculated using the following equation: PRG_{HQ} = [SD]/PRG

Where. PRG_{HQ} = Preliminary Remediation Goal Hazard Quotient

[SD] = Sediment Concentration (ug/kg or mg/kg)

PRG = Preliminary Remediation Goal (ug/kg or mg/kg)

3 - The max COC is the parameter with the greatest PRG_{HQ} at that station that is greater than 1.0

NA - Not applicable because the Sum PRG_{HQ} is less than 1.0

PART 4 - SUMMARY

Table B-4.1 provides a summary of the calculated PRGs for the OFFTA site, based on the three receptor scenarios described in the previous sections of this document. Figure B-1 presents the action areas that are proposed based on the PRGs selected in this document.

Shoreline sediment PRGs for lifetime recreational exposure to shoreline sediment were calculated for arsenic, benzo(a)pyrene, benz(a)anthracene, benzo(b)flouranthene, and dibenz(a,h)anthracene. These PRGs are developed for site specific contaminants targeted to the 1E-6 risk level to ensure total cancer risks are less than RIDEM criteria of 1E-5. The risk-based PRG for arsenic defaults to the agreed on background arsenic level (6.2 mg/kg) to assure that the final PRG is not below background. Table B-1.2 shows that one or more of these PRGs are exceeded at most shoreline stations sampled.

Nearshore and offshore sediment PRGs based on lifetime recreational ingestion of shellfish were calculated for arsenic, cadmium, chromium, mercury, PCBs, and five PAH compounds. These PRGs are developed for site specific contaminants targeted to the 1E-6 risk level to ensure total cancer risks are less than RIDEM criteria of 1E-5. Arsenic was adjusted to 10% of its tissue concentration to account for the availability of this compound in shellfish tissue. Site sediments were not found to exceed these PRGs, and thus they do not drive action at any location.

Nearshore and offshore sediment PRGs based on ecological receptors were calculated forfive PAH compounds. Table B-3.11 indicates that the exceedances of these PRGs are focused on OFF-5, where the ecological risk assessment indicated that high potential for risk to ecological receptors was present (exposure and effects relationships identified). Lower exceedances were also noted at stations OFF-3 and OFF-6, which are near OFF-5.

TABLE B-4.1
SUMMARY OF PRELIMINARY REMEDIATION GOALS (PRGs) FOR MARINE SEDIMENT
OLD FIREFIGHTING TRAINING AREA, NSN NEWPORT, RHODE ISLAND

Contaminant	Ecological PRGs	Human Health Lifetime Recreational Exposure PRGs	Lifetime Recreational Lobster Ingestion PRGs
Polyaromatic Hydrocarbons (ug/kg)			
2-Methylnaphthalene	135		
Acenaphthylene	502		
Benz(a)anthracene		1338	34270
Benzo(a)pyrene	2929	134	9360
Benzo(b)fluoranthene		1338	51296
Dibenz(a,h)anthracene		134	6742
Benzo(g,h,I)perylene	3518		
Indeno(1,2,3-cd)pyrene	4266		72519
PCB/Pesticides			
Total PCB Congeners			175
Metals (mg/kg)			
Arsenic**		6.2**	82
Cadmium			10
Chromium			3708
Mercury			2.3
STATION EXCEEDANCES	**OFF-3,5,6**	**SSD-333 through 337 (3)**	**NONE**

Note: All Human health PRGs are based on an exposure specific risk of 1E-6.

Human health wading PRGs are calculated from and applicable to Stations SSD-333 through 337.
Lobster Ingestion PRGs only compared to Marine sediment stations (OFF-1 through OFF-21)
Ecological PRGs only compared to marine sediment stations (OFF-1 Through OFF-21)
** arsenic PRG for human health is based on HHRA and background assessment
(1) - Subsistence lobster ingestion PRGs not to be used.
(2) - Ecological PRGs for metals are eliminated based on low AVS-SEM values indicating no toxicity from metals - see text
(3) - No data is available for the intertidal area west of SSD-333: This area is covered with boulders and concrete slabs
(4) - ERL and ERM values are depicted for comparison only. ERLs and ERMs are not to be used as cleanup values.

OFF-3	DEPTH = 0-0.5 FT	
BENZO(A)PYRENE	3450 J	UG/KG
BENZO(GHI)PERYLENE	5370 J	UG/KG
INDENO(1,2,3-CD)PYRENE	6560 J	UG/KG

OFF-333(HH-W)	DEPTH = 0-0.5 FT.	
BENZO(A)PYRENE (DUP)	770 J	UG/KG
BENZO(A)PYRENE (DUP)	910 J	UG/KG

OFF-5	DEPTH = 0-0.5 FT	
2-METHYLNAPHTHALENE	330 J	UG/KG
ACENAPHTHYLENE	509	UG/KG
BENZO(A)PYRENE	4830	UG/KG
BENZO(GHI)PERYLENE	5990 J	UG/KG
INDENO(1,2,3-CD)PYRENE	7390	UG/KG

INNER TIDAL AREA NO.	LOW-TIDE AREA
333	3,660 sf
334	8,990 sf
335	12,700 sf
336	10,610 sf
337	10,300 sf

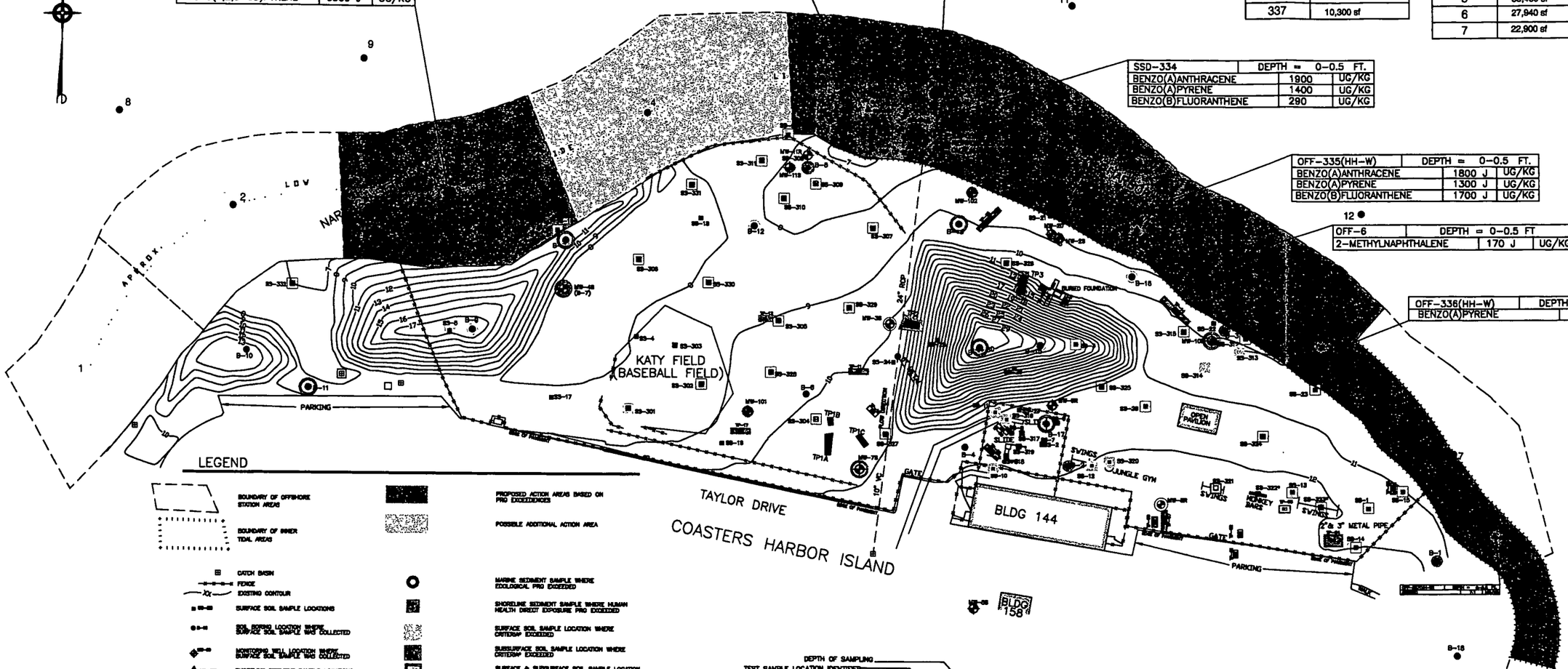
AREA NO.	AREA
1	19,430 sf
2	25,110 sf
3	24,980 sf
4	27,440 sf
5	33,460 sf
6	27,940 sf
7	22,900 sf

SSD-334	DEPTH = 0-0.5 FT.	
BENZO(A)ANTHRACENE	1900	UG/KG
BENZO(A)PYRENE	1400	UG/KG
BENZO(B)FLUORANTHENE	290	UG/KG

OFF-335(HH-W)	DEPTH = 0-0.5 FT.	
BENZO(A)ANTHRACENE	1800 J	UG/KG
BENZO(A)PYRENE	1300 J	UG/KG
BENZO(B)FLUORANTHENE	1700 J	UG/KG

OFF-6	DEPTH = 0-0.5 FT	
2-METHYLNAPHTHALENE	170 J	UG/KG

OFF-336(HH-W)	DEPTH = 0-0.5 FT.	
BENZO(A)PYRENE	520 J	UG/KG



LEGEND

- BOUNDARY OF OFFSHORE STATION AREAS
- BOUNDARY OF INNER TIDAL AREAS
- CATCH BASIN
- FENCE
- EXISTING CONTOUR
- SURFACE SOIL SAMPLE LOCATIONS
- SOIL BORING LOCATION WHERE SURFACE SOIL SAMPLE WAS COLLECTED
- MONITORING WELL LOCATION WHERE SURFACE SOIL SAMPLE WAS COLLECTED
- SHORELINE SEDIMENT SAMPLE LOCATIONS
- STORM SEWER
- TEST PIT LOCATION WHERE SUBSURFACE SOIL SAMPLE(S) WERE COLLECTED (BAREZ, 6/97)
- TEST PIT LOCATION WHERE SUBSURFACE SOIL SAMPLE(S) WERE COLLECTED (TRC, 1/94)
- PROPOSED ACTION AREAS BASED ON PRG EXCEEDENCES
- POSSIBLE ADDITIONAL ACTION AREA
- MARINE SEDIMENT SAMPLE WHERE ECOLOGICAL PRG EXCEEDED
- SHORELINE SEDIMENT SAMPLE WHERE HUMAN HEALTH DIRECT EXPOSURE PRG EXCEEDED
- SURFACE SOIL SAMPLE LOCATION WHERE CRITERIAP EXCEEDED
- SUBSURFACE SOIL SAMPLE LOCATION WHERE CRITERIAP EXCEEDED
- SURFACE & SUBSURFACE SOIL SAMPLE LOCATION WHERE CRITERIAP EXCEEDED

* RIDEM RESIDENTIAL DIRECT EXPOSURE CRITERIA (EXCEPT FOR ARSENIC (PROPOSED 8.2 MG/KG BACKGROUND LEVEL WAS USED)

SELECT CONTAMINANTS INCLUDE ARSENIC, LEAD, BENZO(A)PYRENE, AND TPH

DEPTH OF SAMPLING
TEST SAMPLE LOCATION IDENTIFIER

OFF-3	DEPTH = 0-0.5 FT	
INDENO(1,2,3-CD)PYRENE	6560 J	UG/KG

CONTAMINANT TESTED
SAMPLE RESULTS

TYPICAL CONTAMINANT LEVEL BOX

U INDICATES CONTAMINANT NOT DETECTED AT DETECTION LEVEL SPECIFIED
J INDICATES THAT QUANTITATION IS APPROXIMATE

TAGS WITH GRAY BACKGROUNDS HAVE OTHER CONTAMINANTS THAT EXCEED THE CRITERIA.
TAGS WITH WHITE BACKGROUNDS LIST ALL CONTAMINANTS THAT EXCEED THE CRITERIA.
SEE TABLES 1 AND 2 FOR A COMPLETE LIST OF CONTAMINANTS EXCEEDING CRITERIA.

GRAPHIC SCALE

0' 100' 200'

1 INCH = 100 FEET

NOTES AND REFERENCES:

1. DRAWING COMPILED FROM A DRAWING ENTITLED "BASE MAP OLD FIRE FIGHTING TRAINING AREA NETC, NEWPORT, RHODE ISLAND, JULY 1997, PROJ. NO. 7578 CTO: 288, BY BROWN & ROOT ENVIRONMENTAL, SOURCE: BASE PLAN BY GUERRIERE & HALNON, INC., DATED NOVEMBER 10, 1997, AND THE ADDITION OF FIELD MEASURED FEATURES, BY LOUIS FEDERICI AND ASSOCIATES 3/16/99, PRESENTED ON A DRAWING ENTITLED "KADY FIELD, TOPOGRAPHIC, SOIL SAMPLE LOCATION, AND SITE SURVEY AT THE OLD FIRE FIGHTING TRAINING AREA, NAVAL STATION NEWPORT IN NEWPORT, RHODE ISLAND FOR TETRA TECH NUS, INC., LOUIS FEDERICI & ASSOCIATES, 3/16/99, DWG NO. 990205-01.

2. HORIZONTAL DATUM BASE ON THE RI STATE PLANE COORDINATE SYSTEM NAD 1927. VERTICAL DATUM BASED ON NAVEL BASE MEAN LOW WATER.

3. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.

4. PLAN NOT TO BE USED FOR DESIGN.

SEDIMENT AREAS EXCEEDING PRGs

OLD FIRE FIGHTER TRAINING AREA SITE, COASTERS HARBOR ISLAND

NAVAL STATION NEWPORT, RHODE ISLAND

DRAWN BY:	R.G. DEWSNAP	REV.:	0
CHECKED BY:	J. FORRELLI	DATE:	APRIL 24, 2001
SCALE:	1" = 100'	FILE NO.:	\DWG\5278\0445\SED_EX_B.DWG

FIGURE B-1

TETRA TECH NUS, INC.
55 Jonspin Road Wilmington, MA 01887
(978)658-7899

APPENDIX C

AREA AND VOLUME ESTIMATES

APPENDIX C
AREA AND VOLUME ESTIMATES
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

This appendix provides the supporting documentation for the estimation of areas and volumes of soil and sediment to be addressed at the OFFTA site.

C.1 SOIL AND DEBRIS AREAS/VOLUMES

The estimation of volume for the soil alternatives was accomplished in two parts: the mounds at the site and the remaining soil below grade. To estimate the volume of the mounds, a contour map was used, and the area between each successive concentric contour line was measured. A base elevation for the surrounding terrain was chosen for each mound, and the volume within each contour was calculated based on its height above the base elevation. A spreadsheet showing the measurements and calculations is provided in Table C-1.

The second volume estimate was performed for the remaining soil below grade, assuming that the mounds were removed to the elevation of the surrounding terrain Based on the depth intervals of the contaminated samples, the site was divided into several areas, and estimates were made for the depth of each area as provided in Table C-2. These areas are presented on the color-coded map in Figure 2-3

An estimate was made of the percentage of the volume that is debris. The estimate for the mound was 50% debris, and the estimate for the remaining volume was 20% debris. Estimated debris and soil volumes are provided in Table C-3. Resulting debris and soil volumes are as follows:

Media	Mounds (cy)	Soil (cy)	TOTAL (cy)
Debris	5,450	7,720	13,170
Soil	5,450	30,880	36,330
TOTAL	10,900	38,600	49,500

C.2 SEDIMENT ACTION AREAS/VOLUMES AND EELGRASS AREAS

The contaminated sediment area was estimated using Figure 2-4, which shows the action areas delineated. Areas (in square feet (sf)) associated with area at Sampling Stations OFF-3, -4, -5, and -6 are shown in a table on the Figure 2-4. In addition to these areas, sediment along the shoreline in Station OFF-7 area is also included. A separate area measurement was made for this portion of sediment, which includes the area from the shoreline to the low-tide line along Station OFF-7 and extending on to the south of Station OFF-7. This area can also be described as nearshore area at Sampling Station SSD-337 and part of Sampling Station SSD-336.

The depth of the contaminated sediment is assumed to be 2 feet in all areas. This depth interval of contamination above PRGs was chosen based on core samples collected at Stations 5, 5E, and 6.

The total volume of sediment is calculated by multiplying the estimated areas by the 2-foot depth.

To estimate eelgrass bed areas, it was assumed that 25% of the area of Stations 3, 4, and 5 that are seaward of the low-tide line contain eelgrass beds. This area is shown with hatching on Figure 5-1. The associated depth of sediment in the eelgrass beds is also 2 feet.

In summary, the areas and volumes of the sediment and eelgrass are as follows. Supporting information is provided in Table C-4

Medium	Area (sq ft)	Volume (cu yd)
Sediment	130,520	9,668
Eelgrass	10,810	801

TABLE C-1
MOUND VOLUME ESTIMATES
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

	Contour Interval (ft)	Height above 11 ft	Map Area* (sq in)	Area (sf)	Volume (cf)	Volume (cy)
Central Mound	>30	19	0.33	528	10032	371.6
	29-30	18 5	0.35	560	10360	383.7
	28-29	17.5	0 36	576	10080	373.3
	27-28	16.5	0.37	592	9768	361.8
	26-27	15.5	0.45	720	11160	413.3
	25-26	14.5	0.49	784	11368	421.0
	24-25	13.5	0.58	928	12528	464.0
	23-24	12.5	0.59	944	11800	437.0
	22-23	11.5	0.67	1072	12328	456 6
	21-22	10.5	0.69	1104	11592	429.3
	20-21	9.5	0.72	1152	10944	405.3
	19-20	8.5	0.8	1280	10880	403.0
	18-19	7.5	0.88	1408	10560	391.1
	17-18	6.5	0.97	1552	10088	373.6
	16-17	5.5	1.04	1664	9152	339 0
	15-16	4.5	1.11	1776	7992	296.0
	14-15	3.5	1.27	2032	7112	263.4
	13-14	2 5	1.3	2080	5200	192.6
	12-13	1.5	1.48	2368	3552	131.6
						6907 3

	Contour Interval (ft)	Height above 8 ft	Map Area* (sq in)	Area (sf)	Volume (cf)	Volume (cy)
West Mound	>17	9	0 67	1072	9648	357.3
	16-17	8.5	0 95	1520	12920	478.5
	15-16	7.5	1.04	1664	12480	462.2
	14-15	6.5	1.21	1936	12584	466.1
	13-14	5.5	1.3	2080	11440	423.7
	12-13	4.5	1.54	2464	11088	410.7
	11-12	3.5	1.96	3136	10976	406.5
	10-11	2.5	1.69	2704	6760	250.4
	9-10	1.5	1 65	2640	3960	146.7
						3402.1

	Contour Interval (ft)	Height above 9 ft	Map Area* (sq in)	Area (sf)	Volume (cf)	Volume (cy)
Far West Mound	>13	4	0.81	1296	5184	192.0
	12-13	3.5	0.74	1184	4144	153 5
	11-12	2.5	0.95	1520	3800	140.7
	10-11	1.5	0.97	1552	2328	86 2
						572.4

GRAND TOTAL 10881.8 cy

* Plan scale. 1" = 40'

TABLE C-2
CONTAMINATED SOIL VOLUME ESTIMATE
EXCLUDING THE MOUNDS
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Depth of Excav. (ft)	Area* (sq in)	Area (sf)	Volume (cf)	Volume (cy)
2	4.85	7760	15520	574.8
8	16.24	25984	207872	7699.0
4	35 91	57456	229824	8512 0
8	0.29	464	3712	137.5
8	14.75	23600	188800	6992 6
6	5 34	8544	51264	1898.7
9	3.58	5728	51552	1909.3
2	56.19	89904	179808	6659.6
10	4.47	7152	71520	2648.9
6	1 59	2544	15264	565 3
		229136		37597.6

* Areas in square inches were measured on map with a scale of 1"=40'

TABLE C-3
DEBRIS AND SOIL PERCENTAGE
DRAFT FEASIBILITY STUDY
OLD FIREFIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

MOUNDS

Total Volume	10,900	cubic yards

Classification	Percent by Vol.	Associated Volume
Debris	50%	5,450
Soil	50%	5,450
TOTALS	**100%**	**10,900**

REMAINING AREA EXCLUDING MOUNDS

Total Volume	38,600	cubic yards

Classification	Percent by Vol.	Associated Volume
Debris	20%	7,720
Soil	80%	30,880
TOTALS	**100%**	**38,600**

TABLE C-4
CONTAMINATED SEDIMENT VOLUME ESTIMATE
DRAFT FEASIBILITY STUDY
OLD FIRE FIGHTING TRAINING AREA
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

AREA AND VOLUME OF SEDIMENT:

Sampling Station Area	Area (sf)	Depth (ft)	Volume (cf)	Volume (cy)
3	24,980	2	49,960	1,850
4	27,440	2	54,880	2,033
5	33,460	2	66,920	2,479
6	27,940	2	55,880	2,070
7*	16,700	2	33,400	1,237
TOTALS	**130,520**	**--**	**261,040**	**9,668**

* Area 7 includes only the area along the shoreline consisting of low-tide area SSD-337 and part of SSD- 336.

AREA OF EELGRASS

Assume that 25% of Areas 3, 4, and 5 that are past the low-tide line contain eelgrass

Sampling Station Area	Area (sf)	Area Past Low-Tide (sf)	Area of Eelgrass (sf)	Associated Volume (cy)
3	24,980	10,980	2,745	203
4	27,440	16,280	4,070	301
5	33,460	15,980	3,995	296
TOTALS	**85,880**	**43,240**	**10,810**	**801**

APPENDIX D

COST ESTIMATES

Tetra Tech NUS			*Calculation Sheet*
Client: Navy CLEAN	File No.	**By:** RD	**Page** 1 of 1
Subject: Assumptions and Cost Basis, Soil Alternative 1, OFFTA FS, CTO 218		**Checked by:** JD	**Date:** April 5, 2001

Soil Alternative 1: No Action

CAPITAL COST ASSUMPTIONS: N/A

O&M COST ASSUMPTIONS: N/A

5-YEAR COST ASSUMPTIONS:

1 5-year reviews at 200 LOE @ $100/hr. Approx. $1500 ODCs. Total = $ 21,500 per event Reviews to occur in years 5, 10, 15, 20, 25, and 30.

Present Worth Analysis
Soil Alternative 1 - No Action
OFFTA Feasibility Study
NAVSTA Newport
Newport, Rhode Island
04/05/01

PRESENT WORTH ANALYSIS

YEAR	PRESENT WORTH FACTOR (i = 7%)	CAPITAL COSTS	O & M COSTS	5-YEAR COSTS	PRESENT WORTH
0	1.000	$0			$0
1	0.935		$0		$0
2	0.873		$0		$0
3	0.816		$0		$0
4	0.763		$0		$0
5	0.713		$0	$21,500	$15,329
6	0.666		$0		$0
7	0.623		$0		$0
8	0.582		$0		$0
9	0.544		$0		$0
10	0.508		$0	$21,500	$10,930
11	0 475		$0		$0
12	0.444		$0		$0
13	0 415		$0		$0
14	0.388		$0		$0
15	0.362		$0	$21,500	$7,793
16	0.339		$0		$0
17	0.317		$0		$0
18	0.296		$0		$0
19	0.277		$0		$0
20	0 258		$0	$21,500	$5,556
21	0.242		$0		$0
22	0.226		$0		$0
23	0.211		$0		$0
24	0.197		$0		$0
25	0.184		$0	$21,500	$3,961
26	0.172		$0		$0
27	0.161		$0		$0
28	0.150		$0		$0
29	0.141		$0		$0
30	0.131		$0	$21,500	$2,824
		TOTAL PRESENT WORTH =			$46,393
					$46,000

Discount rate of 7% per OSWER Directive No 9355.3-20, June 25, 1993

Soil Alternative 2: Removal, Treatment using LTTS and Soil Washing, and Backfill

CAPITAL COST ASSUMPTIONS:

1. Pre-Design Investigation (PDI)

   PDI consisting of soil borings/cores to further delineate the site and to delineate lateral extent of contaminants exceeding the PRGs. Assume 20 soil borings at an average 15-foot depth with associate analytical costs for PAHs, and metals.

   - Mobilization/demobilization @ $13,500
   - Sample collection @ $600 each or $12,000
   - Analytical @ $350/sample for 25 samples including QA/QC samples or $8750
   - Data validation $3,200
   - Reporting @ $3,500
   - Oversight and management @ $4,500

   Total costs approx. = $45,450

2. Mobilization/Demobilization includes providing office trailers, temporary utilities and sanitary facilities, delivery and removal of major construction equipment, and providing all other facilities and materials needed by the management staff.

3. Metal debris and concrete debris will be removed from the site and the shoreline before excavating.

4. Soil and debris will be piled up separately Any visual contamination on the debris will be washed of before sending to storage pile. Wash water will be collected in 55-gallon drums and disposed of accordingly.

5. Excavation Work

   - Approximately 49,500 cy will be excavated as shown in the areal contamination map Depth of excavation will be up to the water table or bottom of contaminated depth interval, whichever reached first

   - It is assumed that staging areas are available at no cost in the vicinity of OFFTA.

   - Excavated soil and debris staged separately Debris (estimated at 13,170 cy) will be sent to RCRA Landfill (D) for proper disposal. Because of uncertainty of extent of subsurface contamination, and most of the treated soil will be used as backfill, it is conservatively assumed that all excavated soil will be processed through the treatment train. Site will be backfilled with treated soil supplemented by new fill material.

   - Treatment train consists of LTTS and soil washing operations. It is assumed that soil marked for treatment will be free of large debris and aggregates. Excavated volumes are assumed to be as shown in Table 1. Total debris for Landfill (RCRA-D) disposal is estimated as 13,170 cy. The remaining 36,330 cy will be treated and used as backfill.

   - Preparation, maintenance, and removal of the staging area was estimated at a lump sum of $11,000, which includes 2 laborers and a backhoe for 10 days and misc. materials

- The costs for disposal are as per recent project (Melville Landfill). TSDF disposal (to Model City, NY) is $120 per ton and RCRA-D disposal for debris is $70 per ton and soil that can be used as cover is $25/ton (Fall River Landfill). Imported fill is $7 per ton.

- Soil wash liquid disposal: POTW disposal is $1.54 /1000 gal (E-2000-33-19-7102). Transport for 5,000-gal tank for 20 miles - $1 65 /mile (E-2000-33-19-0207)

Table 1

Mounds

Total Volume	10,900	cy

Classification	Percent by Vol.	Associated Volume
Debris	50%	5,450
Soil	50%	5,450
Totals	100%	10,900

Remaining Area Excluding Mounds

Total Volume	38,600	cy

Classification	Percent by Vol	Associated Volume
Debris	20%	7,720
Soil	80%	30,880
Totals	100%	38,600

O&M COST ASSUMPTIONS:

1. Post-Remediation sampling will be conducted at 4 wells for three rounds each 6 months apart A total of six samples will be collected at each event and will be analyzed for DRO, GRO, SVOCs, and metals. Analysis costs will be $822.42 for each sample ($86.25+97.75+348 75+289.67 = $822.42. Source: Recent analysis cost, E-2000-33021619, 33021621) Sampling effort will be at 100 LOE @$100/hr. Total cost for event: $14,935.

5-YEAR COST ASSUMPTIONS:

1. 5-year review at 200 LOE @ $100/hr. Approx. $1500 ODCs. Total = $ 21,500 per event. Review to occur in year 5

CAPITAL COST ESTIMATE **DRAFT**
SOIL ALTERNATIVE 2 - REMOVAL, TREATMENT WITH LTTS AND SOIL WASHING AND BACKFILL
OFFTA FEASIBILITY STUDY
NAVSTA NEWPORT
NEWPORT, RHODE ISLAND
CTO 0218

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal Direct Cost
1- PRE-DESIGN INVESTIGATION											
1 1 Soil borings and analyses	1	ls	$45,450 00	$0 00	$0 00	$0 00	$45,450	$0	$0	$0	$45,450
2 - MOBILIZATION/DEMOBILIZATION											
2 1 Mobilize/demobilize equipment	1	ls				$7,500 00	$0	$0	$0	$7,500	$7,500
2 2 Office trailer	4	mo				$181 00	$0	$0	$0	$724	$724
2 3 Sanitary facilities	4	mo				$120 00	$0	$0	$0	$480	$480
2 4 Truck scale	4	mo				$2,862 00	$0	$0	$0	$11,448	$11,448
2 5 Site survey/construction layout	5 5	acres		$45 00	$445 00		$0	$248	$2,448	$0	$2,695
2 6 Electric/phone hookups	1	ls	$2,000 00				$2,000	$0	$0	$0	$2,000
2 7 Project closeout report	1	ls			$10,000 00		$0	$0	$10,000	$0	$10,000
3 - SITE PREPARATION											
3 1 Clear and grub site - minimal	5 5	acres			$980 00	$2,700 00	$0	$0	$5,390	$14,850	$20,240
3 2 Install/remove silt fence	3000	lf		$0 45	$0 42		$0	$1,350	$1,260	$0	$2,610
3 3 Construct diversion dikes/channels	2000	lf					$0	$0	$0	$0	$0
3 4 Construct temporary sediment basin/vegetate/backfill	800	cy			$4 85	$5 60	$0	$0	$3,880	$4,480	$8,360
3 5 Truck decon pad											
a) Concrete pad - 8"	40	cy		$70 00	$125 00	$5 00	$0	$2,800	$5,000	$200	$8,000
b) Gravel base - 6"	30	cy		$7 50	$3 33	$8 00	$0	$225	$100	$240	$565
c) Curb	120	lf		$3 07	$1 99	$0 05	$0	$368	$239	$6	$613
d) Collection sump	1	ls		$1,450 00	$500 00	$220 00	$0	$1,450	$500	$220	$2,170
e) Splash guard	780	sf		$1 25	$1 00		$0	$975	$780	$0	$1,755
3 6 Construction entrance	1	ls		$620 00	$86 00	$50 00	$0	$620	$86	$50	$756
3 7 Construct soil staging area	1	ls		$11,000			$0	$11,000	$0	$0	$11,000
3 8 Maintain soil staging area	1	ls		$5,500 00	$0 00	$0 00	$0	$5,500	$0	$0	$5,500
3 9 Remove decontamination pad	1	ls			$250 00	$500 00	$0	$0	$250	$500	$750
3 10 Decontamination pad, silt fence disposal	150	ton	$10 00				$1,500	$0	$0	$0	$1,500
3 11 Personnell and equipment decon facilities and services											
a) Personnel decon Trailer	4	mo	$1,500 00	$0 00	$200 00	$0 00	$3,104	$0	$414	$0	$3,518
b) PPE rolloff cont	4	mo	$500 00	$0 00	$0 00	$0 00	$1,035	$0	$0	$0	$1,035
4 - SITE MANAGEMENT STAFFING											
4 1 Site manager	320	hr	$0 00	$0 00	$36 00	$0 00	$0	$0	$14,901	$0	$14,901
4 2 Site engineer	640	hr	$0 00	$0 00	$32 00	$0 00	$0	$0	$13,245	$0	$13,245
4 3 Site supervisor/foreman	640	hr	$0 00	$0 00	$30 00	$0 00	$0	$0	$12,418	$0	$12,418
4 4 Site safety officer	640	hr	$0 00	$0 00	$25 00	$0 00	$0	$0	$10,348	$0	$10,348
5 - HOME OFFICE PROJECT MANAGEMENT AND SUPPORT											
5 1 Project manager	64	hr	$0 00	$0 00	$45 00	$0 00	$0	$0	$3,725	$0	$3,725
5 2 Project administrator	120	hr	$0 00	$0 00	$30 00	$0 00	$0	$0	$1,863	$0	$1,863
5 3 Health and safety director	40	hr	$0 00	$0 00	$35 00	$0 00	$0	$0	$724	$0	$724
5 4 Procurement/subcontracting	160	hr	$0.00	$0 00	$30 00	$0.00	$0	$0	$6,209	$0	$6,209
5 5 Clerical support	160	hr	$0 00	$0 00	$12 50	$0 00	$0	$0	$2,587	$0	$2,587

DRAFT

CAPITAL COST ESTIMATE
SOIL ALTERNATIVE 2 - REMOVAL, TREATMENT WITH LTTS AND SOIL WASHING AND BACKFILL
OFFTA FEASIBILITY STUDY
NAVSTA NEWPORT
NEWPORT, RHODE ISLAND
CTO 0218

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal Direct Cost
6 - EXCAVATION											
6.1 Excavate/load material	49500	cy			$0 48	$1 16	$0	$0	$23,937	$57,637	$81,574
6 2 Segregate material with FID	80	day			$100 00	$100 00	$0	$0	$8,000	$8,000	$16,000
6 3 Haul material to for stockpiling	49500	cy			$0 37	$2 15	$0	$0	$18,315	$106,425	$124,740
6 4 Dump/stockpile material	49500	cy			$0 44	$1 04	$0	$0	$21,533	$51,356	$72,889
6 5 Stockpiled material sampling/analysis - 1/150 cy	218	ea	$85 00		$100 00		$18,530	$0	$21,800	$0	$40,330
6 6 Stockpiled material sampling/analysis - 1/500 cy	27	ea	$1,050 00		$200 00		$28,350	$0	$5,400	$0	$33,750
6 7 Excavation confirmatory sampling/analysis	50	ea	$60 00		$100 00		$3,000	$0	$5,000	$0	$8,000
6 8 Excavation confirmatory sampling/analysis	25	ea	$500 00		$100 00		$12,500	$0	$2,500	$0	$15,000
6 9 Trench Box	4	mo				$1,500 00	$0	$0	$0	$6,000	$6,000
7 - DEWATER EXCAVATIONS											
7 1 4-inch trash pump	4	mo			$840 00	$840 00	$0	$0	$3,360	$3,360	$6,720
7 2 20,000 gallon temporary storage tank	4	mo				$1,219 00	$0	$0	$0	$4,876	$4,876
7 3 Pump out tanks with 5,000 gallon tanker truck	4	mo			$1,500 00	$3,000 00	$0	$0	$6,000	$12,000	$18,000
7 4 Transportation - 5,000 -gal tanker for 10 miles	80	tanks	$16 50				$1,320	$0	$0	$0	$1,320
7.5 Disposal of excavation water	400	kgal	$1 54				$616	$0	$0	$0	$616
8 - TREATMENT OF CONTAMINATED MATERIAL											
8 1 LTTS equipment mobilization	1	ls	$512,500				$512,500	$0	$0	$0	$512,500
8 2 LTTS treatment	54450	ton	$30 75				$1,674,338	$0	$0	$0	$1,674,338
8 3 Carbon unit for offgas	1	ls	$8,429 00				$8,429	$0	$0	$0	$8,429
8 4 Soil washing unit	4	mo	$127,305				$509,220	$0	$0	$0	$509,220
8 5 Operating labor	1200	hr	$664 77				$797,724	$0	$0	$0	$797,724
8 6 Materials	120	day	$904 10				$108,492	$0	$0	$0	$108,492
8 7 T&D nonhazardous material-debris (RCRA Landfill-D)	19755	ton	$70 00				$1,382,850	$0	$0	$0	$1,382,850
8 8 Pump out tanks with 6,000 gallon tanker truck (washw	4	mo			$1,500 00	$3,000 00	$0	$0	$6,000	$12,000	$18,000
8 9 Disposal of washwater	1080	kgal	$1 54				$1,663	$0	$0	$0	$1,663
8 10 Transportation - 5,000 -gal tanker for 10 miles	216	loads	$16 50				$3,564	$0	$0	$0	$3,564
8 11 Treated soil confirmatory sampling/analysis	160	ea	$60 00		$100 00		$9,600	$0	$16,000	$0	$25,600
8 12 Treated soil confirmatory sampling/analysis	80	ea	$500 00		$100 00		$40,000	$0	$8,000	$0	$48,000
8 13 Air Pollution Permit	120	hr	$0 00	$1,000 00	$30 00	$0 00	$0	$0	$1,863	$0	$1,863
8 14 Reactivation of spent carbon	4000	lb	$0 05				$200	$0	$0	$0	$200
9 - RESTORATION											
9 1 Import clean fill	2000	cy		$10 50			$0	$21,000	$0	$0	$21,000
9.2 Place/grade fill	39000	cy			$0 30	$0 83	$0	$0	$11,700	$32,370	$44,070
9 3 Import/place/grade topsoil	3900	cy		$14 00	$0 23	$0 69	$0	$54,600	$897	$2,691	$58,188
9 4 Revegetation	230	msf		$28 00	$7 00	$7 35	$0	$6,440	$1,610	$1,691	$9,741
10 - NEW MONITORING WELLS (4)											
10 1 Hollow-stem auger	100	ft			$24 87		$0	$0	$2,487	$0	$2,487
10 2 2-inch PVC well casing	100	ft		$10 08			$0	$1,008	$0	$0	$1,008
10 3 Construction (2-man crew)	1	day	$456 80				$457	$0	$0	$0	$457
10 4 2-inch PVC well Screen	60	ft		$14.02			$0	$841	$0	$0	$841
Subtotal							$5,120,992	$108,425	$260,767	$339,103	$5,829,287

CAPITAL COST ESTIMATE **DRAFT**
SOIL ALTERNATIVE 2 - REMOVAL, TREATMENT WITH LTTS AND SOIL WASHING AND BACKFILL
OFFTA FEASIBILITY STUDY
NAVSTA NEWPORT
NEWPORT, RHODE ISLAND
CTO 0218

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal Direct Cost
Overhead on Labor Cost @	30%								$78,230		$78,230
G & A on Labor Cost @	10%								$26,077		$26,077
G & A on Material Cost @	10%							$10,843			$10,843
G & A on Subcontract Cost @	10%						$512,099				$512,099
Total Direct Cost							$5,633,091	$119,268	$365,074	$339,103	$6,456,535
Indirects on Total Direct Labor Cost @	75%								$273,805		$273,805
Profit on Total Direct Cost @	10%										$645,654
Subtotal											$7,375,994
Health & Safety Monitoring @	6%										$442,560
Cost adjustment for location @	7%										$516,320
Total Field Cost											$8,334,873
Contingency on Total Field Cost @	25%										$2,083,718
Engineering on Total Field Cost @	6%										$500,092
TOTAL COST											$10,918,684
References used for cost estimates											**$10,919,000**

1) Means Heavy Construction Cost Data, 2000, R S Means Co , Inc , Kingston, MA
2) Echos Environmental Remediation Unit Cost ,2000, 6th Annual Edition, Delta Technologies Group, Inc , Englewood, CO
3) Echos Environmental Remediation Assemblies Cost , 1998, 4th Annual Edition, Delta Technologies Group, Inc , Englewood, CO
4) Historical data based on competitive bids submitted by subcontractors or actual costs at this or other sites

Present Worth Analysis
Soil Alternative 2 - Removal, Treatment with LTTS and Soil Washing, and Backfill
OFFTA Feasibility Study
NAVSTA Newport
Newport, Rhode Island
04/05/01

PRESENT WORTH ANALYSIS

YEAR	PRESENT WORTH FACTOR (i = 7%)	CAPITAL COSTS	O & M COSTS	5-YEAR COSTS	PRESENT WORTH
0	1.000	$10,918,684			$10,918,684
1	0 935		$29,870		$27,916
2	0.873		$14,935		$13,045
3	0 816		$0		$0
4	0.763		$0		$0
5	0.713		$0	$21,500	$15,329
6	0.666		$0		$0
7	0.623		$0		$0
8	0.582		$0		$0
9	0 544		$0		$0
10	0.508		$0	$0	$0
11	0.475		$0		$0
12	0.444		$0		$0
13	0.415		$0		$0
14	0.388		$0		$0
15	0.362		$0	$0	$0
16	0.339		$0		$0
17	0 317		$0		$0
18	0 296		$0		$0
19	0 277		$0		$0
20	0.258		$0	$0	$0
21	0.242		$0		$0
22	0 226		$0		$0
23	0.211		$0		$0
24	0.197		$0		$0
25	0.184		$0	$0	$0
26	0.172		$0		$0
27	0 161		$0		$0
28	0.150		$0		$0
29	0.141		$0		$0
30	0.131		$0	$0	$0
		TOTAL PRESENT WORTH =			$10,974,974
					$10,975,000

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

Soil Alternative 3: Removal and Disposal at TSDF

CAPITAL COST ASSUMPTIONS:

1. Pre-Design Investigation (PDI)

   PDI consisting of soil borings/cores advanced to further delineate the site and to delineate lateral extent of contaminants exceeding the PRGs. Assume 20 soil borings at an average 15-foot depth with associate analytical costs for PAHs, and metals

   - Mobilization/demobilization @ $13,500
   - Sample collection @ $600 each or $12,000
   - Analytical @ $350/sample for 25 samples including QA/QC samples or $8750
   - Data validation $3,200
   - Reporting @ $3,500
   - Oversight and management @ $4,500

   Total costs approx. = $45,450

2. Mobilization/Demobilization includes providing office trailers, temporary utilities and sanitary facilities, delivery and removal of major construction equipment, and providing all other facilities and materials needed by the management staff.

3. Metal debris and concrete debris will be removed from the site and the shoreline before excavating.

4. Soil and debris will be piled up separately. Any visual contamination on the debris will be washed of before sending to storage pile. Wash water will be collected in 55-gallon drums and disposed of accordingly

5 Excavation Work

   - Approximately 49,500 cy will be excavated as shown in the areal contamination map. Depth of excavation will be up to the water table or bottom of contaminated depth interval, whichever reached first

   - It is assumed that staging areas are available at no cost in the vicinity of OFFTA.

   - Excavated soil and debris staged separately. It is assumed that 90% of the excavated soil can be disposed of at solid waste landfill (RCRA – D) and can be used as landfill cover material. ISoil requiring treatment (10%) at TSDF will be staged separately. Debris will also disposed of at solid waste landfill (RCRA – D). Because of uncertainty of extent of subsurface contamination, and eliminate any potential contamination, excavated areas will be backfilled with new fill material. Material for landfill disposal will be as follows: Soil for landfill cover-49,045 tons, Soil for TSDF – 5450 tons, Debris for RCRA-D landfill – 19,755 tons.

   - Excavated volumes are assumed to be as shown in Table 1. Total debris for Landfill (RCRA-D) disposal is estimated as 13,170 cy. Out of 36,330 cy of soil, 32,700 cy will be disposed at solid waste landfill (RCRA –D) and the remaining (3630 cy) will be sent to TSDF for treatment and disposal.

- Preparation, maintenance, and removal of the staging area was estimated at a lump sum of $11,000, which includes 2 laborers and a backhoe for 10 days and misc. materials.

- The costs for disposal are as per recent project (Melville Landfill) TSDF disposal (to Model City, NY) is $120 per ton and RCRA-D disposal is $70 per ton for debris and $25 per ton for soil that can be used as cover (Fall River Landfill). Imported fill is $7 per ton.

Table 1

Mounds

Total Volume	10,900	cy

Classification	Percent by Vol.	Associated Volume
Debris	50%	5,450
Soil	50%	5,450
Totals	100%	10,900

Remaining Area Excluding Mounds

Total Volume	38,600	cy

Classification	Percent by Vol.	Associated Volume
Debris	20%	7,720
Soil	80%	30,880
Totals	100%	38,600

O&M COST ASSUMPTIONS:

1. Post-Remediation Groundwater Sampling

   Groundwater sampling will be conducted at four wells for three rounds each 6 months apart. A total of six samples will be collected at each event and will be analyzed for DRO,GRO, SVOCs, and metals. Analysis costs will be $822.42 for each sample ($86.25+97.75+348.75+289 67 = $822.42. Source: Recent analysis cost, E-2000-33021619, 33021621). Sampling effort will be at 100 LOE @$100/hr. Total cost for event : $14,935

5-YEAR COST ASSUMPTIONS:

1. 5-year review in year 5 at 200 LOE @ $100/hr Approx. $1500 ODCs. Total = $ 21,500 per event. Review to occur in year 5.

CAPITAL COST ESTIMATE
SOIL ALTERNATIVE 3 - REMOVAL AND TSDF DISPOSAL
OFFTA FEASIBILITY STUDY
NAVSTA NEWPORT
NEWPORT, RHODE ISLAND
CTO 0218

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Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal Direct Cost
1- PRE-DESIGN INVESTIGATION											
1 1 Soil borings and analyses	1	ls	$45,450 00	$0 00	$0 00	$0 00	$45,450	$0	$0	$0	$45,450
2 - MOBILIZATION/DEMOBILIZATION											
2.1 Mobilize/demobilize equipment	1	ls				$7,500 00	$0	$0	$0	$7,500	$7,500
2 2 Office trailer	4	mo				$181 00	$0	$0	$0	$724	$724
2 3 Sanitary facilities	4	mo				$120 00	$0	$0	$0	$480	$480
2 4 Truck scale	4	mo				$2,862 00	$0	$0	$0	$11,448	$11,448
2 5 Site survey/construction layout	5 5	acres		$45 00	$445 00		$0	$248	$2,448	$0	$2,695
2 6 Electric/phone hookups	1	ls	$2,000 00				$2,000	$0	$0	$0	$2,000
2 7 Project closeout report	1	ls			$10,000 00		$0	$0	$10,000	$0	$10,000
3 - SITE PREPARATION											
3 1 Clear and grub site - minimal	5 5	acres			$980 00	$2,700 00	$0	$0	$5,390	$14,850	$20,240
3 2 Install/remove silt fence	3000	lf		$0 45	$0 42		$0	$1,350	$1,260	$0	$2,610
3 3 Construct diversion dikes/channels	2000	lf					$0	$0	$0	$0	$0
3 4 Construct temporary sediment basin/vegetate/backfill	800	cy			$4 85	$5 60	$0	$0	$3,880	$4,480	$8,360
3 5 Truck decon pad											
a) Concrete pad - 8"	40	cy		$70 00	$125 00	$5 00	$0	$2,800	$5,000	$200	$8,000
b) Gravel base - 6"	30	cy		$7 50	$3 33	$8 00	$0	$225	$100	$240	$565
c) Curb	120	lf		$3 07	$1.99	$0 05	$0	$368	$239	$6	$613
d) Collection sump	1	ls		$1,450 00	$500 00	$220 00	$0	$1,450	$500	$220	$2,170
e) Splash guard	780	sf		$1 25	$1 00		$0	$975	$780	$0	$1,755
3 6 Construction entrance	1	ls		$620 00	$86 00	$50 00	$0	$620	$86	$50	$756
3 7 Construct soil staging area	1	ls		$11,000 00			$0	$11,000	$0	$0	$11,000
3 8 Maintain soil staging area	1	ls		$5,500 00	$0 00	$0 00	$0	$5,500	$0	$0	$5,500
3 9 Remove decontamination pad	1	ls			$250 00	$500 00	$0	$0	$250	$500	$750
3 10 Decontamination pad, silt fence disposal	150	ton	$10 00				$1,500	$0	$0	$0	$1,500
3 11 Personnell and equipment decon facilities and services											
a) Personnel decon Trailer	4	mo	$1,500 00	$0 00	$200 00	$0 00	$3,104	$0	$414	$0	$3,518
b) PPE rolloff cont	4	mo	$500 00	$0 00	$0 00	$0 00	$1,035	$0	$0	$0	$1,035
4 - SITE MANAGEMENT STAFFING											
4 1 Site manager	320	hr	$0 00	$0 00	$36 00	$0 00	$0	$0	$14,901	$0	$14,901
4 2 Site engineer	640	hr	$0 00	$0 00	$32 00	$0 00	$0	$0	$13,245	$0	$13,245
4 3 Site supervisor/foreman	640	hr	$0 00	$0 00	$30 00	$0 00	$0	$0	$12,418	$0	$12,418
4 4 Site safety officer	640	hr	$0 00	$0 00	$25 00	$0 00	$0	$0	$10,348	$0	$10,348
5 - HOME OFFICE PROJECT MANAGEMENT AND SUPPORT											
5 1 Project manager	64	hr	$0 00	$0 00	$45 00	$0 00	$0	$0	$3,725	$0	$3,725
5 2 Project administrator	120	hr	$0 00	$0 00	$30 00	$0 00	$0	$0	$1,863	$0	$1,863
5 3 Health and safety director	40	hr	$0 00	$0 00	$35 00	$0 00	$0	$0	$724	$0	$724
5 4 Procurement/subcontracting	160	hr	$0 00	$0 00	$30 00	$0 00	$0	$0	$6,209	$0	$6,209
5 5 Clerical support	160	hr	$0 00	$0 00	$12 50	$0 00	$0	$0	$2,587	$0	$2,587

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CAPITAL COST ESTIMATE
SOIL ALTERNATIVE 3 - REMOVAL AND TSDF DISPOSAL
OFFTA FEASIBILITY STUDY
NAVSTA NEWPORT
NEWPORT, RHODE ISLAND
CTO 0218

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal Direct Cost
6 - EXCAVATION											
6 1 Excavate/load material	49500	cy			$0.48	$1 16	$0	$0	$23,937	$57,637	$81,574
6 2 Segregate material with FID	80	day			$100 00	$100 00	$0	$0	$8,000	$8,000	$16,000
6 3 Haul material to for stockpiling	49500	cy			$0 37	$2 15	$0	$0	$18,315	$106,425	$124,740
6 4 Dump/stockpile material	49500	cy			$0 44	$1 04	$0	$0	$21,533	$51,356	$72,889
6 5 Stockpiled material sampling/analysis - 1/150 cy	218	ea	$85 00		$100 00		$18,530	$0	$21,800	$0	$40,330
6 6 Stockpiled material sampling/analysis - 1/500 cy	27	ea	$1,050 00		$200 00		$28,350	$0	$5,400	$0	$33,750
6 7 Excavation confirmatory sampling/analysis	50	ea	$60 00		$100 00		$3,000	$0	$5,000	$0	$8,000
6 8 Excavation confirmatory sampling/analysis	25	ea	$500 00		$100 00		$12,500	$0	$2,500	$0	$15,000
6 9 Trench Box	4	mo				$1,500 00	$0	$0	$0	$6,000	$6,000
7 - DEWATER EXCAVATIONS											
7 1 4-inch trash pump	4	mo			$840 00	$840 00	$0	$0	$3,360	$3,360	$6,720
7 2 20,000 gallon temporary storage tank	4	mo				$1,219 00	$0	$0	$0	$4,876	$4,876
7 3 Pump out tanks with 5,000 gallon tanker truck	4	mo			$1,500 00	$3,000 00	$0	$0	$6,000	$12,000	$18,000
7 4 Transportation - 5,000 -gal tanker for 10 miles	80	tanks	$16 50				$1,320	$0	$0	$0	$1,320
7 5 Disposal of excavation water	400	kgal	$1 54				$616	$0	$0	$0	$616
8 - TRANSPORTATION AND DISPOSAL OF CONTAMINATED MATERIAL											
8 1 Load nonhazardous material into trucks	45870	cy			$0 19	$0 28	$0	$0	$8,715	$12,844	$21,559
8.2 Load hazardous material into trucks	3630	cy			$0 28	$0 35	$0	$0	$1,000	$1,271	$2,271
8 3 Level C PPE (4-man field crew)	32	mday		$34 54			$0	$1,105	$0	$0	$1,105
8 4 T&D nonhazardous material - debies (RCRA Landfill-	19755	ton	$70 00				$1,382,850	$0	$0	$0	$1,382,850
8 5 T&D hazardous material (RCRA Landfill-C)	5450	ton	$120 00				$654,000	$0	$0	$0	$654,000
8 6 T&D nonhazardous soil cover (RCRA Landfill-D)	49045	ton	$25 00				$1,226,125	$0	$0	$0	$1,226,125
9 - RESTORATION											
9 1 Import clean fill	39000	cy		$10 50			$0	$409,500	$0	$0	$409,500
9 2 Place/grade fill	39000	cy			$0 30	$0 83	$0	$0	$11,700	$32,370	$44,070
9 3 Import/place/grade topsoil	3900	cy		$14 00	$0 23	$0 69	$0	$54,600	$897	$2,691	$58,188
9 4 Revegetation	230	msf		$28 00	$7 00	$7 35	$0	$6,440	$1,610	$1,691	$9,741
10 - NEW MONITORING WELLS (4)											
10 1 Hollow-stem auger	100	ft			$24 87		$0	$0	$2,487	$0	$2,487
10 2 2-inch PVC well casing	100	ft		$10 08			$0	$1,008	$0	$0	$1,008
10 3 Construction (2-man crew)	1	day	$456 80				$457	$0	$0	$0	$457
10 4 2-inch PVC well Screen	60	ft		$14 02			$0	$841	$0	$0	$841
Subtotal							$3,335,387	$498,030	$238,620	$341,217	$4,413,254

CAPITAL COST ESTIMATE
SOIL ALTERNATIVE 3 - REMOVAL AND TSDF DISPOSAL
OFFTA FEASIBILITY STUDY
NAVSTA NEWPORT
NEWPORT, RHODE ISLAND
CTO 0218

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Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal Direct Cost
Overhead on Labor Cost @	30%								$71,586		$71,586
G & A on Labor Cost @	10%								$23,862		$23,862
G & A on Material Cost @	10%							$49,803			$49,803
G & A on Subcontract Cost @	10%						$333,539				$333,539
Total Direct Cost							$3,668,926	$547,833	$334,068	$341,217	$4,892,044
Indirects on Total Direct Labor Cost @	75%								$250,551		$250,551
Profit on Total Direct Cost @	10%										$489,204
Subtotal											$5,631,799
Health & Safety Monitoring @	6%										$337,908
Cost adjustment for location @	7%										$394,226
Total Field Cost											$6,363,933
Contingency on Total Field Cost @	15%										$954,590
Engineering on Total Field Cost @	6%										$381,836
TOTAL COST											$7,700,359
References used for cost estimates											**$7,700,000**

1) Means Heavy Construction Cost Data, 2000, R S Means Co , Inc , Kingston, MA
2) Echos Environmental Remediation Unit Cost ,2000, 6th Annual Edition, Delta Technologies Group, Inc , Englewood, CO
3) Echos Environmental Remediation Assemblies Cost , 1998, 4th Annual Edition, Delta Technologies Group, Inc , Englewood, CO
4) Historical data based on competitive bids submitted by subcontractors or actual costs at this or other sites

Present Worth Analysis
Soil Alternative 3 - Removal and Off-site Disposal
OFFTA Feasibility Study
NAVSTA Newport
Newport, Rhode Island
04/05/01

PRESENT WORTH ANALYSIS

YEAR	PRESENT WORTH FACTOR (i = 7%)	CAPITAL COSTS	O & M COSTS	5-YEAR COSTS	PRESENT WORTH
0	1.000	$7,700,359			$7,700,359
1	0.935		$29,870		$27,916
2	0.873		$14,935		$13,045
3	0 816		$0		$0
4	0.763		$0		$0
5	0 713		$0	$21,500	$15,329
6	0.666		$0		$0
7	0.623		$0		$0
8	0 582		$0		$0
9	0.544		$0		$0
10	0.508		$0	$0	$0
11	0.475		$0		$0
12	0.444		$0		$0
13	0.415		$0		$0
14	0.388		$0		$0
15	0.362		$0	$0	$0
16	0.339		$0		$0
17	0 317		$0		$0
18	0.296		$0		$0
19	0 277		$0		$0
20	0 258		$0	$0	$0
21	0.242		$0		$0
22	0.226		$0		$0
23	0.211		$0		$0
24	0.197		$0		$0
25	0.184		$0	$0	$0
26	0.172		$0		$0
27	0 161		$0		$0
28	0.150		$0		$0
29	0.141		$0		$0
30	0.131		$0	$0	$0
		TOTAL PRESENT WORTH =			$7,756,649
					$7,757,000

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

Tetra Tech NUS			Calculation Sheet
Client: Navy CLEAN	File No	**By:** RD	**Page** 1 of 1
Subject: Assumptions and Cost Basis, Sediment Alternative 1, OFFTA FS, CTO 218		**Checked by:** JD	**Date:** April 4, 2001

Sediment Alternative 1: No Action

CAPITAL COST ASSUMPTIONS: N/A

O&M COST ASSUMPTIONS: N/A

5-YEAR COST ASSUMPTIONS:

1. 5-year reviews at 200 LOE @ $100/hr. Approx. $1500 ODCs. Total = $ 21,500 per event. Reviews to occur in years 5, 10, 15, 20, 25, and 30.

Present Worth Analysis
Sediment Alternative 1 - No Action
OFFTA Feasibility Study
NAVSTA Newport
Newport, Rhode Island
04/05/01

PRESENT WORTH ANALYSIS

YEAR	PRESENT WORTH FACTOR (i = 7%)	CAPITAL COSTS	O & M COSTS	5-YEAR COSTS	PRESENT WORTH
0	1.000	$0			$0
1	0.935		$0		$0
2	0 873		$0		$0
3	0.816		$0		$0
4	0.763		$0		$0
5	0.713		$0	$21,500	$15,329
6	0.666		$0		$0
7	0.623		$0		$0
8	0 582		$0		$0
9	0.544		$0		$0
10	0.508		$0	$21,500	$10,930
11	0.475		$0		$0
12	0.444		$0		$0
13	0.415		$0		$0
14	0.388		$0		$0
15	0.362		$0	$21,500	$7,793
16	0 339		$0		$0
17	0 317		$0		$0
18	0.296		$0		$0
19	0.277		$0		$0
20	0.258		$0	$21,500	$5,556
21	0.242		$0		$0
22	0.226		$0		$0
23	0 211		$0		$0
24	0.197		$0		$0
25	0.184		$0	$21,500	$3,961
26	0.172		$0		$0
27	0.161		$0		$0
28	0.150		$0		$0
29	0.141		$0		$0
30	0.131		$0	$21,500	$2,824
		TOTAL PRESENT WORTH =			$46,393
					$46,000

Discount rate of 7% per OSWER Directive No 9355.3-20, June 25, 1993

Sediment Alternative 2: Limited Action

CAPITAL COST ASSUMPTIONS:

1. Access Restrictions:

A row of fencing will be installed at each end of OFFTA, connected to the existing fence corners, and extend to the mean low water line. Buoys will be installed at 100-foot increments along the shoreline, ten feet offshore of the mean-low tide line. Warning signs will be posted on the fence and buoys and at strategic locations on shore to warn people of the hazards associated with the use of the area.

- 150 lf fence @ $19.09 = $2,865
- 15 line posts @ $60 00 = $900
- 6 end posts @ $81.50 = $489
- 10 buoys and anchors @ $400 ea = $4,000
- 2 days of boat rental = $1,000
- 15 - 12"X18" warning signs @ $42.44ea. = $636

Total Fence, Sign, and Buoy Cost = $9,890

O&M COST ASSUMPTIONS:

1. Long-term Monitoring:

Analyses:

- Sediment chemistry (PAHs, arsenic); 5 samples plus 2 QC samples
- Biota chemistry 5 samples (PAHs, arsenic),
- Toxicity Amphipod; 5 samples
- Toxicity Arabacia; 5 samples

Labor Costs: (1 event/year)

- Sediment sampling: Sample collection with equipment and crew = approximately $485/sample. Collection of 5 samples = $2,485 (QC samples collected at no additional cost)
- Biota sampling: Sample collection with equipment and crew = approximately $1043/sample. Collection of 5 samples = $5,215
- Project mgmt/coord. ≈ 30 hours/year @ $80/hr (w/O&P) = $2,400
- Annual. add $300 M&IE, ODCs & supplies @ $200; & shipping @ $200.
- Data Validation $5,808.
- Report prep. $9,500.

Total Labor ≅ $26,108 annually for years 1-5 and at 5 -year review cycles

Estimated analytical costs:

- Sediment chemistry (PAHs, arsenic) $283/sample @ 7 samples/yr = $1,981
- Biota chemistry (PAHs, arsenic) @ $1100/sample @ 5 samples/yr = $5,500
- Toxicity Amphipod @ $863/ sample @ 5 samples/yr = $4,315
- Toxicity Arabacia @ $662/ sample @ 5 samples/yr = $3,310

Total Analytical ≅ $15,105 annually for years 1-5 and at 5 -year review cycles

2. Inspection and Maintenance:

   Quarterly inspections (fence, buoys and biota) including fieldwork and reporting, Engineer @ 16 LOE @ 80/hr = $1280/quarter; approximately $300/quarter ODCs = $1,580/quarter or $6,320/year, assume 10% of total replacement cost per year for fence/sign/buoy maintenance $2,466. Total = $8,786 annually

5-YEAR COST ASSUMPTIONS:

1. Each reviews at 200 LOE @ $100/hr. Approx. $1500 ODCs Total = $ 21,500 per event. Reviews to occur in years 5, 10, 15, 20, 25, and 30.

Present Worth Analysis
Sediment Alternative 2 - Limited Action
OFFTA Feasibility Study
NAVSTA Newport
Newport, Rhode Island
04/05/01

YEAR	PRESENT WORTH FACTOR (i = 7%)	CAPITAL COSTS	O & M COSTS	5-YEAR COSTS	PRESENT WORTH
0	1.000	$9,890			$9,890
1	0 935		$49,999		$46,728
2	0 873		$49,999		$43,671
3	0.816		$49,999		$40,814
4	0 763		$49,999		$38,144
5	0.713		$49,999	$21,500	$50,978
6	0 666		$8,786		$5,854
7	0 623		$8,786		$5,471
8	0.582		$8,786		$5,114
9	0.544		$8,786		$4,779
10	0.508		$49,999	$21,500	$36,346
11	0.475		$8,786		$4,174
12	0.444		$8,786		$3,901
13	0.415		$8,786		$3,646
14	0.388		$8,786		$3,407
15	0.362		$49,999	$21,500	$25,915
16	0.339		$8,786		$2,976
17	0 317		$8,786		$2,781
18	0.296		$8,786		$2,599
19	0.277		$8,786		$2,429
20	0.258		$49,999	$21,500	$18,477
21	0.242		$8,786		$2,122
22	0.226		$8,786		$1,983
23	0 211		$8,786		$1,853
24	0.197		$8,786		$1,732
25	0.184		$49,999	$21,500	$13,174
26	0.172		$8,786		$1,513
27	0.161		$8,786		$1,414
28	0.150		$8,786		$1,321
29	0.141		$8,786		$1,235
30	0.131		$49,999	$21,500	$9,393
		TOTAL PRESENT WORTH =			$393,836
					$394,000

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

Sediment Alternative 3: Limited Dredging/Excavation and Disposal

CAPITAL COST ASSUMPTIONS:

1. Pre-Design Investigation (PDI)

   PDI consisting of soil borings/cores advanced to further determine the grain size and nature of the sediments and to delineate lateral extent of contaminants exceeding the PRGs. Assume 25 soil borings at an average 5-foot depth with associate analytical costs for PAHs, arsenic, and geotechnical testing.

   - Mobilization/demobilization @ $33,750
   - Sample collection @ $600 each or $15,000
   - Analytical @ $283/sample for 55 samples including QA/QC samples or $15,565
   - Data validation $6,600
   - Reporting @ $5,000
   - Oversight and management @ $5,500

   Total costs approx. = $81,415.

2. Mobilization/Demobilization includes providing office trailers, temporary utilities and sanitary facilities, delivery and removal of major construction equipment, and providing all other facilities and materials needed by the management staff

3. It is assumed that no subgrade preparation will be required prior to dredging/excavating the contaminated sediments. Large debris and boulders will be removed from the sediments after they have been dredged, but prior to dewatering.

4 Erosion controls will be provided to reduce migration of sediments during the dredging operations by means of a silt boom The silt boom will be anchored around the perimeter of the dredge area.

5 Bay haul road will be constructed to excavate near shore contaminated sediments. The road will be built at a height of 8' (2' above the water level) and will be of graded crushed gravel base. The road will be of 20' wide at the top and 20' at the base with 1:1 slope. A total of approximately 6650 cy of crushed stone (RIDOT R-3) will be required. At a cost of $21.56 per cy of installed stone (ECHOS 026112205), cost is estimated at $144,000. Excavation will be carried out using trackhoe with extended reach arm.

6. Excavation Work

   - Approximately 2.75 acres of area will be dredged to a depth of 2 feet (approximately 8,870 cu yd) to remove contaminated sediment.

   - It is assumed that OFFTA area will be used as a materials staging, dewatering, and project office area at no cost. Dewatered dredge spoils will be staged at this area pending transport to the TSDF/off-site landfill

   - Preparation, maintenance, and removal of the staging area was estimated at a lump sum of $11,000, which includes 2 laborers and a backhoe for 10 days and misc. materials. Dewatering/screening activities will be performed on the shore (as required) to prepare the sediments for off-base disposal. It is assumed dewatering/screening equipment and crew is

assumed to cost $4,500 per day and is assumed that extensive dewatering will not be required each day. On-site bulking of the sediments is included in the dewatering cost (if necessary) It is assumed that the production rate for the dredging operation will be 300 cy/day and the operation will take 30 workdays.

- It is assumed that over-the-road transport of waste will be done with out any improvements to the bridge near the site.

- Water quality testing will be performed daily during dredging removal activities. It is assumed that three samples will be collected daily from outside of the silt curtain work area. Samples will be analyzed for PAHs, arsenic, and total suspended solids (TSS).

7. Shoreline-Based Work

- A portable cofferdam system will be erected along the shoreline in the west end of the action area. The cofferdam will extend out to the 2-foot MLW line. The area will be continuously dewatered with pumps so that the excavation of sediments can occur in "dry" conditions An estimated 20% (1775 cy) will be excavated in this manner.

- Dry excavated sediments will be screened and hauled directly to the landfill from the excavation site. Backfill materials will be placed immediately following removal of the contaminated sediments.

- Access to the work area will be from along the western side of OFFTA. Excavation, handling, and placement of materials will be accomplished using tracked excavators, a wheeled front-end loader, screener, and off-road dump trucks at a rate of 600 cy/day. Costs include a survey crew to verify grades during placement.

- A rip-rap revetment system will be installed along the shoreline to control wave erosion. It is assumed that 10-foot wide layer of rip-rap will be placed along the 1,360-foot length of the action area using land-based equipment

- Since this work will be performed concurrently with the excavation work, no additional water quality testing is required.

- The backfill materials consisting of sand/gravel/stone will be placed over an area approximately 2.75 acres. Assuming a bulking factor of 20%, approximately 10,300 cy of backfill will be placed. Also, since 20% of the dredged material (1,775 cy) will be screened and re-used, only 7,450 cy of material will be required from off-site sources.

- Because of low contamination levels it is assumed that most of the sediment can be disposed of at RCRA-D landfill. For the estimation purposes, 90% of the sediment (after backfill) is assumed to be disposed of at RCRA-D landfill, 9% of sediment will need stabilization after which it would be disposed of at RCRA-D landfill, and 1% of sediment would be disposed of at TSDF (RCRA-C).

- The costs for disposal are as per recent project (Melville Landfill). TSDF disposal (to Model City, NY) is $120 per ton (as per Carl Tippman of Foster Wheeler from McAllister project) and RCRA-D disposal is $70 per ton (disposal cost from Fall River Landfill) including transportation.

O&M COST ASSUMPTIONS:

1 Long-term Monitoring:

Analyses:

- Sediment chemistry (PAHs, arsenic); 5 samples plus 2 QC samples
- Biota chemistry 5 samples (PAHs, arsenic);
- Toxicity Amphipod; 5 samples
- Toxicity Arabacia; 5 samples

Labor: (1 event/year)

- Sediment sampling: Sample collection with equipment and crew = approximately
- $485/sample Collection of 5 samples = $2,485 (QC samples collected at no additional cost)
- Biota sampling. Sample collection with equipment and crew = approximately $1043/sample.
- Collection of 5 samples = $5,215
- Project mgmt/coord ≈ 30 hours/year @ $80/hr (w/O&P) = $2,400
- Annual. add $300 M&IE, ODCs & supplies @ $200; & shipping @ $200.
- Data Validation $5,808.
- Report prep. $9,500.

Total Labor ≅ $26,108 annually for years 1-5 and at 5 -year review cycles

Estimated analytical costs:

- Sediment chemistry (PAHs, arsenic) $283/sample @ 7 samples/yr. = $1,981
- Biota chemistry (PAHs, arsenic) @ $1100/sample @ 5 samples/yr = $5,500
- Toxicity Amphipod @ $863/ sample @ 5 samples/yr = $4,315
- Toxicity Arabacia @ $662/ sample @ 5 samples/yr = $3,310

Total Analytical ≅ $15,105 annually for years 1-5 and at 5 -year review cycles

2. Inspection for Habitat Recovery:

Qualitative inspections to be performed by an Marine Biologist: Assume 2 days (8 hr/day) for inspection and travel and 2 days (16 hr) to prepare an inspection report. 32 hours total @ $80/hr = $2,560 plus $300 ODCs & travel costs, and $2,000 equipment costs (boat and underwater video). Total quarterly Inspection costs are $4,860. Total annual costs are $19,440 for years 1-5 and at 5-year review cycles.

3 5-year reviews at 200 LOE @ $100/hr. Approx. $1500 ODCs. Total = $ 21,500 per event. Reviews to occur in years 5, 10, 15, 20, 25, and 30.

CAPITAL COST ESTIMATE
SEDIMENT ALTERNATIVE 3 - LIMITED REMOVAL WITH DISPOSAL OFF-BASE
OFFTA FEASIBILITY STUDY
NAVSTA NEWPORT
NEWPORT, RHODE ISLAND
CTO 0218

DRAFT

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal Direct Cost
1- PRE-DESIGN INVESTIGATION											
1 1 Sediment/soil borings and analyses	1	ls	$81,415 00	$0 00	$0 00	$0 00	$81,415 00	$0 00	$0 00	$0 00	$81,415 00
2 - MOBILIZATION/DEMOBILIZATION											
2 1 Office trailer (1 each)	2	mo	$400 00	$0 00	$0 00	$0 00	$827 83	$0 00	$0 00	$0 00	$827 83
2 2 Portable communication equipment sets	4	ea	$400 00	$0 00	$0 00	$0 00	$1,600 00	$0.00	$0 00	$0 00	$1,600 00
2 3 Equipment mob /demob. (support equip)	1	ls	$40,000 00	$0 00	$0 00	$0 00	$40,000 00	$0 00	$0 00	$0 00	$40,000 00
2 4 Site utility hook-ups (electric, phone, etc)	1	ls	$3,000 00	$0 00	$0 00	$0 00	$3,000 00	$0 00	$0 00	$0 00	$3,000 00
2 5 Site utilities	2	mo	$4,000 00	$0 00	$0 00	$0 00	$8,278 33	$0 00	$0 00	$0 00	$8,278 33
2 6 Pick-up truck (rental, 3 each)	2	mo	$2,850 00	$450 00	$0 00	$0 00	$5,898 31	$931 31	$0 00	$0 00	$6,829 63
2 7 Certification/close-out reports	1	ea	$7,000 00	$2,000 00	$15,000 00	$3,000 00	$7,000 00	$2,000 00	$15,000 00	$3,000.00	$27,000 00
3 - PERSONNEL AND EQUIP. DECON. FACILITIES AND SERVICES											
3 1 1) Personnel decon trailer	2	mo	$1,500 00	$0.00	$200 00	$0 00	$3,104 38	$0 00	$413 92	$0 00	$3,518 29
3 2 2) PPE rolloff cont.	2	mo	$500 00	$0 00	$0 00	$0 00	$1,034 79	$0 00	$0 00	$0.00	$1,034 79
4 - SITE MANAGEMENT STAFFING											
4 1 Site manager	166	hr	$0 00	$0 00	$36 00	$0 00	$0 00	$0 00	$5,960 40	$0 00	$5,960 40
4 2 Site engineer	331	hr	$0 00	$0 00	$32 00	$0 00	$0 00	$0 00	$10,596 27	$0 00	$10,596 27
4 3 Site supervisor/foreman	331	hr	$0 00	$0 00	$30 00	$0 00	$0 00	$0 00	$9,934 00	$0 00	$9,934 00
4 4 Site safety officer	331	hr	$0 00	$0 00	$25 00	$0 00	$0 00	$0 00	$8,278 33	$0 00	$8,278 33
5 - HOME OFFICE PROJECT MANAGEMENT AND SUPPORT											
5 1 Project manager	33	hr	$0 00	$0 00	$45 00	$0 00	$0 00	$0 00	$1,490 10	$0 00	$1,490 10
5 2 Project administrator	62	hr	$0 00	$0 00	$30 00	$0 00	$0 00	$0 00	$1,862 63	$0 00	$1,862 63
5 3 Health and safety director	21	hr	$0 00	$0 00	$35 00	$0 00	$0 00	$0 00	$724 35	$0.00	$724 35
5 4 Procurement/subcontracting	83	hr	$0 00	$0 00	$30 00	$0 00	$0 00	$0 00	$2,483 50	$0 00	$2,483 50
5 5 Clerical support	83	hr	$0 00	$0 00	$12 50	$0 00	$0 00	$0 00	$1,034 79	$0 00	$1,034 79
6 - DREDGING/WATER TREATMENT											
6 1 Shoreline Debris Removal/disposal at RCRA D Landfill	500	ton	$75 00	$0 00	$0 00	$0 00	$37,500 00	$0 00	$0 00	$0 00	$37,500 00
6 2 Nearshore Debris Removal/Disposal at RCRA D Landfill	50	ton	$75 00	$0 00	$0 00	$0 00	$3,750 00	$0 00	$0 00	$0 00	$3,750 00
6 3 Erosion control, silt boom	3,000	lf	$0 00	$10 00	$4 00	$4 00	$0 00	$30,000 00	$12,000 00	$12,000 00	$54,000 00
6.4 Mobilization/demobilization (shore based equip)	1	ls	$5,000 00	$0 00	$0 00	$0 00	$5,000 00	$0 00	$0 00	$0 00	$5,000.00
6 5 Staging area preparation, maintenance, and removal	1	ls	$0 00	$1,000 00	$7,000 00	$3,000 00	$0 00	$1,000 00	$7,000 00	$3,000 00	$11,000 00
6 6 Bay haul road construction	1	ls	$144,000 00	$0 00	$0 00	$0 00	$144,000 00	$0 00	$0 00	$0 00	$144,000 00
6 7 Coffer dam construction and dewatering	1	ls	$20,000 00	$0 00	$0 00	$0 00	$20,000 00	$0 00	$0 00	$0 00	$20,000 00
6 8 Mobilization/demobilization (Off-shore based equip)	1	ls	$10,000 00	$0 00	$0 00	$0 00	$10,000 00	$0 00	$0 00	$0 00	$10,000 00
6 9 Excavate/screen/haul shorelinesediments	1,775	cy	$7 00	$0 00	$0 00	$0 00	$12,425 00	$0 00	$0 00	$0 00	$12,425 00
6 10 Excavate/Dredge, haul nearshore sediments	7,095	cy	$7 00	$0 00	$0 00	$0 00	$49,665 00	$0 00	$0 00	$0 00	$49,665 00
6 11 Dredge water treatment	24	day	$4,500 00	$0 00	$0 00	$0 00	$106,425 00	$0 00	$0 00	$0 00	$106,425 00
6 12 Sediment confirmation testing	25	ea	$883 00	$0 00	$0 00	$0 00	$22,075 00	$0 00	$0 00	$0 00	$22,075 00
6 13 Water quality testing	24	day	$3,600 00	$50 00	$200 00	$150 00	$85,140 00	$1,182 50	$4,730 00	$3,547 50	$94,600 00
6 14 Disposal/transport to RCRA D Landfill	7,183	ton	$70 00	$0 00	$0 00	$0 00	$502,834 50	$0 00	$0 00	$0 00	$502,834 50
6 15 Disposal/transport to RCRA D Landfill w/ stabilization	718	ton	$90 00	$0 00	$0 00	$0 00	$64,650 15	$0 00	$0 00	$0 00	$64,650.15
6 16 Disposal/transport to RCRA C Landfill	80	ton	$120 00	$0 00	$0 00	$0 00	$9,577 80	$0 00	$0 00	$0 00	$9,577 80

CAPITAL COST ESTIMATE
SEDIMENT ALTERNATIVE 3 - LIMITED REMOVAL WITH DISPOSAL OFF-BASE
OFFTA FEASIBILITY STUDY
NAVSTA NEWPORT
NEWPORT, RHODE ISLAND
CTO 0218

DRAFT

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal Direct Cost
7 - BACKFILL PLACEMENT											
7 1 Shoreline imported sand/gravel cap installation (2 ft)	1,775	cy	$0 00	$15 00	$4 93	$11 23	$0 00	$26,625 00	$8,750 75	$19,933 25	$55,309 00
7 2 Shoreline screened sand/gravel cap installation (2 ft)	1,420	cy	$0 00	$0 00	$4 93	$11 23	$0 00	$0 00	$7,000 60	$15,946 60	$22,947 20
7 3 Shorline riprap placement	1,512	SY	$65 00	$0 00	$0 00	$0 00	$98,280 00	$0 00	$0 00	- $0 00	$98,280 00
7 4 Nearshore imported sand/gravel cap installation (2 ft)	5,676	cy	$25 17	$15 00	$1 66	$0 00	$142,864 92	$85,140 00	$9,422 16	$0 00	$237,427 08
7 5 Nearshore screened sand/gravel cap installation (2 ft)	1,419	cy	$25 17	$0 00	$1 66	$0 00	$35,716 23	$0 00	$2,355 54	$0 00	$38,071 77
7 6 Water quality monitoring (3 samples/day)	12	day	$3,600 00	$50 00	$200 00	$150 00	$42,570 00	$591 25	$2,365 00	$1,773 75	$47,300 00
Subtotal							$1,544,632	$147,470	$111,402	$59,201	$1,862,706
Overhead on Labor Cost @ 30%									$33,421		$33,421
G & A on Labor Cost @ 10%									$11,140		$11,140
G & A on Material Cost @ 10%								$14,747			$14,747
G & A on Subcontract Cost @ 10%							$154,463				$154,463
Total Direct Cost							$1,699,095	$162,217	$155,963	$59,201	$2,076,477
Indirects on Total Direct Labor Cost @ 75%									$116,972		$116,972
Profit on Total Direct Cost @ 10%											$207,648
Subtotal											$2,401,097
Health & Safety Monitoring @ 6%											$144,066
Cost adjustment for location @ 7%											$168,077
Total Field Cost											$2,713,240
Contingency on Total Field Cost @ 25%											$678,310
Engineering on Total Field Cost @ 6%											$162,794
TOTAL COST											$3,554,344
References used for cost estimates											**$3,554,000**

1) Means Heavy Construction Cost Data, 2000, R S. Means Co , Inc , Kingston, MA
2) Echos Environmental Remediation Unit Cost ,2000, 6th Annual Edition, Delta Technologies Group, Inc , Englewood, CO
3) Echos Environmental Remediation Assemblies Cost , 1998, 4th Annual Edition, Delta Technologies Group, Inc , Englewood, CO
4) Historical data based on competitive bids submitted by subcontractors or actual costs at this or other sites
5) Excavation cost is based on hourly rate of $130 61 for 2CY track loader (E2000-17030217), With 300 CY/ 8hr, rate is approxi $ 3 48/CY
6) Costs for Hauling to staging area are based on $3 49/CY (02320-0200) Cost for excavation and hauling is approx $7/CY

Present Worth Analysis
Sediment Alternative 3 - Limited Dredging and Off-site Disposal
OFFTA Feasibility Study
NAVSTA Newport
Newport, Rhode Island
04/05/01

PRESENT WORTH ANALYSIS

YEAR	PRESENT WORTH FACTOR (I = 7%)	CAPITAL COSTS	O & M COSTS	5-YEAR COSTS	PRESENT WORTH
0	1.000	$3,554,344			$3,554,344
1	0.935		$60,653		$56,685
2	0.873		$60,653		$52,977
3	0.816		$60,653		$49,511
4	0.763		$60,653		$46,272
5	0.713		$60,653	$21,500	$58,574
6	0.666		$0		$0
7	0.623		$0		$0
8	0.582		$0		$0
9	0.544		$0		$0
10	0.508		$60,653	$21,500	$41,762
11	0 475		$0		$0
12	0.444		$0		$0
13	0.415		$0		$0
14	0.388		$0		$0
15	0 362		$60,653	$21,500	$29,776
16	0.339		$0		$0
17	0 317		$0		$0
18	0.296		$0		$0
19	0.277		$0		$0
20	0.258		$60,653	$21,500	$21,230
21	0.242		$0		$0
22	0.226		$0		$0
23	0.211		$0		$0
24	0.197		$0		$0
25	0 184		$60,653	$21,500	$15,137
26	0 172		$0		$0
27	0.161		$0		$0
28	0.150		$0		$0
29	0.141		$0		$0
30	0.131		$60,653	$21,500	$10,792
		TOTAL PRESENT WORTH =			$3,937,060
					$3,937,000

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993

Sediment Alternative 4: Dredging/Excavation and Disposal

CAPITAL COST ASSUMPTIONS:

1. Pre-Design Investigation (PDI)

   PDI consisting of soil borings/cores advanced to further determine the grain size and nature of the sediments and to delineate lateral extent of contaminants exceeding the PRGs. Assume 25 soil borings at an average 5-foot depth with associate analytical costs for PAHs, arsenic, and geotechnical testing.

   - Mobilization/demobilization @ $33,750
   - Sample collection @ $600 each or $15,000
   - Analytical @ $283/sample for 55 samples including QA/QC samples or $15,565
   - Data validation $6,600
   - Reporting @ $5,000
   - Oversight and management @ $5,500

   Total costs approx. = $81,415.

2. Mobilization/Demobilization includes providing office trailers, temporary utilities and sanitary facilities, delivery and removal of major construction equipment, and providing all other facilities and materials needed by the management staff.

3. It is assumed that no subgrade preparation will be required prior to dredging/excavating the contaminated sediments Large debris and boulders will be removed from the sediments after they have been dredged, but prior to dewatering.

4. Erosion controls will be provided to reduce migration of sediments during the dredging operations by means of a silt boom. The silt boom will be anchored around the perimeter of the dredge area.

5 Bay haul road will be constructed to excavate near shore contaminated sediments. The road will be built at a height of 8' (2' above the water level) and will be of graded crushed gravel base. The road will be of 20' wide at the top and 20' at the base with 1:1 slope. A total of approximately 6650 cy of crushed stone (RIDOT R-3) will be required. At a cost of $21.56 per cy of installed stone (ECHOS 026112205), cost is estimated at $144,000 Excavation will be carried out using trackhoe with extended reach arm.

6. Excavation work

   - Approximately 3 acres of area will be dredged to a depth of 2 feet (approximately 9,670 cy) to remove contaminated sediment.

   - It is assumed that OFFTA area will be used as a materials staging, dewatering, and project office area at no cost. Dewatered dredge spoils will be staged at this area pending transport to the TSDF/off-site landfill.

   - Preparation, maintenance, and removal of the staging area was estimated at a lump sum of $11,000, which includes 2 laborers and a backhoe for 10 days and misc. materials. Dewatering/screening activities will be performed on the barge and on shore (as required) to prepare the sediments for off-base disposal. It is assumed that the barge, crew, and

dredging equipment cost is $8,600 per day and shore-based equipment to load/off-load materials to barge is $6,500/day. Dewatering/screening equipment and crew is assumed to cost $4,500 per day and is assumed that extensive dewatering will not be required each day. On-site bulking of the sediments is included in the dewatering cost (if necessary). It is assumed that the production rate for the dredging operation will be 300 cy/day and the operation will take 50 workdays.

- It is assumed that over-the-road transport of waste will be done with out any improvements to the bridge near the site.

- Water quality testing will be performed daily during dredging removal activities. It assumed that three samples would be collected daily from outside of the silt curtain work area. Samples will be analyzed for PAHs, arsenic, and total suspended solids (TSS).

7. Shoreline-Based Work

- Dry excavated sediments will be screened and hauled directly to the landfill from the excavation site Backfill materials will be placed immediately following removal of the contaminated sediments.

- Access to the work area will be from along the western side of OFFTA Excavation, handling, and placement of materials will be accomplished using tracked excavators, a wheeled front-end loader, screener, and off-road dump trucks at a rate of 600 cy/day. Costs include a survey crew to verify grades during placement

- A rip-rap revetment system will be installed along the shoreline to control wave erosion. It is assumed that 10-foot wide layer of rip-rap will be placed along the 1,360-foot length of the action area using land-based equipment.

- Since this work will be performed concurrently with the excavation work, no additional water quality testing is required.

- The backfill materials consisting of sand/gravel/stone will be placed over an area approximately. Assuming a bulking factor of 20%, approximately 11,604 cy of backfill will be placed. Also, since 20% of the dredged material (1,935 cy) will be screened and re-used, only 9,670 cy of material will be required from off-site sources.

- Because of low contamination levels, it is assumed that most of the sediment can be disposed of at RCRA-D landfill. For the estimation purposes, 90% of the sediment (after backfill) is assumed to be disposed of at RCRA-D landfill, 9% of sediment will need stabilization after which it would be disposed of at RCRA-D landfill, and 1% of sediment would be disposed of at TSDF (RCRA-C).

- The costs for disposal are as per recent project (Melville Landfill). TSDF disposal (to Model City, NY) is $120 per ton (as per Carl Tippman of Foster Wheeler) and RCRA-D disposal is $70 per ton (disposal cost from Fall River Landfill) including transportation.

O&M COST ASSUMPTIONS:

1. Long-term Monitoring:

   Analyses:
   - Sediment chemistry (PAHs, arsenic); 5 samples plus 2 QC samples
   - Biota chemistry 5 samples (PAHs, arsenic);
   - Toxicity Amphipod; 5 samples
   - Toxicity Arabacia; 5 samples

   Labor: (1 event/year)
   - Sediment sampling. Sample collection with equipment and crew = approximately
   - $485/sample. Collection of 5 samples = $2,485 (QC samples collected at no additional cost)
   - Biota sampling Sample collection with equipment and crew = approximately $1043/sample.
   - Collection of 5 samples = $5,215
   - Project mgmt/coord ≈ 30 hours/year @ $80/hr (w/O&P) = $2,400
   - Annual. add $300 M&IE; ODCs & supplies @ $200, & shipping @ $200.
   - Data Validation $5,808.
   - Report prep. $9,500

   Total Labor ≅ $26,108 annually for years 1,2, and 5.

   Estimated analytical costs:
   - Sediment chemistry (PAHs, arsenic) $283/sample @ 7 samples/yr = $1,981
   - Biota chemistry (PAHs, arsenic) @ $1100/sample @ 5 samples/yr = $5,500
   - Toxicity Amphipod @ $863/ sample @ 5 samples/yr = $4,315
   - Toxicity Arabacia @ $662/ sample @ 5 samples/yr = $3,310

   Total Analytical ≅ $15,105 annually for years 1,2, and 5.

2. Inspection for Habitat Recovery:

   Qualitative inspections to be performed by an Marine Biologist: Assume 2 days (8 hr/day) for inspection and travel and 2 days (16 hr) to prepare an inspection report. 32 hours total @ $80/hr = $2,560 plus $300 ODCs & travel costs, and $2,000 equipment costs (boat and underwater video). Total quarterly Inspection costs are $4,860. Total annual costs are $19,440 for years 1,2, and 5.

3. 5-year reviews at 200 LOE @ $100/hr. Approx. $1500 ODCs. Total = $ 21,500 per event Assumed only one review to occur in year 5 because virtually all sediment > PRGs will be removed.

CAPITAL COST ESTIMATE
SEDIMENT ALTERNATIVE 4 - REMOVAL WITH DISPOSAL OFF-BASE
OFFTA FEASIBILITY STUDY
NAVSTA NEWPORT
NEWPORT, RHODE ISLAND
CTO 0218

DRAFT

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal Direct Cost
1- PRE-DESIGN INVESTIGATION											
1 1 Sediment/soil borings and analyses	1	ls	$81,415 00	$0 00	$0 00	$0 00	$81,415 00	$0 00	$0 00	$0 00	$81,415 00
2 - MOBILIZATION/DEMOBILIZATION											
2 1 Office trailer (1 each)	3	mo	$400 00	$0 00	$0 00	$0 00	$1,160 33	$0 00	$0 00	$0 00	$1,160 33
2 2 Portable communication equipment sets	4	ea	$400 00	$0 00	$0 00	$0 00	$1,600 00	$0 00	$0 00	$0 00	$1,600 00
2 3 Equipment mob /demob (support equip)	1	ls	$40,000 00	$0 00	$0 00	$0 00	$40,000 00	$0 00	$0.00	$0 00	$40,000 00
2 4 Site utility hook-ups (electric, phone, etc)	1	ls	$3,000 00	$0 00	$0 00	$0 00	$3,000 00	$0 00	$0 00	$0 00	$3,000 00
2 5 Site utilities	3	mo	$4,000 00	$0 00	$0 00	$0 00	$11,603 33	$0 00	$0 00	$0 00	$11,603 33
2 6 Pick-up truck (rental, 3 each)	3	mo	$2,850 00	$450 00	$0 00	$0 00	$8,267 38	$1,305 38	$0 00	$0 00	$9,572 75
2 7 Certification/close-out reports	1	ea	$7,000 00	$2,000 00	$15,000 00	$3,000 00	$7,000 00	$2,000 00	$15,000 00	$3,000 00	$27,000 00
3 - PERSONNEL AND EQUIPMENT DECON. FACILITIES AND SERVICES											
3 1 Personnel decon trailer	3	mo	$1,500 00	$0 00	$200 00	$0 00	$4,351 25	$0 00	$580 17	$0 00	$4,931 42
3 2 PPE rolloff cont	3	mo	$500 00	$0 00	$0 00	$0 00	$1,450 42	$0 00	$0 00	$0 00	$1,450 42
4 - SITE MANAGEMENT STAFFING											
4 1 Site manager	232	hr	$0 00	$0 00	$36 00	$0 00	$0 00	$0 00	$8,354 40	$0 00	$8,354 40
4 2 Site engineer	464	hr	$0 00	$0 00	$32 00	$0 00	$0 00	$0 00	$14,852 27	$0 00	$14,852 27
4 3 Site supervisor/foreman	464	hr	$0 00	$0 00	$30 00	$0 00	$0 00	$0 00	$13,924.00	$0 00	$13,924 00
4 4 Site safety officer	464	hr	$0 00	$0 00	$25 00	$0 00	$0 00	$0.00	$11,603 33	$0 00	$11,603 33
5 - HOME OFFICE PROJECT MANAGEMENT AND SUPPORT											
5 1 Project manager	46	hr	$0 00	$0 00	$45 00	$0 00	$0 00	$0 00	$2,088 60	$0 00	$2,088 60
5 2 Project administrator	87	hr	$0 00	$0 00	$30 00	$0 00	$0 00	$0 00	$2,610 75	$0 00	$2,610 75
5 3 Health and safety director	29	hr	$0 00	$0 00	$35 00	$0 00	$0 00	$0 00	$1,015 29	$0 00	$1,015 29
5 4 Procurement/subcontracting	116	hr	$0 00	$0 00	$30 00	$0 00	$0 00	$0 00	$3,481 00	$0 00	$3,481 00
5 5 Clerical support	116	hr	$0 00	$0 00	$12 50	$0 00	$0 00	$0 00	$1,450 42	$0 00	$1,450 42
6 - DREDGING/WATER TREATMENT											
6 1 Shoreline Debris Removal/disposal at RCRA D Landfill	500	ton	$75 00	$0 00	$0 00	$0 00	$37,500 00	$0 00	$0 00	$0.00	$37,500 00
6 2 Nearshore Debris Removal/Disposal at RCRA D Landfill	50	ton	$75 00	$0 00	$0 00	$0 00	$3,750 00	$0 00	$0 00	$0 00	$3,750 00
6 3 Erosion control, silt boom	3,000	lf	$0 00	$10 00	$4 00	$4 00	$0 00	$30,000 00	$12,000 00	$12,000.00	$54,000 00
6 4 Mob/Demob (shore based equip)	1	ls	$5,000 00	$0 00	$0 00	$0 00	$5,000 00	$0 00	$0 00	$0 00	$5,000 00
6 5 Staging area preparation, maintenance, and removal	1	ls	$0 00	$1,000 00	$7,000 00	$3,000 00	$0 00	$1,000 00	$7,000 00	$3,000 00	$11,000 00
6 6 Bay haul road construction	1	ls	$144,000 00	$0 00	$0 00	$0 00	$144,000 00	$0 00	$0 00	$0 00	$144,000 00
6 7 Excavation equipment mob /demob	1	ls	$10,000 00	$0 00	$0 00	$0 00	$10,000 00	$0 00	$0 00	$0 00	$10,000 00
6 8 Excavate/haul shoreline sediments	1,935	cy	$7 00	$0 00	$0 00	$0 00	$13,545 00	$0 00	$0 00	$0 00	$13,545.00
6 9 Excavate and haul nearshore sediments	7,735	cy	$7 00	$0 00	$0 00	$0 00	$54,145 00	$0 00	$0.00	$0 00	$54,145 00
6 10 Dredge water treatment	39	day	$4,500 00	$0 00	$0 00	$0.00	$174,037 50	$0 00	$0.00	$0 00	$174,037 50
6 11 Sediment confirmation testing	25	ea	$883 00	$0 00	$0 00	$0 00	$22,075 00	$0 00	$0 00	$0 00	$22,075 00
6 12 Water quality testing	39	day	$3,600 00	$50 00	$200 00	$150 00	$139,230 00	$1,933 75	$7,735 00	$5,801 25	$154,700 00
6 13 Disposal/trans - RCRA D Landfill	8,047	ton	$70 00	$0 00	$0 00	$0 00	$563,314 50	$0 00	$0 00	$0 00	$563,314.50
6.14 Disposal/trans - RCRA D Landfill w/stabilization	805	ton	$90 00	$0 00	$0 00	$0 00	$72,426 15	$0 00	$0 00	$0.00	$72,426 15
6 15 Disposal/trans - RCRA C Landfill	89	ton	$120 00	$0 00	$0 00	$0 00	$10,729 80	$0 00	$0 00	$0 00	$10,729 80

CAPITAL COST ESTIMATE
SEDIMENT ALTERNATIVE 4 - REMOVAL WITH DISPOSAL OFF-BASE
OFFTA FEASIBILITY STUDY
NAVSTA NEWPORT
NEWPORT, RHODE ISLAND
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DRAFT

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal Direct Cost
7 - BACKFILL PLACEMENT											
7 1 Shoreline imported sand/gravel cap installation (2 ft)	1,935	cy	$0 00	$15 00	$4 93	$11 23	$0 00	$29,025 00	$9,539 55	$21,730 05	$60,294 60
7 2 Shoreline screened sand/gravel cap installation (2 ft)	1,548	cy	$0 00	$0 00	$4 93	$11 23	$0 00	$0 00	$7,631 64	$17,384 04	$25,015 68
7 3 Shorline riprap placement	1,512	SY	$65 00	$0 00	$0 00	$0 00	$98,280 00	$0 00	$0 00	$0 00	$98,280 00
7 4 Nearshore imported sand/gravel cap installation (2 ft)	6,188	cy	$25 17	$15 00	$1 66	$0 00	$155,751 96	$92,820 00	$10,272 08	$0 00	$258,844 04
7 5 Nearshore screened sand/gravel cap installation (2 ft)	1,547	vy	$25 17	$0 00	$1 66	$0 00	$38,937 99	$0 00	$2,568 02	$0 00	$41,506 01
7 6 Eelgrass beds restoration	10,795	sf	$5 00	$0 00	$0 00	$0 00	$53,975 00	$0 00	$0 00	$0 00	$53,975 00
7 9 Water quality monitoring (3 samples/day)	13	day	$3,600 00	$50 00	$200 00	$150 00	$46,410 00	$644 58	$2,578 33	$1,933 75	$51,566 67
Subtotal							$1,802,956	$158,729	$134,285	$64,849	$2,160,818
Overhead on Labor Cost @ 30%									$40,285		$40,285
G & A on Labor Cost @ 10%									$13,428		$13,428
G & A on Material Cost @ 10%								$15,873			$15,873
G & A on Subcontract Cost @ 10%							$180,296				$180,296
Total Direct Cost							$1,983,251	$174,602	$187,999	$64,849	$2,410,701
Indirects on Total Direct Labor Cost @ 75%									$140,999		$140,999
Profit on Total Direct Cost @ 10%											$241,070
Subtotal											$2,792,770
Health & Safety Monitoring @ 6%											$167,566
Cost adjustment for location @ 7%											$195,494
Total Field Cost											$3,155,830
Contingency on Total Field Cost @ 25%											$788,957
Engineering on Total Field Cost @ 6%											$189,350
TOTAL COST											$4,134,137
References used for cost estimates											**$4,134,000**

1) Means Heavy Construction Cost Data, 2000, R S Means Co , Inc., Kingston, MA
2) Echos Environmental Remediation Unit Cost ,2000, 6th Annual Edition, Delta Technologies Group, Inc , Englewood, CO
3) Echos Environmental Remediation Assemblies Cost , 1998, 4th Annual Edition, Delta Technologies Group, Inc , Englewood, CO
4) Historical data based on competitive bids submitted by subcontractors or actual costs at this or other sites
5) Excavation cost is based on hourly rate of $130 61 for 2CY track loader (E2000-17030217), With 300 CY/ 8hr, rate is approxi $ 3 48/CY
6) Costs for Hauling to staging area are based on $3 49/CY (02320-0200) Cost for excavation and hauling is approx $7/CY

Present Worth Analysis
Sediment Alternative 4 - Dredging and Off-site Disposal
OFFTA Feasibility Study
NAVSTA Newport
Newport, Rhode Island
04/05/01

PRESENT WORTH ANALYSIS

YEAR	PRESENT WORTH FACTOR (i = 7%)	CAPITAL COSTS	O & M COSTS	5-YEAR COSTS	PRESENT WORTH
0	1 000	$4,134,137			$4,134,137
1	0 935		$60,653		$56,685
2	0.873		$60,653		$52,977
3	0.816		$0		$0
4	0.763		$0		$0
5	0.713		$60,653	$21,500	$58,574
6	0.666		$0		$0
7	0 623		$0		$0
8	0.582		$0		$0
9	0.544		$0		$0
10	0.508		$0	$0	$0
11	0.475		$0		$0
12	0.444		$0		$0
13	0.415		$0		$0
14	0.388		$0		$0
15	0.362		$0	$0	$0
16	0.339		$0		$0
17	0 317		$0		$0
18	0.296		$0		$0
19	0.277		$0		$0
20	0.258		$0	$0	$0
21	0 242		$0		$0
22	0.226		$0		$0
23	0.211		$0		$0
24	0.197		$0		$0
25	0.184		$0	$0	$0
26	0.172		$0		$0
27	0.161		$0		$0
28	0.150		$0		$0
29	0.141		$0		$0
30	0.131		$0	$0	$0
		TOTAL PRESENT WORTH =			$4,302,373
					$4,302,000

Discount rate of 7% per OSWER Directive No. 9355.3-20, June 25, 1993