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FINAL FEASIBILITY STUDY REPORT OPERABLE UNIT 9 (OU9) SITE 34 NSY PORTSMOUTH ME
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TETRA TECH

Final
Feasibility Study Report for Operable Unit 9

Portsmouth Naval Shipyard

Kittery, Maine

Naval Facilities Engineering Command
Mid-Atlantic

Contract Number N62470-08-D-1001
Contract Task Order WE26

May 2013

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FINAL
FEASIBILITY STUDY REPORT FOR OPERABLE UNIT 9

PORTSMOUTH NAVAL SHIPYARD
KITTERY, MAINE

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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Section	Revision	Description
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Final Feasibility Study for Operable Unit 9 Signature Page	Revision 0; May 2013	The signature was signed and updated to indicate the document is final as of May 2013.
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Appendix F – Responses to Comments	---	The response to MEDEP comment on the draft final document was included at the end of Appendix F.

I hereby acknowledge that this document, Feasibility Study for Operable Unit 9, Portsmouth Naval Shipyard, Kittery, Maine, was prepared with my consultation and review.

STATE OF MAINE
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May 2013
James R. Forrelli, P.E.
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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

SECTION **PAGE NO.**

APPENDICES

TABLES

NUMBER **PAGE NO.**

FIGURES

NUMBER

ACRONYMS AND ABBREVIATIONS

˚F	Degrees Fahrenheit
ARAR	Applicable or Relevant and Appropriate Requirement
BAP	Benzo(a)pyrene
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cfm	Cubic feet per minute
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CMR	Code of Maine Rules
COC	Chemical of concern
CSF	Cancer slope factor
CSM	Conceptual site model
CTE	Central Tendency Exposure
CTO	Contract Task Order
DoD	Department of Defense
EPC	Exposure point concentration
FFA	Federal Facility Agreement
FS	Feasibility Study
GHG	Greenhouse gas
GRA	General response action
HHRA	Human Health Risk Assessment
HI	Hazard Index
HSWA	Hazardous and Solid Waste Amendment
IAS	Initial Assessment Study
ILCR	Incremental Lifetime Cancer Risk
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
ISCO	In-situ chemical oxidation
LUC	Land use control
MEDEP	Maine Department of Environmental Protection
mg/kg	Milligram per kilogram
MLW	Mean Low Water
MRSA	Maine Revised Statues Annotated
NAD	North American Datum
NAVD88	North American Vertical Datum of 88

NAVFAC	Naval Facilities Engineering Command
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NERP	Navy Environmental Restoration Program
NOx	Nitrous oxides
NPL	National Priorities List
NPW	Net Present Worth
O&M	Operation and maintenance
OSHA	Occupational Safety and Health Association
OU	Operable Unit
PAH	Polycyclic aromatic hydrocarbon
PEF	Particulate emission factor
PM_{10}	Particulate matter
PNS	Portsmouth Naval Shipyard
PPE	Personal protection equipment
ppt	Part per thousand
PRAP	Proposed Remedial Action Plan
PRG	Preliminary remediation goal
psi	Pound per square inch
RAB	Restoration Advisory Board
RAGs	Remedial Action Guidelines
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RfD	Reference dose
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SMP	Site Management Plan
SSI	Site Screening Investigation
SOx	Sulfur oxides
SVE	Soil vapor extraction
SWMU	Solid Waste Management Unit
TBC	To be considered
TEQ	Toxicity equivalency quotient
TSD	Treatment, storage, and disposal

UIC	Underground Injection Control
USC	United States Code
USEPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

INTRODUCTION

This Feasibility Study (FS) Report for Operable Unit (OU) 9 at Portsmouth Naval Shipyard (PNS), Kittery, Maine, was prepared by Tetra Tech for the United States Department of the Navy, Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic under the Comprehensive Long-Term Environmental Action Navy (CLEAN) program, Contract Number N62470-08-D-1001, Contract Task Order (CTO) WE26. This report describes the formulation and evaluation of remedial alternatives to address the potentially unacceptable risks at OU9 to human health based on the results of the Remedial Investigation (RI) Report for OU9 (Tetra Tech, 2012). This FS was prepared to fulfill the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). As required by CERCLA, primary consideration is given to remedial alternatives that provide adequate protection of human health and the environment and attain or exceed the regulatory requirements and guidance that may govern remedial activities. In addition to CERCLA requirements, this FS was also prepared with consideration of other regulatory requirements and guidance, as appropriate.

OU9 consists of Site 34 – Former Oil Gasification Plant, Building 62. Evaluations of remedial alternatives to address potentially unacceptable risks to human health for OU9 are presented in this FS. There are no unacceptable risks to the environment. This FS was conducted to establish Remedial Action Objectives (RAOs), screen remedial technologies, and assemble, evaluate, and compare remedial alternatives that will be used in selecting a remedial action for OU9. A Proposed Remedial Action Plan (PRAP) will be submitted after this FS is finalized and will present the Navy's recommended remedial action for OU9 based on the information provided in this FS.

CONCEPTUAL SITE MODEL

OU9 has been used for industrial purposes since the 1870s, and the current land use is industrial. The site is covered with buildings or pavement in the west and south and covered with grass north and east of Building 62, with some trees and shrubs in the far northeastern portion. Overburden groundwater is not present at OU9. The site use is likely to remain industrial; however, unrestricted residential, recreational, commercial, or industrial use of the site may be possible future scenarios if the Shipyard were to close. Ecological exposure at OU9 is not considered significant because the site is currently and was historically located within an industrial area of PNS, and no ecological habitat was identified at the site. The primary source of contamination at OU9 is ash from past industrial activities at Building 62 (i.e., oil gasification and blacksmithing). The majority of this ash was removed from the site as part of a removal action that occurred in 2007. A few pockets of residual ash remain in subsurface soil from approximately 2 to 8 feet below ground surface (bgs), and ash may be present under Building 62 Annex. No ash was found under Building 62. The residual ash is characterized by elevated levels of carcinogenic polycyclic aromatic hydrocarbons (PAHs). Past site-related pesticide storage and rinsing activities have not resulted in a CERCLA release to soil at the site.

MEDIA OF CONCERN

The media of concern addressed in this FS are subsurface soil outside Building 62 and ash that may be present under Building 62 Annex. For subsurface soil, carcinogenic PAHs are present at concentrations that could result in potentially unacceptable risks to hypothetical future residents. There were no potential unacceptable risks for any other risk scenarios evaluated based upon the 5 percent soil containing ash/burnt material and 95 percent remaining soil weighted exposure point concentration (EPC) risk evaluation which is the most representative risk evaluation conducted in the OU9 RI based on site conditions and therefore used in this FS report. The chemicals of concern (COCs) for OU9 are carcinogenic PAHs including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-CD)pyrene. Ash from past Building 62 activities may be present beneath the Building 62 Annex floor, built after Building 62 industrial activities ended. Ash from past Building 62 activities has carcinogenic PAHs that could result in future potentially unacceptable risks to human receptors if the Building 62 Annex floor was removed exposing ash, if present.

REMEDIAL ACTION OBJECTIVES

RAOs are medium-specific goals for protecting human health and the environment. RAOs are required to specify the COCs, exposure routes and receptors of concern, and an acceptable contaminant level or range of levels for each exposure route. Acceptable contaminant levels are based on site-specific preliminary remediation goals (PRGs) as a starting point, after which a final remediation goal is determined when a remedy is selected. The OU9 COCs are benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-CD)pyrene. For remedial evaluations these carcinogenic PAHs are evaluated in terms of equivalency of toxicity to benzo(a)pyrene (BAP) expressed as a single concentration called the BAP toxicity equivalency quotient (TEQ). The following RAOs were developed for OU9:

- Prevent hypothetical future residential exposure through ingestion of, dust inhalation of, and dermal contact with subsurface soil containing carcinogenic PAH concentrations exceeding residential PRG.

- Prevent potential future exposure to carcinogenic PAHs in ash that may be present under the floor of Building 62 Annex.

A PRG is a chemical-specific goal for a representative site concentration (based on a representative exposure concentration for an exposure unit, not individual sample result concentrations) that, when achieved, will result in site concentrations that do not pose an unacceptable risk for the targeted receptor. A PRG was developed on a receptor-specific basis for protection of human health from exposure to soil contaminants. The developed PRG was used to determine the remediation areas and volumes addressed by alternatives in this FS. Two areas were identified, one is an area of elevated PAH-contaminated subsurface soil (2 to 8 feet bgs) located north of Building 62 and the other is ash that may be present under the Building 62 Annex floor.

DEVELOPMENT OF ALTERNATIVES

The primary objective of this phase of the FS was to develop an appropriate range of remedial alternatives from applicable technology types and process options. The No Action alternative is included, as required under CERCLA, to establish a basis for comparison with other alternatives. In addition to No Action (Alternative 1), three alternatives were developed; Alternative 2 – Land Use Controls (LUCs) for Elevated PAH Area and Building 62 Annex; Alternative 3 – Excavation of Elevated PAH Area and Building 62 Annex LUCs; and Alternative 4 – In-Situ Chemical Oxidation (ISCO) Treatment of Elevated PAH Area and Building 62 Annex LUCs. There are no plans for the Shipyard to remove Building 62 Annex; therefore, an excavation or treatment option for ash under the Annex was not evaluated.

DETAILED AND COMPARATIVE ANALYSIS OF ALTERNATIVES

In the detailed analysis section of this FS, each alternative is evaluated against seven of the nine CERCLA criteria. In selecting a remedy, in accordance with CERCLA, overall protectiveness of human health and the environment and compliance with Applicable or Relevant and Appropriate Requirements (ARARs) are “threshold criteria” that *must* be satisfied for an alternative to be eligible for selection. Reduction of toxicity, mobility, or volume through treatment, short-term effectiveness, long-term effectiveness and permanence, implementability, and cost are “balancing criteria” that are used to weigh trade-offs between alternatives. Two of the nine CERCLA criteria (state and community acceptance), not evaluated as part of this FS, are “modifying criteria.” After a preferred alternative has been identified and submitted for public comment via a PRAP, the modifying criteria are taken into account during preparation of the Record of Decision (ROD). Table ES-1 provides a summary of the comparative analysis for the four alternatives.

TABLE ES-1: SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

ALTERNATIVE	ALTERNATIVE 1 NO ACTION	ALTERNATIVE 2: LUCS FOR ELEVATED PAH AREA AND BUILDING 62 ANNEX	ALTERNATIVE 3: EXCAVATION OF ELEVATED PAH AREA AND BUILDING 62 ANNEX LUCS	ALTERNATIVE 4: ISCO TREATMENT OF ELEVATED PAH AREA AND BUILDING 62 ANNEX LUCS
Estimated Time Frame (months)				
Designing and Constructing the Alternative	N/A	12	12	12 to18
Achieving the Cleanup Objectives	N/A	12	13	13 to19
Criteria Analysis				
Threshold Criteria				
Protects Human Health and the Environment ➢ Will it protect you and plant and animal life on and near the site?	○	●	●	●
Meets federal and state regulations ➢ Does the alternative meet federal and state environmental statutes, regulations and requirements?	N/A	●	●	●
Primary Balancing Criteria				
Provides long-term effectiveness and is permanent ➢ Will the effects of the cleanup last?	○	◉	◉	◉
Reduces mobility, toxicity, and volume of contaminants through treatment ➢ Are the harmful effects of the contaminants, their ability to spread, and the amount of contaminated material present reduced?	○	○	○	●
Provides short-term protection ➢ How soon will the site risks be reduced? ➢ Are there hazards to workers, residents, or the environment that could occur during cleanup?	N/A	●	◉	◉
Can it be implemented ➢ Is the alternative technically feasible? ➢ Are the goods and services necessary to implement the alternative readily available?	N/A	●	◉	◉
Cost ($) ➢ Upfront costs to design and construct the alternative (capital costs) ➢ Operating and maintaining any system associated with the alternative (O&M costs) ➢ Periodic costs associated with the alternative (periodic costs) ➢ Total cost in today's dollars (30-year NPW cost)	$0	$15,000 capital 30-year NPW: $197,000	$423,000 capital 30-year NPW: $605,000	$356,000 capital 30-year NPW: $538,000
Modifying Criteria				
State Agency Acceptance ➢ Does Maine Department of Environmental Protection (MEDEP) agree with the Navy's recommendation?	To be determined after the public comment period on the PRAP.			
Community Acceptance ➢ What objections, suggestions, or modifications does the public offer during the comment period?	To be determined after the public comment period on the PRAP.			
Relative comparison of the nine balancing criteria and each alternative: ● – Good , ◉ – Average, ○ – Poor; N/A – not applicable;				

1.0 INTRODUCTION

1.1 PURPOSE OF REPORT

This Feasibility Study (FS) Report for Operable Unit (OU) 9 at Portsmouth Naval Shipyard (PNS), Kittery, Maine, was prepared by Tetra Tech for the United States Department of the Navy, Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic under the Comprehensive Long-Term Environmental Action Navy (CLEAN) program, Contract Number N62470-08-D-1001, Contract Task Order (CTO) WE26. This report describes the formulation and evaluation of remedial alternatives to address the potentially unacceptable risks at OU9 to human health and the environment based on the results of the Remedial Investigation (RI) Report for OU9 (Tetra Tech, 2012). This FS was prepared to fulfill the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). As required by CERCLA, primary consideration is given to remedial alternatives that provide adequate protection of human health and the environment and alternatives that attain or exceed the regulatory requirements and guidance that may potentially govern remedial activities. In addition to CERCLA requirements, this FS was also prepared with consideration of other regulatory requirements and guidance, as appropriate.

1.2 SCOPE AND OBJECTIVES

Evaluations of remedial alternatives to address potentially unacceptable risks to human health for OU9 are presented in this FS. There are no unacceptable risks to the environment. Current and future potential offshore impacts were addressed by removal action conducted in 2007 at OU9 (Shaw, 2008); therefore, OU9 is no longer a source to the offshore. Offshore impacts from past releases are being addressed under OU4.

This FS was conducted to establish Remedial Action Objectives (RAOs); to screen remedial technologies; and to assemble, evaluate, and compare remedial alternatives that will be used in selecting a remedial action for OU9. A Proposed Remedial Action Plan (PRAP), will be submitted after this FS is finalized and will present the Navy's recommended remedial action for OU9. This FS fulfills the requirements of CERCLA and is consistent with United States Environmental Protection Agency (USEPA) Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA, 1988) and the Navy Environmental Restoration Program (NERP) Manual, Chapter 8, (Navy, 2006).

1.3 REPORT ORGANIZATION

This report has been divided into the following five sections:

- Section 1.0 – Introduction: This section provides a description of the purpose, scope, and objectives of this FS. This section also provides a summary of background information and the OU9 RI Report.

- Section 2.0 – Remedial Action Objectives: This section presents Applicable or Relevant and Appropriate Requirements (ARARs), the medium of concern, RAOs, preliminary remediation goals (PRGs), and areas and volumes of soil to be addressed by the remedial alternatives for OU9.

- Section 3.0 – Identification and Screening of Technologies and Development of Alternatives: This section discusses the general response actions (GRAs) identified to attain the RAOs, the screening of technology types and process options, description and evaluation of technologies, and development of alternatives.

- Section 4.0 – Description and Detailed Analysis of Remedial Alternatives: This section describes the conceptual design of the alternatives and discusses the detailed analysis of alternatives using the seven criteria of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

- Section 5.0 – Comparative Analysis of Alternatives: This section provides a comparison of the alternatives using the detailed analysis information presented in Section 4.0.

Appendix A provides supporting information including a discussion of PRG development and calculations used in the development and evaluation of remedial alternatives. Appendix B provides alternative-specific ARARs tables. Appendix C provides the cost estimates for the alternatives. Appendix D includes area and quantity calculations. Appendix E presents an environmental footprint evaluation of remedial alternatives in this FS. Appendix F provides the responses to regulatory comments on the FS.

1.4 FACILITY AND OU9 BACKGROUND INFORMATION

A brief description of PNS and the history of the facility, as well as a description and history of OU9, are provided in this section.

1.4.1 Facility Description and History

PNS is a military facility with restricted access on an island located in the Piscataqua River, as shown on Figure 1-1. The Piscataqua River is a tidal estuary that forms the southern boundary between Maine and New Hampshire. PNS is located in Kittery, Maine, north of Portsmouth, New Hampshire, at the mouth of the Great Bay Estuary (commonly referred to as Portsmouth Harbor).

PNS is engaged in the conversion, overhaul, and repair of submarines for the Navy. The long history of shipbuilding in Portsmouth Harbor dates back to 1690, when the first warship launched in North America, the Falkland, was built. PNS was established as a government facility in 1800, and it served as a repair and building facility for ships during the Civil War. The first government-built submarine was designed and constructed at PNS during World War I. A large number of submarines have been designed, constructed, and repaired at this facility since 1917. PNS continues to service submarines as its primary military focus.

Prior to CERCLA and Resource Conservation and Recovery Act (RCRA) regulations, years of shipbuilding and submarine repair work at PNS resulted in hazardous substances being released into soil, groundwater, surface water, and sediment on and around Seavey Island. As a result, investigation and remediation activities were performed under the Department of Defense (DoD) Installation Restoration Program (IRP). Paralleling CERCLA, the IRP focuses on the cleanup of contamination from past hazardous waste operations and past hazardous material spills. The IRP is further discussed in the Site Management Plan (SMP) for PNS (Amended Fiscal Year 2012, Navy, 2012).

Investigations of hazardous substance releases at PNS began in 1983 with the Initial Assessment Study (IAS) (Weston, 1983). USEPA became involved with PNS in 1985 when the agency requested information on PNS hazardous wastes and conducted a visual site inspection under the authority of RCRA. Since 1988, Maine Department of Environmental Protection (MEDEP) has also provided oversight of investigation and remediation at PNS. In March 1989, USEPA issued a Corrective Action Permit under the RCRA Hazardous and Solid Waste Amendments (HSWA) of 1984 (USEPA, 1989) that required PNS to investigate 13 Solid Waste Management Units (SWMUs) and take appropriate corrective action. Until the mid-1990s, investigations at PNS were conducted under RCRA authority. Effective May 31, 1994, PNS was included on the National Priorities List (NPL), and subsequent studies have been conducted under the authority of CERCLA, commonly known as Superfund. Consistent with the transition from RCRA to CERCLA, the SWMU terminology was replaced with “site.” Ongoing work meets the intent of the HSWA Permit, but the ongoing studies to develop and evaluate remedial activities are conducted as part of FSs (CERCLA terminology) which combine both RCRA and CERCLA criteria.

The Federal Facility Agreement (FFA) for PNS was signed by USEPA and the Navy in September 1999, became effective February 2000, and supersedes the HSWA Permit. The state of Maine has elected not to be a party to the FFA at this time. However, the state is afforded a participatory role in the site remediation process by virtue of CERCLA. Among other things, the FFA outlines roles and responsibilities, establishes deadlines/schedules, outlines work to be performed, and provides a dispute resolution process for primary documents. The FFA for PNS ensures that CERCLA decisions will be consistent with RCRA and other federal and state hazardous waste statutes and regulations as appropriate for the sites at PNS. USEPA, MEDEP, and the Navy continue to work toward site cleanup at PNS under CERCLA.

1.4.2 OU9 Description

OU9 is located in the northwestern portion of PNS, as shown on Figure 1-1. OU9 consists of Site 34 – Former Oil Gasification Plant, which is located east of a bridge from the mainland to PNS. The general layout of OU9 is shown on Figure 1-2. Building 62, the former oil gasification plant, and Building 62 Annex are included in OU9. The offshore area is included in OU4.

OU9 is an industrial area. Building 62 and Building 62 Annex are used for storage of non-hazardous materials. The majority of OU9 is relatively flat, with a gentle slope from the south of the site toward the north of Building 62 and a steep slope to the water's edge at the shoreline of the Piscataqua River Back Channel. The buildings around the perimeter of the site include a Shipyard work shop to the west (Building 60), temporary storage spaces for non-hazardous materials to the south and southeast (Buildings 40 and 43), and a parking garage to the east (Building 376). Former Building 63 was located east of Building 62. As shown on Figure 1-2, areas west and south of Building 62 are paved, and areas north and east of Building 62 are covered with grass or other vegetation and are considered open-green areas. Riprap covers the slope north of Building 62.

1.4.3 OU9 History

OU9 is the location of a former oil gasification plant. Building 62 (built in the late 1800s) and Building 62 Annex (built in the 1940s) are the most prominent features related to the use of OU9. Site history is detailed in the RI Report for OU9 (Tetra Tech, 2012) and is summarized as follows:

- 1870s to early 1900s: Coal was used to provide heat for gasification operations that converted kerosene to illuminating gas. The gasification operations took place in Building 62, and gas was piped to other areas of PNS to be used in lamps.

- 1901 to 1912: The gasification plant in Building 62 was closed, all the machinery was removed, and a concrete floor was reportedly laid in the building.

- 1915 to 1930: The Shipyard Public Works Department used Building 62 as a blacksmith shop, during which time (in 1919) the building was reportedly gutted by a fire.

- 1930 to 1985: The Shipyard Public Works Department used Building 62 for storage activities, including storage of pesticides, insecticides, and/or herbicides. A steam line on the exterior of the building, at the wash pad, was reportedly used for flushing equipment and washing coveralls used during pesticide shop activities. Pesticide storage activities at Building 62 began in the 1960s and ended when a new pesticide control shop was built on the southern side of the Shipyard in 1985.

- 1940s: Building 62 Annex was built and used for temporary storage of non-hazardous materials.
- 1985 to present: The Shipyard Public Works Department continues to use the Building 62 and Building 62 Annex for temporary storage of non-hazardous materials.

Based on these historical site uses, coal combustion was the major source of OU9 contamination. Tar generation during the oil gasification process and pesticide operations in Building 62 were also identified as potential sources of OU9 contamination. A removal action was conducted in 2007 to remove the majority of ash at the site, as discussed further in Section 1.5 (Shaw, 2008).

1.5 SUMMARY OF OU9 ENVIRONMENTAL INVESTIGATIONS AND ACTIONS

The data from previous investigations were used to evaluate site characteristics, the nature and extent of contamination, and site risks. Soil samples collected during the Site Screening Investigation (SSI) and RI field activities are shown on Figure 1-3. A summary of the OU9 RI Report, including nature and extent of contamination, is presented in Section 1.6. Table 1-1 provides brief summaries of the previous investigations at OU9.

TABLE 1-1 PREVIOUS INVESTIGATIONS AND DOCUMENTATION

INVESTIGATION	DATE	ACTIVITIES
Soil and Sediment Sampling	1998	Site 34 was identified as a potential PNS IRP site when ash was observed on the northern side of Building 62 in 1998. One soil sample from the ash, one soil sample near the ash, and two sediment samples in the intertidal offshore area were collected and analyzed.
Limited Ash Excavation	1999	A limited excavation of ash from the former ash pile was conducted, but the excavation was terminated when the volume of ash encountered exceeded the estimated two 55-gallon drums.

TABLE 1-1 PREVIOUS INVESTIGATIONS AND DOCUMENTATION

INVESTIGATION	DATE	ACTIVITIES
SSI	2003	Soil (including ash material) and sediment sampling was conducted. Temporary monitoring wells were installed at several borings; however, groundwater was not present in soil, and the wells were subsequently abandoned. The SSI Report concluded that polycyclic aromatic hydrocarbons (PAHs) and select metals (antimony, lead, and mercury) were the contaminants associated with ash at OU9, and that by removing the ash, the majority of site risks would be addressed. The SSI Report indicated that source contamination had not migrated from ash to underlying soil. Pesticide concentrations at the site did not indicate that pesticide storage and rinsing activities resulted in a CERCLA release to soil at the site and were not detected at concentrations that would cause an unacceptable risk. The SSI Report recommended that a RI be performed after the removal action to address the potential residual risks from site operations. Additional investigation to delineate the extent of ash to support the removal action was also recommended.
Ash Extent Evaluation	2004	The visual presence of ash was used to determine the approximate extent of the ash to support a non-time-critical removal action. Gray to off-white ash was only observed inside the ash pile. Burnt material outside the ash pile was mostly fine- to coarse-grained sands and clinkers. The recommended alternative was removal of the majority of ash from the site.
Removal Action	2007	The removal action included removal of ash on the northern and southern sides of the site and stabilization of a portion of the shoreline. The majority of ash was excavated and backfilled with soil from an off base borrow source. As part of the removal action, ash and soil mixed with ash were removed by excavating from the surface until native material with no ash was observed. Native and non-native materials were identified based on their color. Before backfilling, photographs of the excavation area were taken. Most areas were excavated to 2 to 4 feet below ground surface (bgs); the former ash pile area was excavated to 6 to 7 feet bgs. During the removal action, the concrete foundation of former Building 63 was removed, and a thin layer of ash was found under the foundation, which was excavated as part of the removal action.

TABLE 1-1 PREVIOUS INVESTIGATIONS AND DOCUMENTATION		
INVESTIGATION	**DATE**	**ACTIVITIES**
RI	2009 and 2010	Conducted to define the nature and extent of residual contamination and to support the risk assessment with data collected after the 2007 removal action. Borings were drilled below Building 62, and soil samples were collected from areas where ash was previously excavated and from unexcavated areas of the site. Soil sample locations and depths were selected to provide data for the fill soil and native soil and to support the Human Health Risk Assessment (HHRA). In August 2009 soil samples were collected and the laboratory analyses indicated that fill and underlying soil in the excavated area had chemical concentrations and variability greater than expected; whereas soil in the unexcavated area had chemical concentrations and variability less than expected. Although no tar or ash was found under Building 62, an unexpected pocket of ash and coal was discovered in the subsurface in the excavated area north of Building 62, between the building and the riprap on the ledge to the river. To adequately characterize contaminant distribution and corresponding risks at OU9, additional soil samples were collected in September 2010 and were used with the 2009 data to evaluate the nature and extent of contamination and human health risk in the RI report.

1.6 OU9 RI REPORT SUMMARY

The Navy prepared the OU9 RI Report to assess the nature and extent of contamination and risks associated with the contamination at Site 34. The following provides a summary of site characteristics, nature and extent of contamination, fate and transport of contamination, results of the risk assessment, and conclusions and recommendations as provided in the OU9 RI Report (Tetra Tech, 2012).

Elevations discussed herein and throughout this FS are based on the 2002 PNS Vertical Datum and Control Network. The 2002 PNS Vertical Datum equates 0 feet in the North American Vertical Datum of 1988 (NAVD88) to 96.78 feet (Civil Consultants, 2002). Horizontal locations are based on the North American Datum (NAD) of 1983, Maine State Plane Coordinate System, West Zone.

1.6.1 Site Characteristics

Site characterization information including regional and site-specific information on demography, land use, surface features, climatology, surface water, hydrology, ecology, geology, hydrogeology, and the shoreline revetment is provided in Section 3.0 of the OU9 RI Report. Information on site characteristics was used in the RI to support the evaluation of the nature and extent of contamination, development of the conceptual site model (CSM), and understanding of potential site risks. Figure 1-4 presents the CSM and includes a description of the site, potential receptors, contamination sources, and potential migration routes. The following provides a brief summary of pertinent information reported in the OU9 RI Report.

1.6.1.1 Demography and Land Use

PNS has approximately 80 officers and enlisted personnel and about 4,400 civilian employees (PNS, 2011). Kittery, Maine, is a residential community of 9,500 people, and Portsmouth, New Hampshire, has a population of approximately 21,000 (based on the 2010 Census). Area industries include retail and wholesale trades, textiles, manufacturing, fishing, shipbuilding, power plants, and gas storage facilities. The countryside north and west of Kittery consists of forests and some farmland. Along the coast, south of Portsmouth, are small communities and seasonal dwellings.

A portion of PNS is on the National Register of Historic Places. OU9 is located within the area placed on the Register and is described as an area with moderate historical archaeological resource sensitivity. Based on review of the Cultural Resources Survey for PNS (Louis Berger Group, 2003), Building 62 was determined to be a contributing element to the National Register District; therefore, any work to be performed near or within these buildings that would affect the structures must comply with Section 106 of the National Historic Preservation Act. In consideration of those requirements, during the 2004 Ash Extent Investigation, subsurface soil borings were inspected by an archaeologist for cultural artifacts. No cultural artifacts were found at any of the subsurface boring locations. The inspection concluded that it was unlikely that the removal of ash deposits from the areas around Building 62, Building 62 Annex, or under former Building 63 would affect historic properties, although it was recommended that additional direct-push (mechanical) methods be used to obtain better data on the presence or absence of cultural artifacts, or that archaeological monitoring be conducted if excavation were to occur in the area north of former Building 63, where a grass-covered picnic area currently exists.

OU9 has been used for industrial purposes since the 1870s, and the current land use is industrial. The site is covered with buildings or pavement in the west and south and covered with grass north and east of Building 62, with some trees and shrubs in the far northeastern portion. To the north of Building 62, the shoreline is steeply sloping with riprap covering the upper portion of the slope. A bedrock outcrop forms the shoreline north of former Building 63. Surface water runoff is collected by storm drains that discharge to storm water outfalls along the shoreline.

1.6.1.2 Physical Characteristics

At OU9, elevations are highest to the south of Building 62 and Building 62 Annex along Smoot Street (117 to 120 feet). North of Building 62, the ground begins to slope steeply down toward the Back Channel. OU9 is relatively flat with an average elevation of 118 feet. The lowest elevations are along the shoreline (Figure 1-2).

Climatology indicates precipitation is evenly distributed with 3 to 5 inches falling per month, with snowfall mainly during November to April and rain May to October. Monthly average temperatures range from 20 to 40 degrees Fahrenheit (°F) from November to April and 50 to 70 °F from May to October.

1.6.1.3 Surface Water and Hydrology

Portsmouth Harbor's main channel is approximately 75 feet below Mean Low Water (MLW), and the Back Channel is approximately 20 feet deep at MLW in the vicinity of Seavey Island. The salinity of the surface water exceeds 20 parts per thousand (ppt), and surface water in the area is not suitable for drinking. Commercial, recreational boating, and lobstering activities are conducted in the Back Channel in the general vicinity of OU9. Semi-diurnal tides are in Piscataqua River and Back Channel, and the mean tidal range is 8.1 feet. There are strong currents in the Piscataqua River and Back Channel.

PNS is a well-developed, highly industrialized area with limited natural surface water drainage. PNS is equipped with an extensive stormwater collection system that drains to the Piscataqua River. Direct surface water runoff also enters the Piscataqua River. OU9 is at an average elevation of 118 feet and based on a flood zone map for the PNS area not within a flood zone (FEMA, 1986).

1.6.1.4 Ecology

Before the 2007 removal action at OU9 was mostly paved or covered with buildings. Currently OU9 is covered with grass and provides limited habitat for some ecological receptors. No known endangered, threatened, or protected species are located within the boundaries of PNS, including OU9. No critical habitats for any species are present at PNS (Maine Fisheries and Wildlife, 1989; NFEC, 1993).

1.6.1.5 Geology

The majority of the current topography at OU9 was created by the 2007 soil removal action (Shaw, 2008). Most areas were excavated to 2 to 4 feet bgs and the ash pile was excavated to 6 to 7 feet bgs. Based on depths to refusal during several different investigations, the bedrock surface generally slopes to the north toward the Back Channel. Bedrock depths across the site vary from 1 to 17 feet bgs. Bedrock consists of a dark gray or greenish-gray quartzite. In unexcavated areas of OU9, native material is typically silty sand. In the excavated area, material above the 2007 excavation surface is backfill material consisting of primarily of silty sand with little to no gravel. Material beneath the 2007 excavation surface consists of silty sand, silt/silty clay, and sand and gravel or gravel present in noncontiguous variable zones, indicating that this material is likely a mixture of reworked native material and historical fill. Isolated pockets of ash and burnt material are also present. Figure 1-4, the CSM, presents the current conditions at OU9. Approximately 5 percent of the overburden at OU9 is estimated to contain ash/burnt material.

1.6.1.6 Hydrogeology

Temporary groundwater wells were installed at several boring locations during the SSI. Although some intervals in the borings were noted as moist or wet during drilling, none of the wells produced groundwater. Field personnel visited the temporary wells during mid- and high-tide conditions and determined that each well was dry. The well screens were installed below the elevation of ash and between 101 to 112 feet. For comparison, the mean high and low tide elevations at PNS are approximately 100 and 92 feet, respectively. Therefore, tidal water is not expected to enter the overburden material at this site. Given the lack of groundwater in the wells installed in the overburden and the overburden elevation relative to high tide, it is apparent that groundwater is not present in the overburden materials at the site.

1.6.2 Nature and Extent of Contamination

The discussion of the nature and extent of contamination at OU9 focuses on the distribution of chemical concentrations across OU9 with consideration of site uses, geological conditions, and whether it was in the excavated or unexcavated portion of the site. Surface and subsurface soil at OU9 were investigated. As provided in the RI Report, for a general understanding of the nature and extent of contamination, concentrations were compared to USEPA residential and industrial Regional Screening Levels and to the maximum facility background detected concentration (see Tables 4-1 and 4-2 in the OU9 RI Report).

PAHs, antimony, lead, and mercury were detected in surface and subsurface soil at OU9. Concentrations were generally greater in subsurface soil than in surface soil. Carcinogenic PAHs [i.e., benzo(a)pyrene (BAP) and related compounds] and lead had maximum concentrations exceeding industrial and residential risk-based screening levels and facility background in surface and subsurface soil. Maximum mercury concentrations in subsurface soil exceeded the residential risk-based screening level and facility background. Mercury concentrations in surface soil and antimony concentrations in surface and subsurface soil were less than the risk-based screening levels and facility background.

In surface soil, most of the lead concentrations, all antimony and mercury concentrations were less than residential screening levels and facility background. Many PAH concentrations were greater than residential screening levels but generally similar to industrial screening levels. Surface soil concentrations of antimony, lead, mercury, and PAHs indicated that contamination was sufficiently removed during the 2007 removal action in the excavated area and that the unexcavated area was not adversely impacted by past contaminant releases at OU9.

In subsurface soil, most of the lead and mercury concentrations and all of the antimony concentrations were less than residential screening levels and facility background. Antimony, lead, and mercury concentrations in subsurface soil for both the excavated and unexcavated areas indicate that subsurface soil was not adversely affected from past OU9 releases. PAH contamination is present and is associated with ash/burnt material, which represents a small portion of site soil (approximately 5 percent) based on the evaluation of subsurface conditions. Most of the burnt material was found in the subsurface soil in the excavated area (north of Building 62); very minor amounts of ash/burnt material were found in the unexcavated area. In summary, PAH contamination in subsurface soil at OU9 is associated with small isolated pockets of burnt material/ash, which were found north of Building 62. Ash from past Building 62 activities may be present beneath the Building 62 Annex floor, built after Building 62 industrial activities ended. Ash from past Building 62 activities has elevated carcinogenic PAH concentrations.

1.6.3 Fate and Transport of Contaminants

The site surface is mostly covered with asphalt/pavement or buildings, limiting mobilization of contaminants through surface water runoff or infiltration of precipitation. The majority of contamination was removed from the site in 2007, and remaining contamination is not subject to erosion. No overburden groundwater is present at OU9, and all contamination is within the unsaturated overburden material; therefore, subsurface soil does not contact groundwater. Only a small portion of OU9 is covered with flora, so herbivore exposure to contamination from feeding on the vegetation is not a concern.

The fate and transport of PAHs, antimony, lead, and mercury are controlled at OU9 mainly by the mobility of soil particles. PAHs are generally considered to be fairly immobile but persistent chemicals in the environment that generally do not migrate vertically to a great extent in soil, and site data indicate that is the case at OU9. PAHs are more likely to adhere to soil particles and be removed from the site via surface water runoff and erosional processes, especially when no pavement is present or if erosion controls are not present or functioning properly. Metals do not undergo any of the degradation reactions that most organic chemicals do; therefore, they are considered to be persistent. The major fate mechanisms for metals are adsorption to the soil matrix and bioaccumulation. The major transport mechanism of OU9 contamination is soil erosion and surface water runoff; however, because most of the site contamination was removed, any risk resulting from offsite migration of remaining contamination in the subsurface is expected to be insignificant.

1.6.4 Risk Assessment Summary

As discussed in Section 6.0 of the OU9 RI (Tetra Tech, 2012), analytical data for soil were used in the HHRA for OU9. The receptors and exposure routes evaluated are summarized in Table 1-2.

TABLE 1-2 RECEPTORS AND EXPOSURE ROUTES EVALUATED IN HHRA	
RECEPTOR	**EXPOSURE ROUTE**
Construction Workers (current/future)	Soil Ingestion - (surface and subsurface soil) Soil Dermal Contact (surface and subsurface soil) Inhalation of Air/Dust Particulates and Vapors (surface and subsurface soil)
Occupational Worker* (current/future)	Soil Ingestion (surface and subsurface soil) Soil Dermal Contact (surface and subsurface soil) Inhalation of Air/Dust Particulates and Vapors (surface and subsurface soil)
Recreational Users* (current/future)	Soil Ingestion (surface and subsurface soil) Soil Dermal Contact (surface and subsurface soil) Inhalation of Air/Dust Particulates and Vapors (surface and subsurface soil)
Residents (hypothetical future)	Soil Ingestion (surface and subsurface soil) Soil Dermal Contact (surface and subsurface soil) Inhalation of Air/Dust Particulates and Vapors (surface and subsurface soil)

*Occupational workers and recreational users may be present currently at OU9; however, there is no current exposure to those receptors because there is no exposed soil.

The HHRA evaluated potential risks under current land use conditions and potential future land use conditions for the entire site under three different exposure point concentration (EPC) scenarios. The first set of EPCs calculated were not weighted (most conservative method and included in the report to assist with risk management decisions), the second set were weighted 90 percent for the excavated area and 10 percent for the unexcavated area [per the OU9 RI Sampling and Analysis Plan (SAP) (Tetra Tech, 2009)], and the third set were calculated by weighting site soil containing ash/burnt material at 5 percent and remaining site soil at 95 percent (most representative of site conditions based on the CSM). In the RI, risks were calculated for these three EPC scenarios to assist with risk management decisions; however, risks calculated based on 5 percent ash/burnt material and 95 percent remaining site soil EPCs are the most representative of potential site risks based on site conditions. The 5 percent ash/burnt material and 95 percent remaining site conditions are the basis for the chemicals of concern (COCs) and PRGs, and therefore are the only risks discussed in this FS.

Potentially unacceptable non-carcinogenic health impacts are not anticipated for any of the receptors under any of the risk evaluations conducted because all calculated target organ/system Hazard Index (HI) values were less than or equal to 1.

None of the receptors evaluated in the risk characterization section of the RI under the Reasonable Maximum Exposure (RME) or Central Tendency Exposure (CTE) scenarios exceed the USEPA target cancer risk range of 1×10^{-4}. RME cancer risks for child residents (6×10^{-5}) and lifetime residents (7×10^{-5}) exposed to surface soil exceed the state of Maine risk guideline of 1×10^{-5}. CTE cancer risks do not exceed the state of Maine cancer risk guidelines for any receptor evaluated.

Potential risks to occupational, recreational, and residential receptors exposed to subsurface soil that could be excavated and brought to the surface were evaluated as part of the uncertainty analysis of the HHRA. No non-carcinogenic subsurface soil risks exceeded an individual target organ HI greater than 1; therefore, no non-carcinogenic adverse effects are anticipated. Potential cancer risks would exceed the USEPA target cancer risk range for child and lifetime residents if subsurface soil were brought to the surface. The main risk contributors are carcinogenic PAHs including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

No ash or tar was found under Building 62; therefore, vapor intrusion of contaminants is not a significant exposure pathway for that building. It is not known whether ash is present underneath Building 62 Annex. According to the DoD Vapor Intrusion Handbook (DoD, 2009) and USEPA's 2002 vapor intrusion guidance, the only PAHs considered sufficiently volatile and toxic to pose a vapor intrusion threat are benzo(a)anthracene and naphthalene. Based on concentrations of benzo(a)anthracene and naphthalene found in soil containing ash at OU9, if ash was present in soil underneath Building 62 Annex, it would not pose an unacceptable vapor intrusion risk.

The site is currently and has historically been located within an industrial area of PNS, and no ecological habitat has been identified at the site. Therefore, there are no onshore concerns for ecological risk.

1.6.5 Conclusions and Recommendations of RI

The nature and extent of contamination in soil at OU9 has been sufficiently defined to support this FS. EPCs weighted 5 percent for samples with ash/burnt material and 95 percent for samples without ash/burnt material were considered most representative of the current CSM, and were therefore used to select COCs and evaluate risks. Potentially unacceptable risks were found for hypothetical child and lifetime residents exposed to subsurface soil. The main chemicals contributing to risk are carcinogenic PAHs [i.e., benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene] and are considered the COCs for OU9.

Although the HHRA evaluated risks based on site areas, PRGs should be developed and applied to the appropriate exposure units across OU9 to determine the remediation areas in this FS.

1.7 SUMMARY OF CONCEPTUAL SITE MODEL

The following is a summary of the OU9 conceptual site model (see Figure 1-4) which includes a description of the site, potential receptors, contamination sources, and potential migration routes. The site is covered with buildings or pavement in the west and south and covered with grass north and east of Building 62, with some trees and shrubs in the far northeastern portion. Overburden groundwater is not present at OU9. OU9 has been used for industrial purposes since the 1870s, and the current land use is industrial. Site use is expected to remain as industrial as long as the Shipyard is in operation. However, unrestricted residential, recreational, commercial, or industrial use of the site may be possible future scenarios if the Shipyard were to close.

Based on the SSI data, pesticide concentrations at OU9 were low in relation to risk screening and facility background levels. Therefore, site-related pesticide storage and rinsing activities had not resulted in a CERCLA release to soil at the site. The primary source of contamination at OU9 is ash from past industrial activities (i.e., oil gasification and blacksmithing). In 2007, a removal action was completed which included removal of ash on the northern and southern sides of the site and stabilization of a portion of the shoreline (Shaw, 2008). The majority of ash was excavated and backfilled with soil from an off base borrow source. As part of the removal action, ash and soil mixed with ash were removed by excavating from the surface until native material with no ash was observed. Migration of ash via erosion to the offshore is no longer a concern because of this removal action.

An RI was conducted to define the nature and extent of residual contamination and to support the risk assessment with data collected after the 2007 removal action. Borings were drilled below Building 62, and soil samples were collected from areas where ash was previously excavated and from unexcavated areas of the site. No tar or ash was found under Building 62; however, an unexpected pocket of ash and coal was discovered in the subsurface in the excavated area north of Building 62, between the building and the riprap on the ledge to the river. Potentially unacceptable risks were estimated for hypothetical future child and lifetime residents exposed to COCs in subsurface soil. The carcinogenic PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-CD)pyrene were selected as COCs.

Because ash or tar was not found under Building 62, vapor intrusion of contaminants is not expected to be a significant exposure pathway for that building. During the 2007 removal action, a thin layer of ash was found under the concrete foundation of Building 63. Although it is not known whether ash is present underneath Building 62 Annex, because the Annex was built after ash generation activities at Building 62, ash could be present under the floor of Building 62 Annex. However, concentrations of PAHs found in soil containing ash at OU9 do not pose an unacceptable vapor intrusion risk. Therefore if ash is present underneath Building 62 Annex it would not pose an unacceptable vapor intrusion risk. Ash, if present beneath the Building 62 Annex floor, would pose a future potential unacceptable risk to industrial workers, recreational users, or hypothetical residents if the Building 62 Annex floor was removed exposing ash.

Because the site is currently and historically been located within an industrial area of PNS, and no ecological habitat has been identified at the site, ecological exposure is not considered significant.

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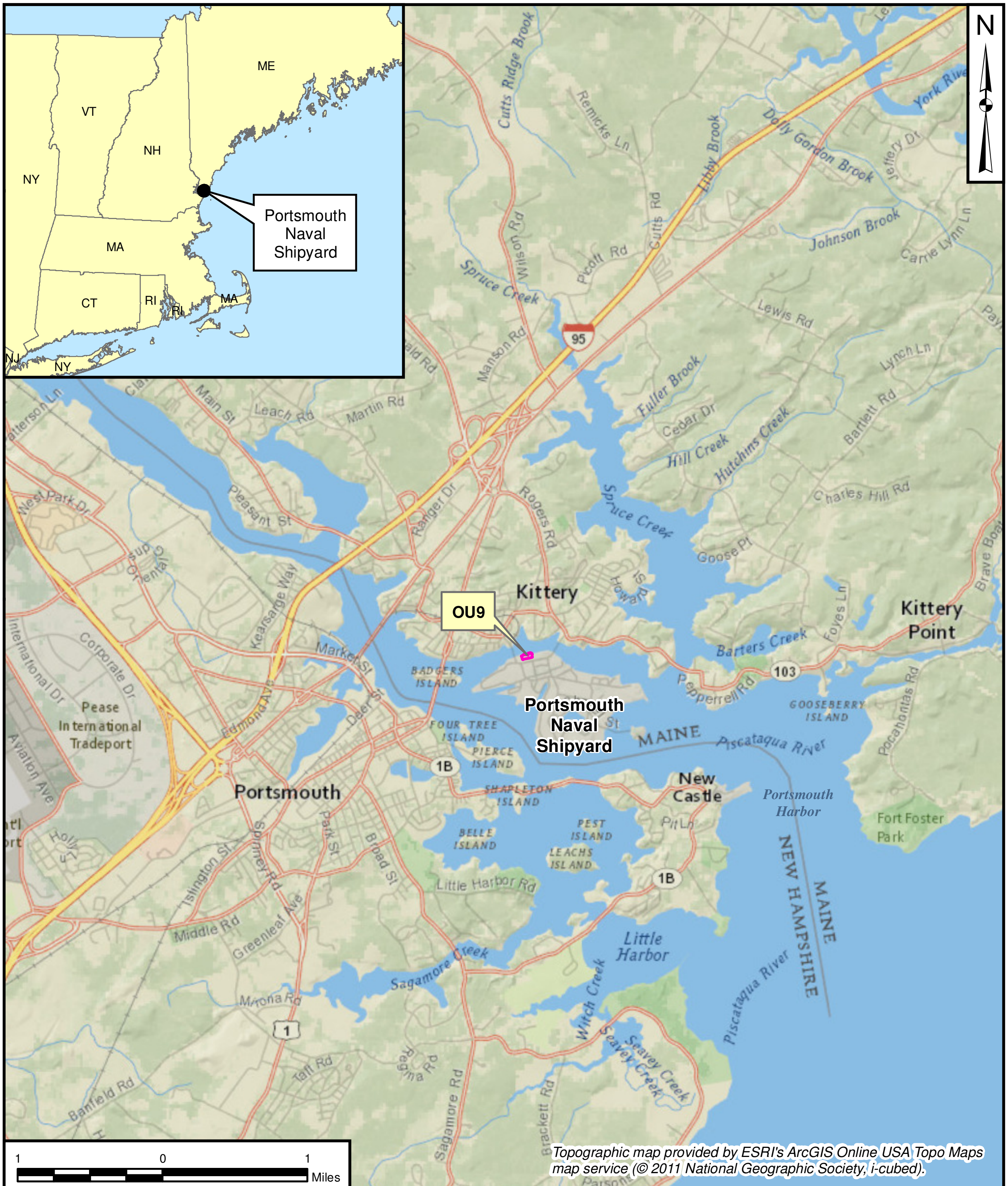
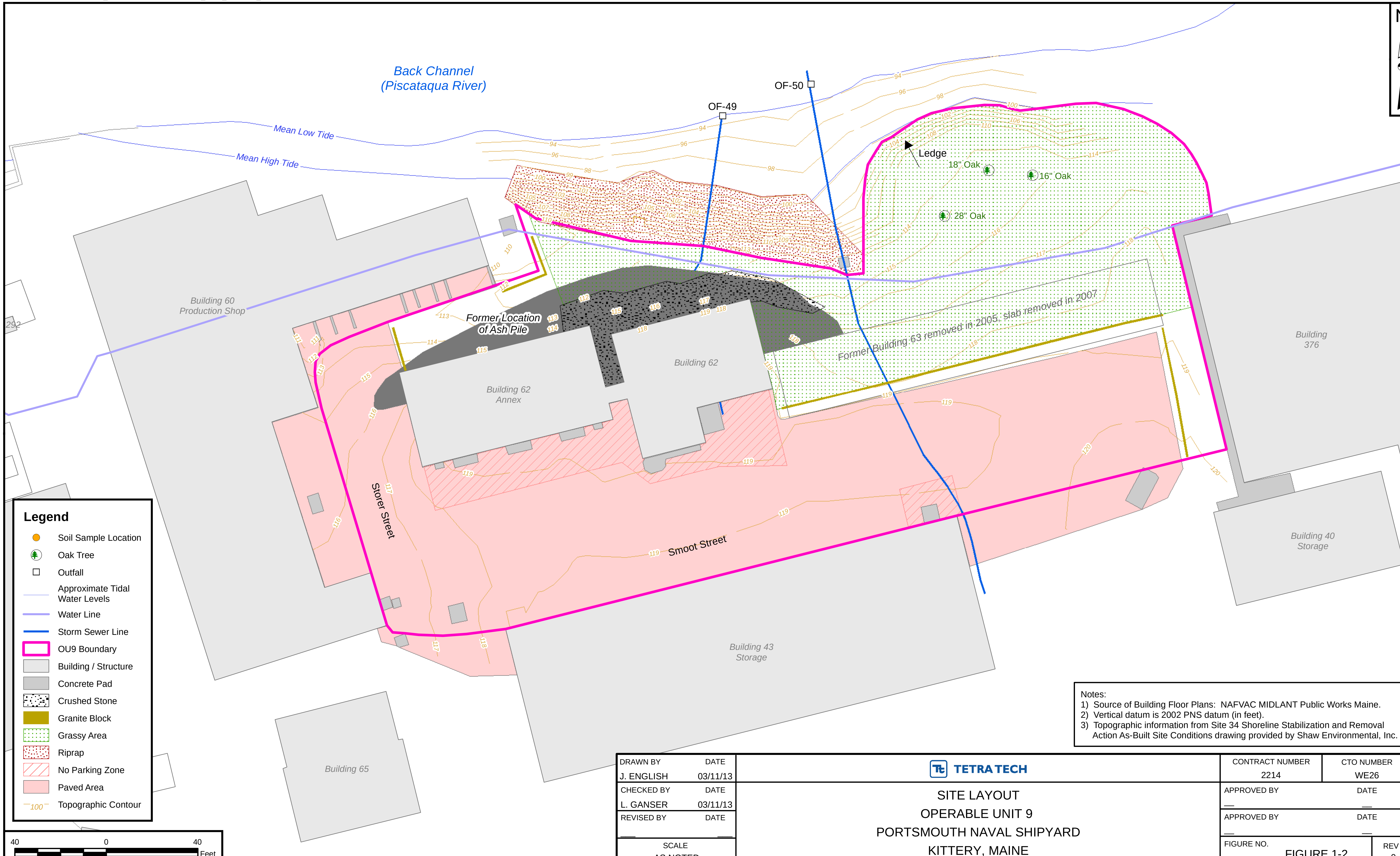


DRAWN BY J. ENGLISH	DATE 06/12/12	TETRA TECH	CONTRACT NUMBER 2214	CTO NUMBER WE26
CHECKED BY F. PADILLA	DATE 10/12/12	VICINITY AND LOCATION MAP OPERABLE UNIT 9 PORTSMOUTH NAVAL SHIPYARD KITTERY, MAINE	APPROVED BY ____	DATE ____
REVISED BY S. PAXTON	DATE 10/12/12		APPROVED BY ____	DATE ____
SCALE AS NOTED			FIGURE NO. FIGURE 1-1	REV 0

PGH P:\GIS\PORTSMOUTH_NSY\MAPDOCS\MXD\OU9_SITE_LAYOUT_2013.MXD 03/11/13 JEE



Notes:
1) Source of Building Floor Plans: NAFVAC MIDLANT Public Works Maine.
2) Vertical datum is 2002 PNS datum (in feet).
3) Topographic information from Site 34 Shoreline Stabilization and Removal Action As-Built Site Conditions drawing provided by Shaw Environmental, Inc.

DRAWN BY	DATE	TETRA TECH	CONTRACT NUMBER	CTO NUMBER
J. ENGLISH	03/11/13		2214	WE26
CHECKED BY	DATE	SITE LAYOUT	APPROVED BY	DATE
L. GANSER	03/11/13	OPERABLE UNIT 9	—	—
REVISED BY	DATE	PORTSMOUTH NAVAL SHIPYARD	APPROVED BY	DATE
—	—	KITTERY, MAINE	—	—
SCALE			FIGURE NO.	REV
AS NOTED			FIGURE 1-2	0

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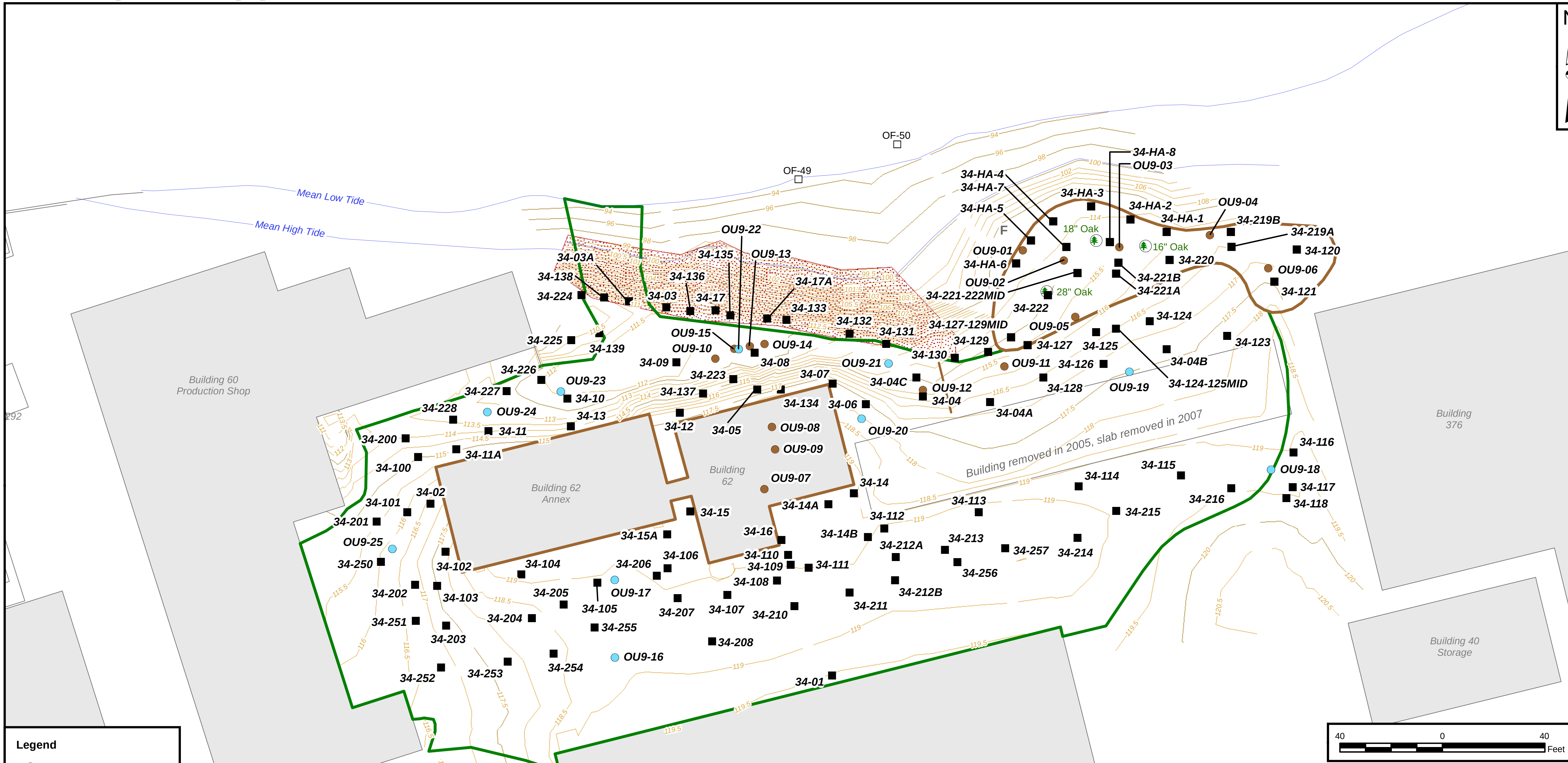
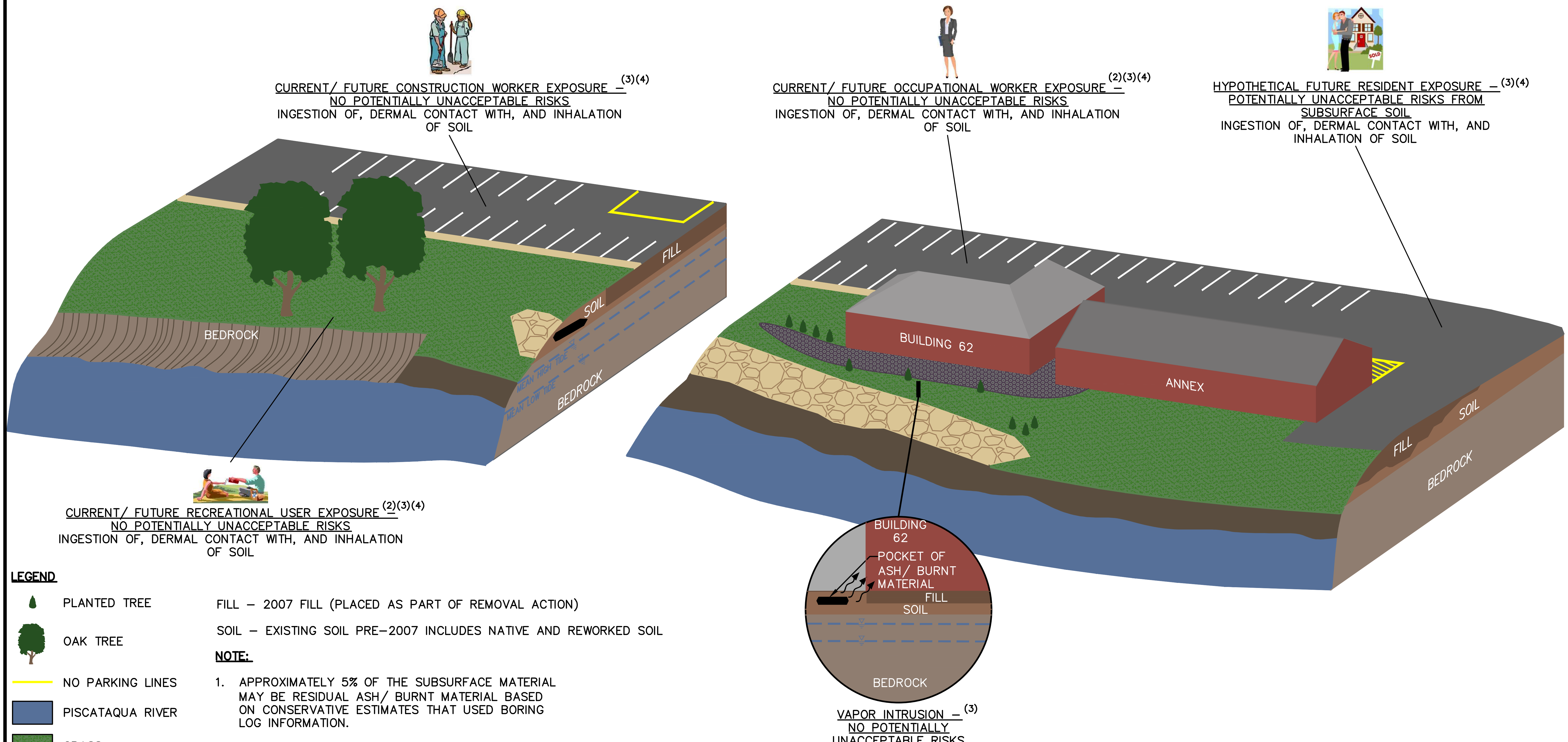


Legend

- 2010 Sample Location
- 2009 Soil Sample Location
- Pre-2007 Sample Location
- Oak Tree
- Outfall
- Approximate Tidal Water Levels
- 2007 Excavation Limit
- Unexcavated Area
- Riprap
- Building / Structure

Notes:
1) Source of Building Floor Plans: NAFVAC MIDLANT Public Works Maine.
2) Vertical datum is 2002 PNS datum (in feet).
3) Topographic information from Site 34 Shoreline Stabilization and Removal Action As-Built Site Conditions drawing provided by Shaw Environmental, Inc.

DRAWN BY J. ENGLISH	DATE 12/13/10	TETRA TECH	CONTRACT NUMBER 2214	CTO NUMBER WE26
CHECKED BY L. GANSER	DATE 03/11/13	SOIL SAMPLE LOCATIONS	APPROVED BY —	DATE —
REVISED BY J. ENGLISH	DATE 03/11/13	OPERABLE UNIT 9 PORTSMOUTH NAVAL SHIPYARD	APPROVED BY —	DATE —
SCALE AS NOTED		KITTERY, MAINE	FIGURE NO. FIGURE 1-3	REV 0



LEGEND

- PLANTED TREE
- OAK TREE
- NO PARKING LINES
- PISCATAQUA RIVER
- GRASS
- PARKING LOT
- RIPRAP
- CRUSHED STONE
- POCKET OF ASH/ BURNT MATERIAL (1)

FILL – 2007 FILL (PLACED AS PART OF REMOVAL ACTION)

SOIL – EXISTING SOIL PRE–2007 INCLUDES NATIVE AND REWORKED SOIL

NOTE:

1. APPROXIMATELY 5% OF THE SUBSURFACE MATERIAL MAY BE RESIDUAL ASH/ BURNT MATERIAL BASED ON CONSERVATIVE ESTIMATES THAT USED BORING LOG INFORMATION.
2. SOIL IS COVERED WITH ASPHALT, GRASS, OR ROCK. SOIL WOULD NEED TO BE EXPOSED FOR OCCUPATIONAL WORKER OR RECREATIONAL USER EXPOSURE.
3. RISKS ARE BASED ON 95/5 EVALUATION AND A 1×10^{-4} ILCR AND HI=1.
4. IF THE FLOOR OF BUILDING 62 ANNEX WAS REMOVED AND ASH IS PRESENT, THERE COULD BE UNACCEPTABLE RISKS FOR RECEPTORS AT OU9.

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PORTSMOUTH NAVAL SHIPYARD
KITTERY, MAINE

CONCEPTUAL SITE MODEL OPERABLE UNIT 9

SCALE: NOT TO SCALE

DATE:	10/11/12
PROJECT NO.:	112G02214
DESIGNED BY:	
DRAWN BY:	NN
CHECKED BY:	
SHEET:	1 OF 1
SIZE: B	FIGURE 1–4

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2.0 REMEDIAL ACTION OBJECTIVES

This section identifies the ARARs, discusses the medium of concern, and develops the RAOs for remedial activities at OU9. ARARs are regulatory requirements and guidance that govern remedial activities. The medium of concern at OU9 is defined along with the volume of the contaminated medium. RAOs are medium-specific goals that define the objectives of conducting remedial actions and are developed to allow consideration of a range of remedial alternatives developed in subsequent sections.

2.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDERED CRITERIA

This subsection discusses the federal and state of Maine ARARs and "to be considered" (TBC) criteria for OU9. The two threshold criteria that remedial alternatives must meet are: (1) protection of human health and the environment and (2) compliance with ARARs. Remedial alternatives must attain or exceed conformance with all ARARs unless a waiver of an ARAR is justified, as described further in this section.

ARARs address a chemical, location, or action at a site and are defined as any standard, requirement, criterion, or limitation under federal environmental law, or any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-siting law that is more stringent than the associated federal standard, requirement, criterion, or limitation, that is either legally applicable to the CERCLA hazardous substance(s) at the site, or is relevant and appropriate under the circumstances of the hazardous substance release.

One of the primary concerns during the development of remedial action alternatives for hazardous waste sites under CERCLA is the degree of human health and environmental protection afforded by a given remedy. Section 121 of CERCLA requires that primary consideration be given to remedial alternatives that attain or exceed ARARs. The purpose of this requirement is to make CERCLA response actions consistent with other pertinent federal and state environmental requirements.

Definitions of the two types of ARARs, as well as TBC criteria, are as follows:

- <u>Applicable Requirements</u> are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site [40 Code of Federal Regulations (CRF) §300.5].

- Relevant and Appropriate Requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, although not "applicable," address problems or situations sufficiently similar (relevant) to those encountered at the CERCLA site that their use is well suited (appropriate) to the particular site.

- TBC Criteria are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing remedial action alternatives and for determining action levels that are protective of human health and/or the environment. Examples of TBC criteria include cancer slope factors (CSFs) and reference doses (RfDs) (40 CFR §.300.5).

Section 121(d)(4) of CERCLA allows the selection of a remedial alternative that will not attain all ARARs if any of six conditions for a waiver of ARARs exists. These six conditions are as follows: (1) the remedial action is an interim measure whereby the final remedy will attain the ARAR upon completion; (2) compliance will result in greater risk to human health and the environment than other options; (3) compliance is technically impracticable; (4) an alternative remedial action will attain the equivalent of the ARAR; (5) for state requirements, the state has not consistently applied the requirement in similar circumstances; or (6) compliance with the ARAR will not provide a balance between protecting public health, welfare, and the environment at the facility with the availability of fund money for response at other facilities (fund-balancing). The last condition only applies to Superfund-financed actions.

ARARs and TBCs fall into three categories. The characterization of these categories is not conclusive because many requirements are combinations of the three types of ARARs and TBCs. These categories are as follows:

- Chemical-Specific: Health- or risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants within the media of concern.

- Location-Specific: Restrictions based on the concentrations of hazardous substances or the conduct of activities in specific locations. These may restrict or preclude certain remedial actions or may apply only to certain portions of a site. Location-specific ARARs and TBCs pertain to special site features, and examples include floodplain and coastal zone requirements.

- Action-Specific: Technology- or activity-based controls or restrictions on activities related to management of hazardous substances. Action-specific ARARs and TBCs pertain to implementing a given remedy. Examples are RCRA requirements for management of hazardous waste that may be generated as part of remedial actions.

Potential chemical-specific, location-specific, and action-specific ARARs and TBCs for OU9 are listed in Tables 2-1, 2-2, and 2-3, respectively.

2.2 MEDIA OF CONCERN

The media of concern that is addressed in this FS is subsurface soil outside Building 62 and ash that may be present under Building 62 Annex. For subsurface soil, carcinogenic PAHs are present at concentrations that could result in potentially unacceptable risks to hypothetical future residents. The COCs for OU9 are carcinogenic PAHs including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-CD)pyrene. Ash from past Building 62 activities may be present beneath the Building 62 Annex floor, built after Building 62 industrial activities ended. Ash from past Building 62 activities contains carcinogenic PAHs that could result in future potentially unacceptable risks to industrial workers, recreational users, or hypothetical residents if the Building 62 Annex floor was removed exposing ash, if present.

2.3 REMEDIAL ACTION OBJECTIVES

RAOs are medium-specific goals for protecting human health and the environment. RAOs are required to specify the contaminants of concern, exposure routes and receptors of concern, and an acceptable contaminant level or range of levels for each exposure route. Acceptable contaminant levels are based on site-specific PRGs as a starting point, after which a final remediation goal is determined when a remedy is selected. For the remedial evaluation for OU9, the COCs, carcinogenic PAHs, are evaluated in terms of equivalency of toxicity to BAP expressed as a single concentration called the BAP toxicity equivalency quotient (TEQ). Based on the potential human health risks for the media of concern, the following RAOs were developed for OU9:

- Prevent hypothetical future residential exposure through ingestion of, dust inhalation of, and dermal contact with subsurface soil containing carcinogenic PAH concentrations exceeding the residential PRG.

- Prevent potential future exposure to carcinogenic PAHs in ash that may be present under the floor of Building 62 Annex.

TABLE 2-1: POTENTIAL CHEMICAL-SPECIFIC ARARS AND TBCS				
MEDIUM/ACTIVITY	**REQUIREMENT/CITATION**	**STATUS**	**SYNOPSIS**	**EVALUATION/ACTION TO BE TAKEN**
FEDERAL				
Soil/Risk Assessment	USEPA Human Health Assessment Group CSFs from Integrated Risk Information System (IRIS)	TBC	CSFs present the most up-to-date information on cancer risk potency for known and suspected carcinogens.	CSFs were used to develop risk-based soil cleanup goals for carcinogenic PAHs.
	Guidelines for Carcinogen Risk Assessment EPA/630/P-03/001F (2005a)	TBC	These guidelines are used to perform HHRA. They provide a framework for assessing possible cancer risks from exposures to pollutants or other agents in the environment.	These guidelines were used to develop risk-based soil cleanup goals for carcinogenic PAHs.
	Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (2005b)	TBC	These guidelines are used to perform HHRA and address a number of issues pertaining to cancer risks associated with early-life exposures in general and provide specific guidance on potency adjustment for carcinogens acting through a mutagenic mode of action.	This guidance was used to develop risk-based soil cleanup goals for carcinogenic PAHs.
STATE				
Soil/Risk Assessment	Maine Remedial Action Guidelines (RAGs) for Soil Contaminated with Hazardous Substances (Section V.H) (MEDEP, 2010)	TBC	The Maine RAGs provide procedures to determine soil cleanup levels unless site-specific risk-based cleanup levels are calculated. Chemical-specific guidelines that may assist in making remedial decisions are also provided. Guidelines are presented for four exposure scenarios.	These guidelines can be used to develop soil cleanup levels. However, per Section V.H, site-specific risk-based cleanup levels were used for OU9 instead of RAGs table values.

TABLE 2-2 POTENTIAL LOCATION-SPECIFIC ARARS AND TBCS				
REQUIREMENT	**REQUIREMENT/CITATION**	**STATUS**	**SYNOPSIS**	**EVALUATION / ACTION TO BE TAKEN**
FEDERAL				
Coastal Zone Management	Coastal Zone Management Act [16 United States Code (USC) 1451 *et seq*]	Applicable	This act provides for the preservation and protection of coastal zone areas. Federal activities that are in or directly affecting the coastal zone must be consistent, to the maximum extent practicable, with a federally approved state management program.	Remedial activities that would impact the adjacent coastal zone would be controlled according to the requirements of the MEDEP program. MEDEP would review remedial action documents to ensure that they meet the substantive requirements of this act.
Other Natural Resources	The Endangered Species Act of 1973 (16 USC 1531 *et seq.*; 50 CFR Parts 17 and 402)	Applicable	Provides for consideration of the impacts on endangered and threatened species and their critical habitats. Requires federal agencies to ensure that any action carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species or adversely affect its critical habitat. The entire state of Maine is considered a habitat of the federally-listed endangered short-nosed sturgeon. The Gulf of Maine population of Atlantic sturgeon are listed as threatened species.	There are no known endangered, threatened, or protected species or critical habitats within the boundaries of PNS. However, short-nosed and Atlantic sturgeons are present in the Piscataqua River. Remedial activities would be conducted so as to avoid any adverse effect under the Act to these sturgeon.
STATE LOCATION-SPECIFIC ARARS AND TBCS				
Natural Resources	Maine Natural Resources Protection Act Permit by Rule Standards [38 Maine Revised Statutes Annotated (MRSA) 480 *et seq.*; 06-096 Code of Maine Rules (CMR) Part 305, 1, 2, and 8]	Applicable	This act regulates activity conducted in, on, or over any protected natural resource or any activity conducted adjacent to and operated in such a way that material or soil may be washed into any freshwater or coastal wetland, great pond, river, stream or brook.	Remedial activities that may disturb soil material near the shoreline of OU9 would be conducted so as to avoid washing any soil into the nearby Piscataqua River. Stormwater management and erosion control practices would be used to prevent excavation soil from entering the river during remedial activities.

TABLE 2-2 POTENTIAL LOCATION-SPECIFIC ARARS AND TBCS

REQUIREMENT	REQUIREMENT/CITATION	STATUS	SYNOPSIS	EVALUATION / ACTION TO BE TAKEN
Coastal Zone	Maine Coastal Management Policies (38 MRSA 1801 *et seq*.) (06-096 CMR chapter 1000)	Applicable	Regulates activities near great ponds, rivers and larger streams, coastal areas, and wetlands. Regulates shoreland activities and development, including (but not limited to) water pollution prevention and control, wildlife habitat protection, and freshwater and coastal wetlands protection. The law is administered at the local government level. Shoreland areas include areas within 250 feet of the normal high-water line of any river or saltwater body and areas within 75 feet of the high-water line of a stream.	Remedial activities, such as excavation and backfilling that may affect storm water runoff, erosion and sedimentation, and surface water quality would be controlled according to these regulations.

TABLE 2-3 POTENTIAL ACTION-SPECIFIC ARARS AND TBCS

REQUIREMENT	CITATION	STATUS	SYNOPSIS	EVALUATION/ACTION TO BE TAKEN
FEDERAL ACTION-SPECIFIC ARARS AND TBCS: NO ARARS OR TBCS				
STATE ACTION-SPECIFIC ARARS AND TBCS				
Hazardous Waste	Identification of Hazardous Wastes 06-096 Part 850	Applicable	These standards establish requirements for determining whether wastes are hazardous based on either characteristic or listing.	Wastes generated during remedial activities would be analyzed to determine whether they are RCRA characteristic hazardous wastes. If determined to be hazardous waste, then the waste would be managed in accordance with regulatory requirements.
	Standards for Generators of Hazardous Waste (38 MRSA 1301 *et seq.*, 06-096 Part 851 (5) and (8))	Applicable	These regulations contain pre-transport and accumulation requirements for the generators of hazardous waste.	Waste determined to be hazardous would be managed on site according to the regulation until disposal offsite.

TABLE 2-3 POTENTIAL ACTION-SPECIFIC ARARS AND TBCS

REQUIREMENT	CITATION	STATUS	SYNOPSIS	EVALUATION/ACTION TO BE TAKEN
Erosion and Sedimentation Control	Erosion and Sedimentation Control (38 MRSA Part 420-C)	Applicable	Erosion control measures must be in place before activities such as filling, displacing, or exposing soil or other earthen materials occur. Prior MEDEP approval is required if the disturbed area is in the direct watershed of a body of water most at risk for erosion or sedimentation.	These controls would be applicable to remedial activities, such as excavation or backfilling, that may disturb soil. Applicable plans would be coordinated with MEDEP before implementation.
Air Emissions	Visible Emissions Regulation (38 MRSA Part 584; 06-096 CMR Part 101)	Applicable	These regulations establish opacity limits for emissions from several categories of air contaminant sources, including general fugitive emissions.	These standards would be met if any of the alternatives result in emission of particulate matter and fugitive matter to the atmosphere (e.g., dust generation).
Underground Injection Wells	Underground Injection Control (UIC) – Class V Wells 06-096 CMR Part 543 (2)(D)(3)	Applicable	These regulations describe the regulatory requirements for subsurface discharges of all fluids. Injection wells for remediation would be classified under (2) (D)(3) – wells used to discharge solutions to remediate in situ. Maine has primacy of the UIC program.	Remedial activities that in include in-situ treatment using injection wells would be conducted in accordance with the substantive requirements for Class IV wells.
Well Abandonment	Guidance for Well and Boring Abandonment, MEDEP, Bureau of Remediation and Waste Management, Division of Technical Services, January 7, 2009	TBC	These guidelines are applicable for the abandonment of borings and monitoring wells.	Abandonment of any injection wells installed as part of remedial activities would be conducted in accordance with these guidelines.

PRGs are chemical-specific goals for representative site concentrations (based on a representative exposure concentration for an exposure unit, not individual sample result concentrations) that, when achieved, will result in site concentrations that do not pose an unacceptable risk for the targeted receptor. A PRG was developed on a receptor-specific basis for protection of human health from exposure to soil contaminants. The developed PRG was used to determine the remediation areas and volumes to be addressed by this FS. The PRGs and associated remediation areas and volumes are discussed in subsequent sections. A discussion of the development of the PRGs can be found in Appendix A. A PRG was developed on a receptor-specific basis for protection of human health from exposure to soil contaminants. The developed PRG was used to determine the remediation areas and volumes addressed by alternatives in this FS. For development of the remediation area and volume for Building 62 Annex, it was assumed that ash is present under the entire area of the building and is a maximum of 2 feet thick (based on observation of ash beneath Building 63 floor).

2.4 PRGS FOR OU9

Site specific risk-based PRGs were developed for the OU9 COCs. The COCs for OU9 are carcinogenic PAHs. A site specific risk-based PRG was developed for carcinogenic PAHs expressed in terms of BAP TEQ. Table 2-4 lists the OU9 residential PRG for carcinogenic PAHs.

TABLE 2-4: PRELIMINARY REMEDIATION GOAL SUMMARY TABLE

RECEPTOR	MEDIA	COC	PRG (MG/KG)	BASIS
Residential	Subsurface soil	Carcinogenic PAHs (based on BAP TEQ)	1.5	Site-Specific risk-based; carcinogen based on ILCR = 1 x10^{-4}.

mg/kg – milligrams per kilogram ILCR – Incremental Lifetime Cancer Risk

(1) PRGs are goals for representative exposure concentrations for an exposure unit and are not intended as pick-up levels. It is possible for a COC to remain on site at concentrations greater than the corresponding EPCs while still being protective of human health and the environment, provided the EPC for that COC is less than the listed PRG.

2.5 REMEDIATION AREAS AND VOLUMES

Remediation areas and volumes were estimated by evaluating areas and volumes of carcinogenic PAH contaminated soil that would need to be remediated for the carcinogenic PAH (based on BAP TEQ) EPC to be less than the PRG. To achieve an EPC less than the PRG for OU9, subsurface soil would need to be remediated to be protective of hypothetical future residents. Based on contaminant distribution, two distinct areas of OU9 would need to be remediated to achieve EPCs less than PRGs (Figure 2-1); soil in the area where PAHs are elevated in subsurface soil north of Building 62, and ash, if present, beneath the floor of Building 62 Annex.

The area where PAHs are elevated is a rectangular area of approximately 175 square feet. Subsurface soil in this area would need to be remediated from 2 to 8 feet bgs; therefore, the volume of soil to be remediated in this area is approximately 1,400 cubic feet, or 52 cubic yards. The figures and calculations supporting the estimation of the areas and volumes are included in Appendix D.

The area of Building 62 Annex is approximately 3,500 square feet. Based on the amount of ash found underneath the foundation of Building 63 when it was removed in 2007, it is estimated that ash may be present underneath Building 62 Annex to a depth of 2 feet bgs. Removing the top 2 feet of ash/soil underneath the floor of Building 62 Annex should remove any ash and/or burnt material under the building, and result in concentrations of PAHs less than or equal to the PRGs. Therefore, for estimating the volume of soil to be removed for the area beneath the Building 62 Annex a depth of 2 feet was assumed which results in an estimated volume of 7,000 cubic feet, or 260 cubic yards of soil.

Remediation through implementation and maintenance of access controls, and requirements for management of excavated soil for the areas of contamination would prevent residential exposure to unacceptable levels of COCs in subsurface soil. This assumes that the controls, protection, and requirements would be effectively maintained in the long term. Remediation through excavation or treatment of contamination could also reduce the COC concentrations at the site to concentrations protective of human health (see Appendix A). Because the Shipyard has no plans to remove Building 62 Annex, active remediation or removal of ash, presumed to be present under the floor of the Annex, was not considered as part of remedial alternatives for OU9. The building and land use controls would prevent unacceptable exposure to contamination under the Annex.

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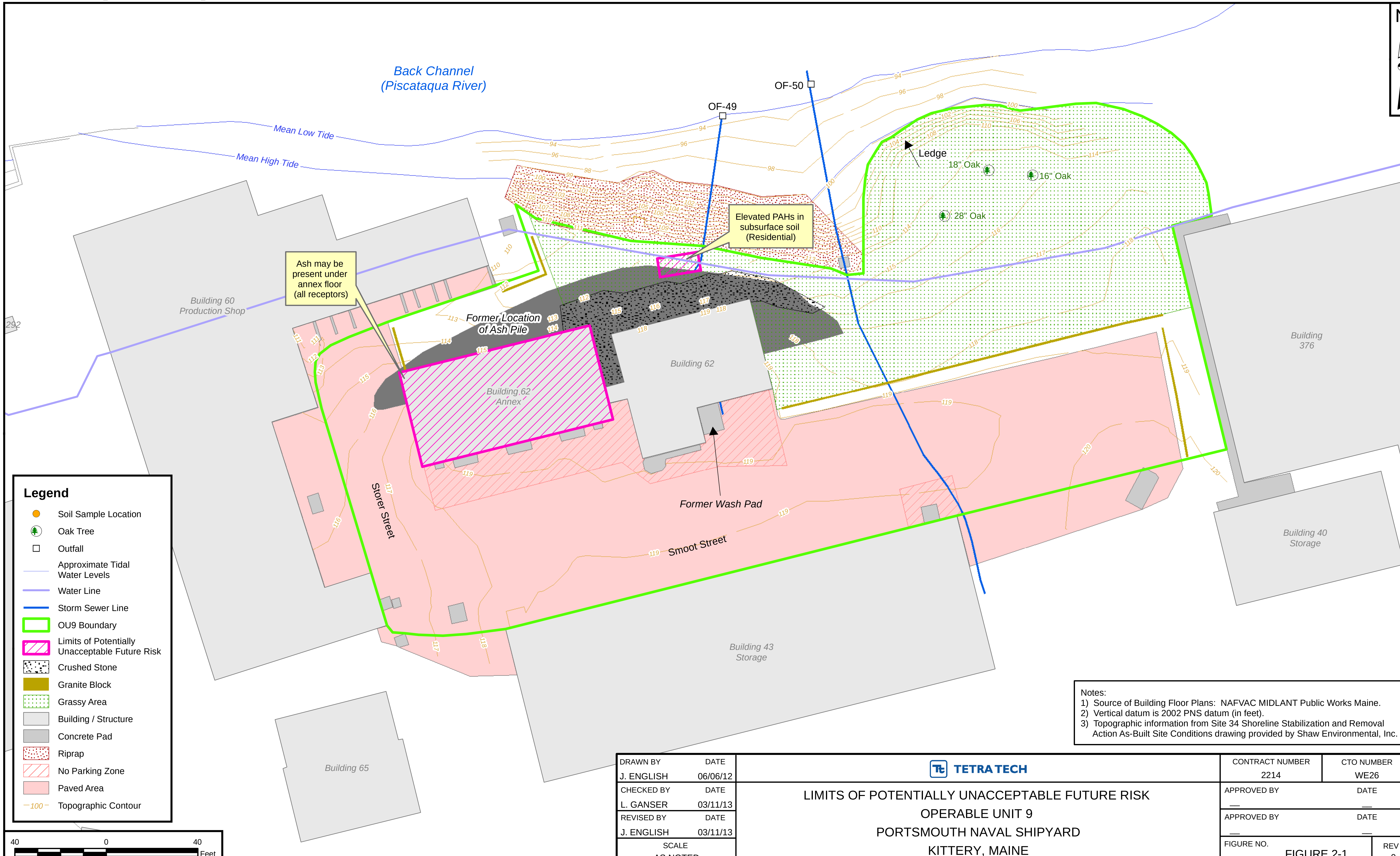

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND DEVELOPMENT OF ALTERNATIVES

This section identifies and screens potential technologies and process options for the assembly of remedial alternatives for OU9. The primary objective of this phase of the FS was to develop an appropriate range of remedial technologies and process options to be used for developing remedial alternatives. Technologies for soil remediation are discussed, and remedial alternatives are assembled in this section. The description of the developed soil remedial alternatives and a detailed analysis of these alternatives are provided in Section 4.0.

Soil remediation technology identification and screening considers the ARARs, COCs, RAOs, PRGs, and areas and volumes of contaminated soil discussed in Section 2.0, and includes identification of GRAs (Section 3.1), preliminary screening of technologies and process options (Section 3.2), and evaluation of representative remedial technologies (Section 3.3). Alternatives are developed using the retained technologies and process options (Section 3.4). The selection of remediation technologies and process options for initial screening is based on USEPA and Navy guidance (USEPA, 1988 and Navy, 2006). The screening is first conducted at a preliminary level to focus on relevant remediation technologies and process options. Then, the screening is conducted at a more detailed level based on three broad evaluation criteria. Finally, process options are selected to represent the remediation technologies that passed the detailed evaluation and screening.

The evaluation criteria for the detailed screening of soil remediation technologies and process options retained after the preliminary screening are effectiveness, implementability, and cost. The following are descriptions of these evaluation criteria:

- Effectiveness
    - Protection of human health and environment; reduction in toxicity, mobility, or volume through treatment; and permanence of solution.
    - Ability of the technology to address the estimated areas and volumes of the contaminated medium.
    - Ability of the technology to meet the RAOs.
    - Technical reliability (innovative versus well proven) with respect to contaminants and site conditions.

- Implementability
  - Overall technical feasibility of the technology at the site.
  - Availability of vendors, mobile units, storage and disposal services, etc.
  - Administrative feasibility.
  - Special long-term considerations (e.g., maintenance and operation requirements).

- Cost (Qualitative)
  - Capital cost.
  - Operation and maintenance (O&M) costs.

3.1 GENERAL RESPONSE ACTIONS

GRAs are the broad frameworks under which remedial technologies are identified to attain RAOs. An assembly of GRAs sets the framework for the development of remedial alternatives for a site. The GRAs for OU9 were assembled with consideration of current and potential future land uses at OU9. The following GRAs were developed for OU9 and are described in the remainder of this subsection:

- No Action
- Limited Action
- Removal
- Treatment
- Disposal

3.1.1 No Action

The no action response is retained throughout the FS process as required by the NCP. The no action response provides a comparative baseline against which other alternatives can be evaluated. Under this response, no remedial action is taken. The contaminated media are left "as is" without the implementation of any monitoring, land use controls (LUCs), containment, removal, treatment, or other mitigating actions.

3.1.2 Limited Action

Limited action includes various LUCs to reduce or eliminate direct contact pathways of exposure. These controls could involve the use of monitoring, land use restrictions, and access controls. The toxicity, mobility, or volume of the contaminants is not reduced through the implementation of LUCs.

3.1.3 Removal

Technologies in this category are used to remove a contaminated medium from its current location for treatment and return to the site after treatment, or for disposal elsewhere without treatment. Removal actions are combined with other GRAs, such as treatment or disposal actions, to develop remedial alternatives.

3.1.4 Treatment

Technologies in this category include in-situ and ex-situ methods to remove a contaminant from or modify or bind a contaminant in an impacted medium and could include physical, chemical, biological, or thermal treatment techniques. The options typically reduce the overall toxicity, mobility, and volume of the impacted medium. Ex-situ treatment processes are combined with other GRAs, such as removal and disposal actions, to develop alternatives.

3.1.5 Disposal

Disposal actions include placement of removed and/or treated materials within a permanent, approved, and permitted disposal facility. Disposal actions are combined with removal actions and could be combined with treatment actions to develop alternatives. Although the location of the contaminant may change, the toxicity, mobility, and volume of the contaminants are not reduced through the implementation of disposal without a treatment process.

3.2 PRELIMINARY SCREENING OF SOIL TECHNOLOGIES AND PROCESS OPTIONS

A variety of technologies and process options were identified under each GRA and screened to focus on relevant technologies and process options based on the conditions, medium of concern, and COCs at OU9. Technologies and process options retained after the preliminary screenings are provided in Table 3-1, and Table 3-2 summarizes the preliminary screening of technologies and process options.

TABLE 3-1: RETAINED OPTIONS FOR SOIL REMEDIATION

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION
No Action	None	Not Applicable
Limited Action	LUCs	Passive Controls: Land Use Restrictions
Removal	Bulk Excavation	Excavation
In-Situ Treatment	Physical/Chemical	Chemical Oxidation
	Biological	Bioventing
Ex-Situ Treatment	Physical/Chemical	Soil Washing
Disposal	Landfill	Off-yard Landfilling

TABLE 3-2: PRELIMINARY SCREENING OF SOIL REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
No Action	None	Not applicable	No activities conducted at the site to address contamination.	**Required by NCP. Retain for baseline comparison to other technologies.**
Limited Action	Land Use Controls	Active Controls: Physical Barriers/ Security Guards	Fencing, markers, warning signs, and monitoring to restrict site access.	Eliminate because contamination is in the subsurface and activity controls are not required to prevent exposure.
		Passive Controls: Deed or Land Use Restrictions	Administrative action using property deeds or other land use prohibitions to restrict future site activities.	**Retain to prevent future residential development and manage excavated soil.**
	Monitoring	Sampling and Analysis	Sampling and analysis of soil, groundwater or other media to evaluate migration of chemical constituents in the environment.	Eliminate because there are no unacceptable risks associated with migration of contamination.
Containment	Surface Protection	Asphalt Cover	Installation of an asphalt cover to prevent direct exposure to contaminated soil and offsite migration of soil through erosion.	Eliminate because it is not required to prevent current or future exposure based on industrial land use and contaminant migration is not a concern.
		Cap	Installation of a multimedia cap to prevent direct exposure to contaminated soil and prevent infiltration of precipitation to unsaturated zone soil.	Eliminate because it is not required to prevent current or future exposure based on industrial land use and contaminant migration is not a concern.
	Vertical Barrier	Sheet Piling	Installation of a vertical barrier with sheet piling to prevent migration of contaminated soil through the revetment	Eliminate because there are no unacceptable risks associated with migration of contamination.
	Vapor Protection	Sealing Building Foundations and Installing Vents	Sealing the foundation of buildings and installation of vents outside of the buildings to mitigate vapor intrusion.	Eliminate because vapor intrusion is not a concern for OU9.
Removal	Bulk Excavation	Excavation	Use of construction equipment such as backhoe, front-end loader, grader, etc. to remove contaminated soil.	**Retain. Excavation would effectively remove contaminated soil from the site.**

TABLE 3-2: PRELIMINARY SCREENING OF SOIL REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS				
GENERAL RESPONSE ACTION	**REMEDIAL TECHNOLOGY**	**PROCESS OPTION**	**DESCRIPTION**	**SCREENING COMMENT**
In-Situ Treatment	Biological	Bioventing	Inoculation of microorganisms and nutrients to enhance naturally occurring biodegradation of COCs.	**Retain. Biodegradation of PAHs in soil via bioventing may be an effective treatment option at this site.**
	Physical/ Chemical	Soil Flushing	Use of water or other solvents to remove COCs by flushing and collecting and treating or disposing of the contaminated fluids.	Eliminate because this process would be very difficult to control in-situ because of the heterogeneous nature of the soil.
		Dynamic Underground Stripping	Injection of steam at the periphery of the contaminated area to volatilize COCs and removal of these COCs through a centrally located extraction well.	Eliminate because of the non- or low-volatility of COCs.
		Soil Vapor Extraction	Use of vacuum and possibly air sparging to volatilize COCs.	Eliminate because PAHs are only partially volatile.
		Chemical Oxidation	Injection of ozone into contaminated soils and subsequent capture of potentially contaminated gases to eliminate COCs via oxidation.	**Retain. Chemical oxidation of PAHs in soil via ozone injection could effectively remove contaminated soil from the site.**
		Chemical Fixation/ Solidification	Mixing of pozzolanic agents in the vadose zone to chemically fix COCs and solidify the matrix. This technology is primarily used to reduce the mobility of contaminants, but it can also be used to prepare a surface barrier for human uptake.	Eliminate because the use of this technology to reduce the mobility of contaminants or to prepare a surface barrier by in-situ application would be difficult to control due to the heterogeneous nature of the soil.
	Thermal	Vitrification/ Radio Frequency Heating	Use of moderate to high temperature to either volatilize COCs or to fuse them into a glass matrix.	Eliminate because COCs are not particularly volatile and in-situ application of this technology would be difficult to control due to the heterogeneous nature of the soil.
Ex-Situ Treatment	Physical/ Chemical	Soil Washing/Solvent Extraction	Use of water or other solvents to remove COCs by solubilizing and/or gravity-based separation of contaminated soil particles.	**Retain. Soil washing is expected to be an effective technology for the elimination of PAHs in soil at OU9.**
		Chemical Fixation/ Solidification	Mixing of pozzolanic agents to chemically fix COCs and solidify the matrix.	Eliminate because onsite areas for construction of a treatment bed are very limited.

TABLE 3-2: PRELIMINARY SCREENING OF SOIL REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENT
	Biological	Onsite Land Farming	Spreading and tilling of contaminated soil into layers of clean surface soil to aerate and biodegrade organic COCs.	Eliminate because onsite areas for construction of a treatment bed are very limited.
		Bioslurry Reactor/Biopile	Treatment of soil in a bioslurry reactor or biopile under controlled conditions using natural or cultured microorganisms to biodegrade organic COCs.	Eliminate because onsite areas for construction of a bioslurry reactor or biopile are very limited.
	Thermal	Incineration	Use of high temperatures to destroy COCs.	Eliminate because this method is only partially effective for PAHs at best.
		Low-Temperature Thermal Desorption	Use of low to moderate temperatures to evaporate COCs and remove them from soil.	Eliminate because PAHs are only partially volatile.
	Solids Processing	Screening	Removal/segregation of material based on size either as a means to remove associated COCs or as a preliminary process to aid in downstream treatment.	Eliminate because the quantity of excavated material is not large enough for application of this technology cost effectively.
	Solids Processing	Crushing/Grinding	Size reduction of wastes as a preliminary process to aid in downstream treatment.	Eliminate because the quantity of excavated material is not large enough for application of this technology cost effectively.
Disposal	Landfill/Recycling	Onsite Landfilling	Disposal of excavated soil and treatment residues in an on-yard landfill.	Eliminate because of lack of space on the yard for landfilling.
		Offsite Landfilling	Disposal of excavated soil and treatment residues in an offsite permitted treatment, storage, and disposal (TSD) facility.	**Retain to dispose of contaminated soils.**
		Recycling	Recycle of recovered material such as metallic lead pieces.	Eliminate because recoverable materials are not expected in excavated materials.

3.3 DESCRIPTION AND EVALUATION OF SOIL REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

The technologies and process options retained after preliminary screening are retained based on an evaluation of three broad evaluation criteria. Screening evaluations generally focus on effectiveness and implementability, with less emphasis on cost. Process options that would be precluded by waste or chemical characteristics and inapplicability to site conditions are screened and eliminated from further consideration. At this stage, no process options are eliminated based on cost. However, a process option within a technology category may not be carried through to the alternative development stage if an equally effective process option is available at a lower cost.

3.3.1 No Action

No Action includes no controls, remediation, or other actions to mitigate risks at the site.

Effectiveness

The No Action alternative would not be effective in meeting the RAOs because there would be no action to prevent potential unacceptable risks from direct human exposure to contaminated material at OU9.

Implementability

There would be no technical implementability concerns because no actions would be implemented.

Cost

There would be no costs associated with no action.

Conclusion

Although the No Action alternative is not effective in meeting RAOs for OU9, it is retained as required under CERCLA and the NCP. The No Action alternative is carried through this FS to provide a baseline for comparison with other alternatives and their effectiveness in mitigating risks posed by site contaminants.

3.3.2 Limited Action

The limited action GRA retained is use restrictions enforced by institutional controls. Passive institutional controls include deed restrictions and LUCs to limit the potential for exposure to impacted media. The type of institutional controls used would depend on the current and likely future use of the site. The Navy would establish LUCs for a remedy, if needed, in a post-Record of Decision (ROD) LUC Remedial Design (RD). The LUC RD would set out the specific actions needed to implement, operate, maintain, and enforce the LUC component of the remedy.

Effectiveness

LUCs are effective in restricting the type of activities that can be performed in the future at identified areas. However, the effectiveness of LUCs is dependent on the system utilized to communicate the locations and restrictions associated with parcels with LUCs. Currently, there is no reason to anticipate the transfer of OU9 land to the public (i.e., OU9 will be owned by the Navy in the near and extended future). Therefore, deed restrictions are not needed for OU9. Institutional controls would require inspections and maintenance to ensure long-term effectiveness.

Implementability

Institutional controls would be readily implementable for OU9. Resources are readily available for the implementation of institutional controls. Long-term inspection and maintenance of the institutional controls would also be readily implementable.

Cost

Both capital and O&M costs associated with the limited action components are low.

Conclusion

Institutional controls are retained for the development of remedial alternatives. LUCs are required for remedial alternatives (except No Action) where contaminated material remains on site.

3.3.3 Removal

The only technology considered under the removal GRA is bulk excavation, which can be performed by a variety of equipment such as tractor shovels (front-end loaders), backhoes, and grade-alls. The type of equipment selected must take into consideration several factors such as the type of material to be removed, load-bearing capacity of the ground surrounding the removal area, depth and areal extent of removal, required rate of removal, and elevation of the groundwater table over the tidal cycle. Excavation is the technology of choice for the removal of well-consolidated material such as soil to depths of up to 30 feet and from well-defined areas of ground with significant load-bearing capacity (i.e., greater than 1,500 pounds per square foot).

The logistics of excavation must take into account the available space for operating equipment, loading and unloading to transport the removed material, location of the site, etc. After excavation is completed, the location is generally filled and graded with clean fill material or treated soil.

Effectiveness

Excavation is a well-proven and effective method of removing contaminated soil from a site. A properly designed excavation would remove contaminated soil such that the site RAOs are met with no restrictions remaining on the site provide potentially contaminated material was excavated from beneath Building 62 Annex. Partial excavation designs could remove the bulk of contamination and reduce the severity and amount of restrictions on a site. Excavation could expose workers to contaminants during the implementation phase, although exposure would be minimized through the use of proper health and safety procedures. Excavation could adversely impact the environment, particularly along the shoreline of the site, if appropriate control measures are not implemented. Combined with appropriate treatment and disposal technologies, excavation would provide greater protection of human health than LUCs because contaminated material would be removed from the site.

Implementability

Depending on the area and volume of soil, excavation at OU9 would be moderately to very difficult to implement because it would have to be carefully managed with respect to existing structures including the main water line (approximately 3 feet bgs) north of Building 62 (see Figure 1-2), and ongoing operations at and near OU9. Excavation equipment and services are readily available from multiple vendors or contractors. This technology is well proven and established in the construction/remediation industry. During excavation, site-specific health and safety procedures and Occupational Safety and Health Association (OSHA) regulations would have to be complied with to ensure that the exposure of workers to COCs is minimized. This would include the wearing of appropriate personal protective equipment (PPE) and the implementation of dust suppression measures.

Under removal/excavation, consideration is given to limited area excavation in the elevated PAH area located north of Building 62, near the water line, as well as excavation of ash, if present, beneath the floor of Building 62 Annex. Excavation under Building 62 Annex would require that the Shipyard to remove this building. Buildings in the surrounding area currently have an occupational use; therefore, dust, debris, and noise produced as a result of excavation would have to be controlled so that occupational workers would not be adversely affected by excavation activities. Appropriate measures would be needed for excavation around above-ground and underground utilities, adjacent to buildings, and along existing shoreline stabilization structures.

Cost

The cost of limited excavation activities at the elevated PAH area would be greater than typical removal actions located on native land because the water main is in the excavation area and cannot be disturbed. The cost of complete excavation in the area beneath the Building 62 Annex would be greater than excavation of native land because the demolition of the Building 62 Annex would also have to be included.

Conclusion

Excavation in the elevated PAH area located north of Building 62 is retained in combination with other processes (e.g., ex-situ treatment or off-yard disposal) for the development of remedial alternatives, but excavation of the ash beneath the Building 62 Annex is not retained for the development of remedial alternatives because the Shipyard currently has no plans to demolish Building 62 Annex.

3.3.4 In-Situ Treatment

Two technologies were considered under the in-situ treatment GRA, chemical oxidation and bioventing. Chemical oxidation using ozone gas would involve the production of ozone onsite and injection of the ozone in closely-spaced delivery points. Bioventing also involves the addition of oxidants to the soil, but it uses low air flow rates to provide only enough oxygen to sustain microbial activity and degradation of the contaminants. Ozone addition is a common technology applied to sites with organic contamination, and bioventing is a newer technology that is also becoming prevalent. Ozone addition is a short to medium-term technology, proceeding fairly quickly due to the oxidizing power of ozone, and bioventing is a medium to long-term technology with cleanup times ranging from a few months to several years.

The logistics of both technologies must take into consideration the depth of contamination and the type of soil when determining the number and spacing of injection points or air sparge wells. Ozone gas in-situ chemical oxidation (ISCO) and bioventing are typically used in conjunction with soil vapor extraction (SVE) to collect and remove volatile contaminants. Both technologies would leave the soil in place and, upon completion, reduce the toxicity of contaminated soil.

Effectiveness

Chemical oxidation by ozone gas injection addition is a well-proven and effective method of removing contamination from soil at a site. Bioventing is a newer technology, but has been successful at sites with the appropriate biological population. Properly designed ozone addition could remove contamination from soil such that the site meets the RAOs and with no restrictions. Properly designed bioventing could also remove contamination from soil such that the site meets the RAOs with no restrictions, but amount of time to achieve the RAOs is variable and the success is dependent on the continued bioactivity at the site.

Ozone addition could expose workers to ozone and contaminated vapors during the implementation phase, and bioventing could also expose workers to contaminated vapors. In both cases, exposure would be minimized through the use of proper health and safety procedures. Ozone addition and bioventing could adversely impact the environment if contaminated vapors were allowed to escape into the air, but appropriate control measures would be implemented to prevent this. Also, there is a risk of explosions when dealing with ozone, but the likelihood of an explosion is extremely low if the systems are designed properly. In-situ soil treatment would provide greater protection of human health in the long-term than LUCs because contaminated material would be treated and removed from the site. Ozone addition is considered slightly more effective than bioventing due to the variability in the time for treatment and possibility of stalling associated with bioventing.

Implementability

Chemical oxidation by ozone addition and bioventing would both be moderately difficult to implement at OU9 due to existing structures (e.g. Building 62 and Building 62 Annex) including the main water line, and ongoing operations (e.g. Shipyard employee parking) at and near OU9. Both technologies would require injection wells, and monitoring equipment, and additional equipment specific to the technology (ozone production facility and circulation equipment for ozone addition and blowers and possibly extraction wells for bioventing). Equipment and services are readily available from multiple vendors or contractors for both of these technologies. Ozone addition is well proven and established in the construction/remediation industry, and bioventing is gaining popularity and has been shown to work well at many sites. During in-situ treatment, site-specific health and safety procedures and OSHA regulations would have to be complied with to ensure that the exposure of workers to COCs is minimized. This would include the wearing of appropriate PPE. Explosion protection measures would also be taken in the case of ozone addition. Neither of these technologies are expected to cause damage to the water main line north of Building 62.

Cost

The cost of in-situ treatment activities at the elevated PAH area north of Building 62 would be relatively high. Both in-situ treatment technologies required installing injection wells, monitoring, and energy to apply ozone or air and remove vapors. Ozone addition would also require the cost of producing the ozone to be applied. Bioventing can be a more cost-effective method for larger sites, but the area to be treated at OU9 is very small, and the duration of time required to treat contamination with bioventing would also contribute to a greater cost.

Conclusion

Ozone addition in the elevated PAH area north of Building 62 is retained in combination with other processes (e.g., LUCs for Building 62 Annex) for the development of remedial alternatives. In-situ remediation underneath Building 62 Annex may be effective and implementable; however, this option was eliminated due to cost. Bioventing is not retained as a viable process for treating the soil contamination north of Building 62 or underneath of Building 62 Annex due to the duration of time required for treatment.

3.3.5 Ex-Situ Treatment

The only technology considered under the ex-situ treatment GRA is soil washing, which is used to remove contamination from soils by separation processes. The type of equipment and chemicals used to separate the COCs from the soil are dependent on both the type of soil and the type of contaminants. Soil is excavated and then sifted to remove any rocks or debris. The sifted soil is then added to the scrubbing vessel, along with water and any chemical agents selected to aid in the separation process, and the mixture passes through mixing blades, additional water, and other mechanical processes. The smaller soil particles and process water contain the majority of the contamination at the end of the process, at which time the water is removed and sent to a treatment plant. The silt and clay particles are tested for the COCs to determine the remaining concentration, and these fine particles can be treated again if necessary. The larger soil particles (sand, gravel) are also analyzed for chemicals. The large- and small-particle size soil can be returned to the site if the contaminant concentrations are acceptable for the intended site use.

The logistics of soil washing must take into account the available space for operating equipment, loading and unloading to transport the removed material, location of the site, etc., as soil washing activities are typically conducted on site.

Effectiveness

Soil washing is an effective method of removing PAH contamination from soil. The effectiveness is limited by the complexity of the contamination, the humic content of the soil, and the amount of organic contamination adhered to clay-sized particles. Based on the type of soil and contamination at OU9, soil washing is expected to be an effective technology for the area of elevated PAH contamination. Soil washing may not be effective for potentially contaminated material underneath of Building 62 Annex because the composition of that material is unknown (i.e., the material may be ash not soil). Soil washing could expose workers to contaminants during the implementation phase, although exposure would be minimized through the use of proper health and safety procedures. Excavation could adversely impact the environment, particularly due to the possibility of air releases during soil scrubbing or leaks of contaminated process water. However, if controls are implemented, the risk of adverse environmental impacts is not significant. Soil washing would provide greater protection of human health than LUCs alone because contamination would be treated and removed from the site.

Implementability

Soil washing at OU9 would be moderately to very difficult to implement. Excavation would be required prior to soil washing, and the challenges discussed for the excavation technology, above, would need to be managed. Additionally, there is limited space at OU9 and the area is an active parking lot so it unlikely there would be enough area available to perform soil washing on-site. Soil washing equipment and services are available, but the number of vendors and contractors that do soil washing in the United States is more limited than for many other treatment technologies. This technology is well proven, but is still relatively new in the construction/remediation industry. During each step of the soil washing process, site-specific health and safety procedures and OSHA regulations would have to be complied with to ensure that the exposure of workers to COCs is minimized. This would include the wearing of appropriate PPE and the implementation of dust suppression measures and air emissions testing.

Cost

The cost of soil washing after excavation activities at the elevated PAH area would be high compared to excavation and disposal of the soil, because additional equipment and chemicals would be required on site including soil homogenizing and screening equipment, the soil washing vessel, and wastewater treatment equipment, along with chemicals needed to treat the wastewater and to extract the contaminants from the soil. This process would also require additional energy, and is more cost-effective with larger volumes of soil.

Conclusion

Ex-situ treatment of soil via soil washing is not retained as a viable technology for the development of remedial alternatives. The cost of the process is too great compared to the benefits of using the treated soil to backfill after excavation, rather than clean fill, and there is likely not enough area on-site for all of the equipment and soil washing activities that would need to take place especially considering the current land use.

3.3.6 Disposal

The only technology considered under this GRA is off-yard landfilling. Off-yard landfilling consists of transporting excavated soil for burial in a permitted off-yard treatment, storage, and disposal (TSD) facility. RCRA non-hazardous waste may be disposed in an RCRA Subtitle D, or solid waste landfill. RCRA-hazardous waste must be disposed in an RCRA Subtitle C, or hazardous waste landfill. All soil disposed off-yard would be characterized for proper disposal. It is anticipated that the material excavated from OU9 would include RCRA non-hazardous and RCRA hazardous materials.

Effectiveness

Off-yard landfilling does not permanently or irreversibly reduce contaminant concentrations. Although the CERCLA preference for treatment relegates direct landfilling to a less preferable option, off-yard landfilling would be an effective disposal option for contaminated soil at OU9. Off-yard landfills are only permitted to operate if they meet certain requirements of design and operation governing foundation, liner, leak detection, leachate collection and treatment, daily cover, post-closure inspections, and monitoring, etc., which ensure the effectiveness of these facilities. The requirements of a RCRA Subtitle C hazardous waste landfill are typically significantly more stringent than those of a RCRA Subtitle D solid waste landfill.

Implementability

Off-yard landfilling with or without treatment would be easily implementable. Permitted RCRA Subtitle C TSD facilities and Subtitle D landfill facilities are available for this purpose.

Cost

The cost of off-yard landfilling would be low to moderate for disposal at a RCRA Subtitle D solid waste landfill and higher for treatment/disposal at a RCRA Subtitle C hazardous waste landfill. However, the volume of soil to be disposed of at an off-yard landfill is relatively small, and therefore, the cost would still be moderate for disposal.

Conclusion

Off-yard landfilling is retained in combination with other process options for the development of remedial alternatives.

3.4 DEVELOPMENT OF SOIL REMEDIATION ALTERNATIVES

The following technologies/process options were retained to develop soil remedial alternatives:

- No Action
- Institutional Controls

- ISCO Treatment
- Excavation
- Off-yard Landfilling

The retained technologies/process options were used to develop four soil remedial alternatives for OU9. Detailed descriptions and evaluations of the alternatives are provided in Section 4.0. The alternatives being considered are discussed below.

- Alternative 1 – No Action
- Alternative 2 – LUCs for Elevated PAH Area and Building 62 Annex
- Alternative 3 – Excavation of Elevated PAH Area and Building 62 Annex LUCs
- Alternative 4 – ISCO Treatment of Elevated PAH Area and Building 62 Annex LUCs

There are no plans for the Shipyard to remove Building 62 Annex; therefore, an excavation or treatment option for ash under the Annex was not included in any alternatives.

4.0 DESCRIPTION AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

This section presents descriptions of the remedial alternatives developed for OU9 and evaluations of each remedial alternative with respect to the criteria of the NCP of 40 CFR 300, as revised in 1990. The criteria and relative importance of these criteria in the CERCLA process are discussed in Section 4.1, and the description and detailed analyses of alternatives are provided in Section 4.2.

4.1 NCP EVALUATION CRITERIA AND RELATIVE IMPORTANCE OF CRITERIA

The evaluation criteria as required by the NCP and the relative importance of these criteria in the CERCLA process are described in the following subsections.

4.1.1 Evaluation Criteria

In accordance with the NCP (40 CFR 300.430), the following nine criteria are used for the evaluation of remedial alternatives:

- 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

Overall Protection of Human Health and the Environment

Remedial alternatives must be assessed for adequate protection of human health and environment in both the short and long term. The remedial alternatives must be able to protect from unacceptable risks posed by hazardous substances or contaminants present at the site by eliminating, reducing, or controlling exposure to levels exceeding remediation goals. Overall protection of human health and the environment draws on the assessment of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

Compliance with ARARs

Remedial alternatives must be assessed to determine whether they attain ARARs under federal environmental laws and state environmental or facility siting laws. If one or more regulations that are applicable cannot be complied with, a waiver must be invoked.

Long-Term Effectiveness and Permanence

Remedial alternatives must be assessed for the long-term effectiveness and permanence they offer, along with the degree of certainty that the alternative would prove successful. Factors that are considered as appropriate include the following:

- <u>Magnitude of Residual Risk</u> - Risk posed by untreated waste or treatment residuals at the conclusion of remedial activities. The characteristics of residuals are considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.

- <u>Adequacy and reliability of controls</u> - Controls, such as containment systems and LUCs, necessary to manage treatment residuals and untreated waste must be shown to be reliable. In particular, this evaluation considers the uncertainties associated with land disposal for providing long-term protection from residual contamination, assessment of the potential need to replace technical components of the alternative (such as a surface cover, sign, or treatment system), and the potential exposure pathways and risks posed if technical components or the entire remedial action needs to be replaced.

Reduction of Toxicity, Mobility, or Volume through Treatment

The degree to which the remedial alternative employs recycling or treatment that reduces the toxicity, mobility, or volume is assessed. This assessment includes how treatment is used to address threats posed by the site. Factors to be considered as appropriate include the following:

- Treatment or recycling processes that the remedial alternative employs and the materials that they would treat.

- Amount of hazardous substances, pollutants, or contaminants that would be destroyed, treated, or recycled.

- Degree of expected reduction in toxicity, mobility, or volume of waste due to treatment or recycling and the specification of which reduction(s) is occurring.

- Degree to which the treatment is irreversible.

- Type and quantity of residual contamination that would remain following treatment considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents.

- Degree to which treatment reduces the inherent hazards posed by principal threats at the site.

Short-Term Effectiveness

The short-term impacts of the remedial alternative are assessed considering the following:

- Short-term risks that might be posed to the community during implementation.

- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures taken to minimize these impacts.

- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation.

- Time until protection is achieved.

Implementability

The ease or difficulty of implementing the alternative is assessed considering the following types of factors, as appropriate:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, reliability of the technology, ease of undertaking additional remedial actions, and ability to monitor the effectiveness of the remedy.

- Administrative feasibility, including activities needed to coordinate with other offices and agencies and the time required obtaining approvals and permits (if needed) from other agencies.

- Availability of services and materials, including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; availability of necessary equipment, specialists, and additional resources; availability of services and materials; and availability of prospective technologies.

Cost

Costs for remedial alternatives include both capital costs and annual O&M costs. Capital costs include both direct and indirect costs expected at the time of alternative implementation. Annual O&M costs include periodic costs that occur following alternative implementation. Typical O&M costs include periodic long-term monitoring and inspections. A net present worth (NPW) of the capital and O&M costs is also provided. The NPW of a remedial alternative is the total of all capital and O&M costs expressed in today's dollars. Typically, the cost estimate accuracy range during the FS stage is plus 50 percent to minus 30 percent of the actual remedial action cost.

State Acceptance

This criterion reflects the statutory requirements to provide for substantial and meaningful regulatory involvement. Formal assessment of regulatory acceptance is completed during the ROD phase, occurring after the PRAP public comment period. In addition, regulatory concerns are continually considered through resolution of regulatory comments received on the FS Report and PRAP.

Community Acceptance

This criterion refers to the community's comments on the remedial alternatives under consideration, where "community" is broadly defined to include all interested parties. These comments are considered throughout the CERCLA process. The community acceptance criterion is evaluated as part of the responsiveness summary presented in the ROD after the public comment period on the PRAP is held. However, community input is obtained through presentation of draft documents including the draft FS and PRAP reports at the Restoration Advisory Board (RAB) meetings.

4.1.2 Relative Importance of Criteria

Among the nine criteria, the threshold criteria are considered to be:

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

The threshold criteria must be satisfied for an alternative to be eligible for selection.

Among the remaining criteria, the following five criteria are considered to be the primary balancing criteria:

- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost

The balancing criteria are used to weigh the relative merits of alternatives.

The remaining two criteria, State Acceptance and Community Acceptance, are considered to be modifying criteria that must be considered during remedy selection. These last two criteria are evaluated after the end of the public comment period on the PRAP. Therefore, this FS addresses seven of the nine criteria.

4.2 DESCRIPTION AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

As noted in Section 3.4, the following remedial alternatives have been developed for soil and ash at OU9:

- Alternative 1 – No Action
- Alternative 2 – LUCs for Elevated PAH Area and Building 62 Annex
- Alternative 3 – Excavation of Elevated PAH Area and Building 62 Annex LUCs
- Alternative 4 – ISCO Treatment of Elevated PAH Area and Building 62 Annex LUCs

A description and detailed analysis of these alternatives are provided in the following sections.

4.2.1 Alternative 1: No Action

4.2.1.1 Description

This alternative is required under CERCLA to establish a basis for comparison with other alternatives. No Action includes no controls, remediation, or other actions to mitigate risks. Five-year reviews are also not included under the No Action alternative.

4.2.1.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 1 would not be protective of human health and would not meet the RAOs for OU9 because no action would be conducted to ensure that exposure to site contamination does not occur.

Compliance with ARARs

Alternative-specific ARARs for Alternative 1 are provided in Table B-1 in Appendix B. As shown in Table B-1, there are no chemical-specific, location-specific, or action-specific ARARs for this alternative.

Long-Term Effectiveness and Permanence

Alternative 1 would not provide long-term effectiveness and permanence. No action would provide no reduction of risks or reliable controls to protect against unacceptable exposure to contamination in the long term.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 would not reduce toxicity, mobility, or volume through treatment because no treatment would occur. There are no principal treatments or processes associated with this No Action alternative. Reduction of contaminant toxicity, mobility, and volume may occur over the long term through natural processes, but with the contaminants on site, this would be expected to be a lengthy process.

Short-Term Effectiveness

Because no action would occur, implementation of Alternative 1 would not pose a short-term risk to on-site workers or result in adverse impacts to the surrounding community or environment. Alternative 1 would not attain RAOs because no action would be conducted.

Implementability

Alternative 1 would be readily implementable because there would be nothing to implement. The technical feasibility criteria including constructability, operability, and reliability are not applicable. The implementability of administrative measures is not applicable because no such measures would be taken.

Cost

There would be no costs associated with Alternative 1 because there are no remedial components.

4.2.2 Alternative 2: LUCs for Elevated PAH Area and Building 62 Annex

4.2.2.1 Description

Alternative 2 consists of instituting LUCs to prevent unacceptable exposure to contaminated subsurface soil in the area north of Building 62 and to ash, if present, beneath Building 62 Annex, as shown on Figure 4-1. The following describes the individual components of Alternative 2:

- LUCs and Inspections – LUCs would prevent residential land use for the PAH-contaminated area north of Building 62 and Building 62 Annex and prevent unrestricted exposure to potential contaminants in the subsurface beneath the floor of Building 62 Annex as long as contamination remains in these two areas. To implement LUCs, the Navy would prepare a LUC RD that would document the LUCs, inspection requirements, and organizations responsible for implementation of LUCs. Requirements for management of excavated soil as part of any future construction activities within the LUC boundary would also be included as part of the LUCs. Because contamination is in the subsurface, fencing for perimeter control, asphalt or ground cover, or other active measures are not necessary to prevent exposure to site contamination. For the purposes of this FS and developing a cost estimate, it was assumed that annual inspections of the site would be conducted to verify continued effectiveness of the LUCs.

- Five-Year Reviews – Because contamination would remain in excess of levels that allow for unlimited use and unrestricted exposure, five-year reviews would be required under this alternative to evaluate the continued adequacy of the remedy.

4.2.2.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 2 would be protective of human health and the environment. Implementation of LUCs under Alternative 2 would provide a formal process to inspect and maintain the controls for the site to ensure the effectiveness of LUCs in preventing unacceptable exposure to contaminants beneath the floor of Building 62 Annex, if present, and prevent residential use of the site. Five-year reviews would be conducted to evaluate the continued adequacy of the remedy.

Compliance with ARARs

Alternative-specific ARARs for Alternative 2 are provided in Table B-2 in Appendix B. The implementation of Alternative 2 would comply with all ARARs for this alternative.

Long-Term Effectiveness and Permanence

Alternative 2 would provide long-term effectiveness and permanence through implementation of LUCs. Although contaminant concentrations would not be actively reduced, risks to human health would be minimized through implementation and maintenance of LUCs. Under Alternative 2, the site would be suitable for continued industrial use, and LUCs would restrict residential use within the LUC boundary. A LUC RD would provide a process to inspect and maintain LUCs for the site to prevent unrestricted exposure of current site users to contamination under Building 62 Annex. Five-year reviews would be conducted to evaluate the continued adequacy of the remedy.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 2 would not reduce toxicity, mobility, or volume through treatment because no treatment would occur. Reduction of contaminant toxicity, mobility, and volume may occur over the long term through natural processes, but with the contaminants on site, this would be expected to be a lengthy process.

Short-Term Effectiveness

Alternative 2 would be effective in the short term. Implementation of LUCs would not pose short-term risk to site workers or result in adverse impacts to the surrounding community or the environment. Alternative 2 could be implemented within 12 months with the completion of a LUC RD, and would attain RAOs upon implementation. A sustainability evaluation of the potential environmental footprint impact for Alternative 2 remedial activities was conducted and the results are provided in Appendix E. The overall environmental impact resulting from Alternative 2 would be low. The relative impact of the greenhouse gas (GHG), nitrous oxide (NOx), sulfur oxide (SOx), and particulate matter (PM_{10}) emissions, and energy consumption compared to more active remedial alternatives (e.g., excavation or treatment) would be low. Alternative 2 does not require any direct water consumption.

Implementability

Alternative 2 would be readily implementable. Administratively, implementation and enforcement of LUCs and five-year reviews would be relatively simple to implement.

Cost

Cost estimates for Alternative 2 are included in Appendix C. The estimated costs (rounded to $1,000) for Alternative 2 are as follows:

- Capital cost: $15,000
- Annual costs: $3,000/year plus $25,000 every 5 years
- 30-year NPW: $197,000

4.2.3 Alternative 3: Excavation of Elevated PAH Area and Building 62 Annex LUCs

4.2.3.1 Description

Alternative 3 consists of excavation and off-yard disposal of contaminated soil in the elevated PAH area north of Building 62 and LUCs for Building 62 Annex. Figure 4-2 shows the excavation and LUCs boundaries under Alternative 3. The following describes the individual components of Alternative 3:

- Excavation and Off-yard Disposal – Soil in the elevated PAH area north of Building 62 would be excavated to the maximum depth of 8 feet bgs where exceedances of the PRG were found. There is a main water line in the excavation area (see Figure 4-2). Necessary precautions would be taken to prevent compromise to its integrity. The excavation would reduce subsurface soil risks to acceptable levels for residential exposure. Confirmation samples would be collected from the floor and sidewalls of the excavation area to confirm that soil with concentrations greater than the PRG has been removed. The actual limits and depths of excavation would be determined by the results of the confirmation samples. Excavated material would be stockpiled, characterized, and properly transported and disposed off-yard.

- Site Restoration – Following excavation, the excavated area would be backfilled to establish pre-construction grades, elevations, and surface types using clean soil and pavement where necessary.

- LUCs and Inspections – LUCs for Building 62 Annex would prevent residential land use and prevent unrestricted exposure to potential contamination in the subsurface beneath the floor of Building 62 Annex as long as contamination may remain in this area. To implement LUCs, the Navy would prepare a LUC RD that would document the LUCs, inspection requirements, and organizations responsible for implementation of LUCs. Requirements for management of excavated soil as part of any future construction activities within the LUC boundary would also be included as part of the LUCs. For the purposes of the FS and developing a cost estimate, it was assumed that annual inspections of the site would be conducted to verify continued effectiveness of the LUCs.

- Five-Year Reviews – Because contamination would remain in excess of levels that allow for unlimited use and unrestricted exposure in the Building 62 Annex area, five-year reviews would be required under this alternative to evaluate the continued adequacy of the remedy.

4.2.3.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 3 would be protective of human health and the environment. Excavation and off-yard disposal of contaminated soil in the area north of Building 62 would eliminate the potential risks for residential exposure outside of Building 62 Annex. Implementation of LUCs for Building 62 Annex would provide a formal process to inspect and maintain LUCs in preventing unacceptable exposure to contaminants beneath the floor of Building 62 Annex, if present, and prevent residential use of the building. Proper controls during excavation and appropriate transportation and disposal of excavated soil and backfilling would minimize any adverse impact from contaminated soil to human health and the environment during construction activities. Five-year reviews would be conducted to evaluate the continued adequacy of the remedy.

Compliance with ARARs

Alternative-specific ARARs for Alternative 3 are provided in Table B-3 in Appendix B. The implementation of Alternative 3 would comply with all ARARs for this alternative.

Long-Term Effectiveness and Permanence

Alternative 3 would provide long-term effectiveness and permanence through removal of contaminated soil in the area north of Building 62 and implementation of LUCs for Building 62 Annex. Excavation and off-yard disposal of the elevated PAH area north of Building 62 would effectively and permanently remove contaminated soil to reduce risks to acceptable levels for residential use outside of Building 62 Annex. LUCs would restrict residential use of Building 62 Annex and restrict access to contamination beneath the floor of Building 62 Annex, if present. A LUC RD would provide a process to inspect and maintain LUCs for Building 62 Annex to prevent unacceptable exposure of current site users to contamination beneath the floor of Building 62 Annex. Five-year reviews would be conducted to evaluate the continued adequacy of the remedy.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 3 would not reduce the toxicity, mobility, and volume through treatment because no treatment would occur. Reduction of contamination in the elevated PAH area north of Building 62 would be achieved by excavation and disposal. Approximately 52 cubic yards of contaminated soil would be permanently and irreversibly removed from the site and disposed off-yard at a hazardous waste landfill. Reduction of contaminant toxicity, mobility, and volume, if present under Building 62 Annex, may occur over the long term through natural processes, but with the contaminants on site, this would be expected to be a lengthy process.

<u>Short-Term Effectiveness</u>

Alternative 3 would be effective in the short term. Controls would be implemented during excavation, off-yard transportation and disposal, backfilling, and regrading activities to protect remediation construction workers, site users, Shipyard employees, and the environment until the construction is completed. These controls would include providing adequate PPE for remediation workers, designated access trails for the Shipyard employees, and construction best management practices to prevent the spread of contamination during construction. In addition, because the excavation would be occurring within an active portion of the Shipyard, implementation of engineering controls, such as dust suppression and erosion controls, and appropriate location and timing of activities would be needed to ensure that the activities would not adversely impact the Shipyard daily operation or the environment. Upon construction completion, the restored excavation area would not adversely impact the Shipyard or the environment. Implementation of LUCs for Building 62 Annex would not pose short-term risk to site workers or result in adverse impacts to the surrounding community or the environment. The remedial action documents would specify the necessary activities to ensure protection of human health and the environment during remedial activities. The work plan would specify the necessary health and safety requirements for remedial activities, including appropriate PPE to minimize exposure to onsite workers and dust suppression requirements during excavation.

Remedial action planning documents (e.g., remedial action work plan and LUC RD) could be completed within 12 months and construction activities (excavation, off-yard transportation and disposal, grading, backfilling, and repaving) would be expected to take 1 month. RAOs would be attained after the LUC RD is implemented and construction activities are completed.

A sustainability evaluation of the potential environmental footprint impact for Alternative 3 remedial activities was conducted and the results are provided in Appendix E. The overall environmental impact resulting from Alternative 3 would be high. The relative impact of the GHG, NOx, SOx, and PM_{10} emissions; and energy consumption for Alternative 3 compared to Alternatives 2 and 4 would be high. Water consumption for Alternative 3 would be high compared to Alternative 2 and similar to Alternative 4. The highest contribution to GHG, NOx, SOx, and PM_{10} emissions would be from activities associated with excavating contaminated soil (e.g. use of excavator and transportation of hazardous materials). High energy consumption would be associated with the production of borrow soil that would be used to backfill the areas excavated. The majority of water consumption would be from Alternative 3 decontamination processes.

Implementability

Alternative 3 would be implementable. The resources, equipment, and materials required for the excavation, backfilling, and grading are readily available. Permitted landfill facilities are also available for soil disposal. Because this is an active part of the Shipyard, there are various utilities in this area, including a known main water line in the excavation area. Therefore, utilities would need to be located and protected during the implementation of this alternative. Excavation in the area north of Building 62 would need to include measures to prevent compromise to the integrity of the water line. Shoring, including slide rail shoring systems, would be considered to address this issue effectively.

The remedial action documents would provide the specifications for excavation, transportation and disposal of contaminated soil, and backfilling of clean soil in the excavated area north of Building 62. The necessary health and safety requirements for any construction activities conducted as part of implementation of the remedy would be identified in the work plan.

Off-yard transportation of the excavated soil would cause additional truck traffic through the Shipyard and would require preparation and implementation of a traffic control plan and the completion of waste manifests. Off-yard disposal of the excavated soil would require prior securing of waste acceptance from the disposal facility. Coordination with the Shipyard during remedial activities would be required to ensure that the activities do not adversely impact Shipyard operations. These administrative procedures could be accomplished. In addition, implementation and enforcement of LUCs and five-year reviews would be relatively simple to implement.

Cost

Cost estimates for Alternative 3 are included in Appendix C. The estimated costs (rounded to $1,000) for Alternative 3 are as follows:

- Capital cost: $423,000
- Annual costs: $3,000/year plus $25,000 every five years
- 30-Year NPW: $605,000

4.2.4 Alternative 4: ISCO Treatment of Elevated PAH Area and Building 62 Annex LUCs

4.2.4.1 Description

Alternative 4 consists of ISCO treatment of the contaminated subsurface soil using ozone in the elevated PAH area north of Building 62 and LUCs for Building 62 Annex. Figure 4-3 shows the treatment and LUCs boundaries. The following describes the individual components of Alternative 4:

- ISCO Treatment – Ozone gas would be injected into the subsurface in the elevated PAH area north of Building 62 to destroy PAHs in soil. For the FS, it is assumed that ten 1-inch diameter micro-porous oxidation points would be installed in this area for ozone injection. An ozone generator would be used to produce ozone at up to 6 percent concentration by weight, which would then be blended with ambient air, allowing the ozone to be injected into the subsurface at typical flow rates of 1 to 4 cubic feet per minute (cfm) and up to 10 cfm at pressures up to 50 pounds per square inch (psi). The system would be programmed to inject ozone alternating between each oxidation point for 30 minutes each and then shutting down for system cool down for 60 minutes before restarting the next cycle. It is assumed that the system would be run continuously for approximately 1 month to completely break down PAH COCs in soil. Any remaining intermediate products from ozone treatment would be more amenable for biodegradation under the aerobic condition enhanced by ozone treatment. Confirmation samples would be collected from the treatment area to confirm that the PAH concentrations have been reduced to less than the PRG. There is a main water line in the treatment area (see Figure 4-3). Necessary precautions would be taken to prevent compromise to its integrity during treatment activities.

- LUCs and Inspections – This would be identical to that of Alternative 3.

- Five-Year Reviews – Because contamination would remain in excess of levels that allow for unlimited use and unrestricted exposure in the Building 62 Annex area, five-year reviews would be required under this alternative to evaluate the continued adequacy of the remedy.

4.2.4.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 4 would be protective of human health and the environment. ISCO treatment in the elevated PAH area north of Building 62 would eliminate potential risks for residential exposure outside of Building 62 Annex. Implementation of LUCs for Building 62 Annex would provide a formal process to inspect and maintain LUCs in preventing unacceptable exposure to contaminants beneath the floor of Building 62 Annex, if present, and prevent residential use of the building. Proper controls during treatment activities would minimize any adverse impacts from contaminated soil to human health and the environment. Five-year reviews would be conducted to evaluate the continued adequacy of the remedy.

Compliance with ARARs

Alternative-specific ARARs for Alternative 4 are provided in Table B-4 in Appendix B. The implementation of Alternative 4 would comply with all ARARs for this alternative.

Long-Term Effectiveness and Permanence

Alternative 4 would provide long-term effectiveness and permanence through treatment of contaminated soil outside of Building 62 Annex and implementation of LUCs for Building 62 Annex. ISCO treatment in the area north of Building 62 would effectively and permanently remove the PAHs contamination in subsurface soil to acceptable levels for residential use outside of Building 62 Annex. LUCs would restrict residential use of Building 62 Annex and restrict access to contamination beneath the floor of Building 62 Annex, if present. A LUC RD would provide a process to inspect and maintain LUCs for Building 62 Annex to prevent unacceptable exposure of current site users to contamination beneath the floor of Building 62 Annex. Five-year reviews would be conducted to evaluate the continued adequacy of the remedy.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4 would reduce the toxicity, mobility, and volume of PAH contamination in subsurface soil in the area north of Building 62 through active treatment with ozone. Approximately 52 cubic yards of subsurface soil would be treated. Reduction of contaminant toxicity, mobility, and volume, if present under Building 62 Annex, may occur over the long term through natural processes, but with the contaminants on site, this would be expected to be a lengthy process.

Short-Term Effectiveness

Alternative 4 would be effective in the short term. Controls would be implemented during installation of ozone injection wells and operation of the ISCO treatment system to protect remediation construction workers, site users, Shipyard employees, and the environment until the treatment is completed. These controls would include providing adequate PPE for remediation construction workers, designated access trails for the Shipyard employees, and construction best management practices to prevent the spread of contamination during construction and operation of the treatment system. In addition, because the ISCO treatment would be occurring within an active portion of the Shipyard, implementation of engineering controls, such as noise controls, and appropriate location and timing of activities would be needed to ensure that the activities would not adversely impact the Shipyard daily operation or the environment. Implementation of LUCs for Building 62 Annex would not pose short-term risk to site workers or result in adverse impacts to the surrounding community or the environment. The remedial action documents would specify the necessary activities to ensure protection of human health and the environment during remedial activities. The work plan would specify the necessary health and safety requirements for remedial activities, including appropriate PPE to minimize exposure to onsite workers and dust suppression requirements during excavation.

Remedial action planning documents (e.g., remedial action work plan and LUC RD) could be completed within 12 to 18 months, construction activities (installation of ozone injection wells) would be expected to take 2 weeks, and treatment activities would be expected to take 1 month. RAOs would be attained after the LUC RD is implemented and treatment activities are completed.

A sustainability evaluation of the potential environmental footprint impact for potential alternative 4 remedial activities was conducted and the results are provided in Appendix E. The overall environmental impact resulting from Alternative 4 is moderate. The relative impact of GHG, NOx, and SOx emissions, and energy consumption for Alternative 4 would be low to moderate. Activities contributing to the highest GHG, NOx, and SOx emissions, and energy consumption would be associated with implementation of Alternative 4 and production of materials used. The relative impact for PM_{10} emissions for Alternative 4 would be low and emissions would be associated with the use of the electricity generator during remedy implementation. The relative impact for water consumption during Alternative 4 would be high and primarily caused by the use of water during the decontamination process.

Implementability

Alternative 4 would be implementable. The resources, equipment, and materials required for the ISCO treatment are readily available. Qualified subcontractors are also available for installation of the ozone treatment system. Because this is an active area of the Shipyard, there are various utilities in this area. Therefore, utilities would need to be located and protected during the implementation of this alternative. ISCO treatment in the area north of Building 62 would need to include measures to prevent compromise to the integrity of the water line in the treatment area (see Figure 4-3).

The remedial action documents would provide the specifications for the ISCO treatment system in the elevated PAH area north of Building 62. The necessary health and safety requirements for any construction activities conducted as part of implementation of the remedy would be identified in the work plan. Coordination with the Shipyard during remedial activities in the area north of Building 62 would be required to ensure that the activities do not adversely impact Shipyard operations. These administrative procedures could be accomplished. In addition, implementation and enforcement of LUCs and five-year reviews would be relatively simple to implement.

Cost

Cost estimates for Alternative 4 are included in Appendix C. The estimated costs (rounded to $1,000) for Alternative 4 are as follows:

- Capital cost: $356,000
- Annual costs: $3,000/year plus $25,000 every 5 years
- 30-Year NPW: $538,000

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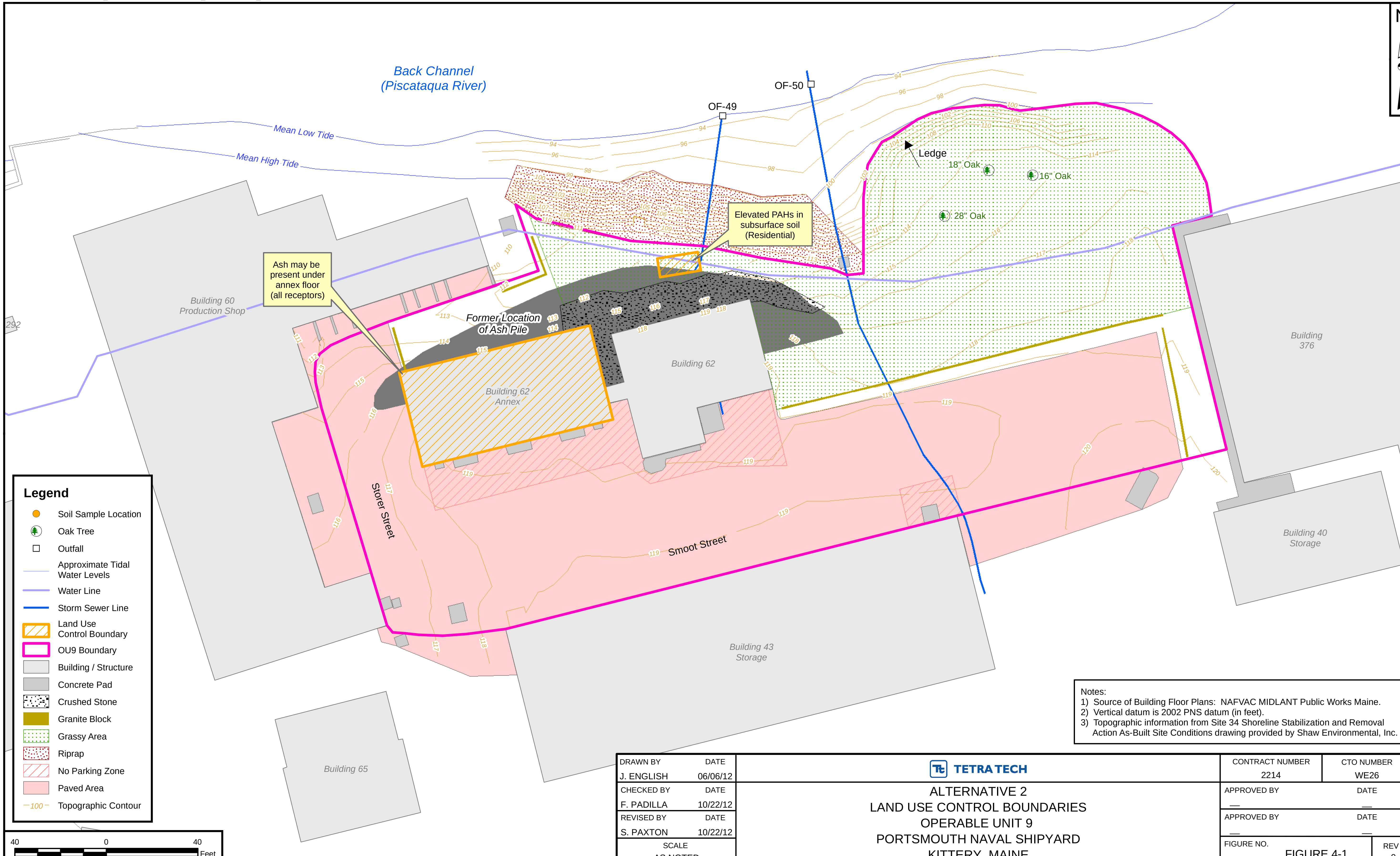

Notes:
1) Source of Building Floor Plans: NAFVAC MIDLANT Public Works Maine.
2) Vertical datum is 2002 PNS datum (in feet).
3) Topographic information from Site 34 Shoreline Stabilization and Removal Action As-Built Site Conditions drawing provided by Shaw Environmental, Inc.

DRAWN BY	DATE	TETRA TECH	CONTRACT NUMBER	CTO NUMBER
J. ENGLISH	06/06/12		2214	WE26
CHECKED BY	DATE	ALTERNATIVE 2	APPROVED BY	DATE
F. PADILLA	10/22/12	LAND USE CONTROL BOUNDARIES	—	—
REVISED BY	DATE	OPERABLE UNIT 9	APPROVED BY	DATE
S. PAXTON	10/22/12	PORTSMOUTH NAVAL SHIPYARD	—	—
SCALE		KITTERY, MAINE	FIGURE NO.	REV
AS NOTED			FIGURE 4-1	0

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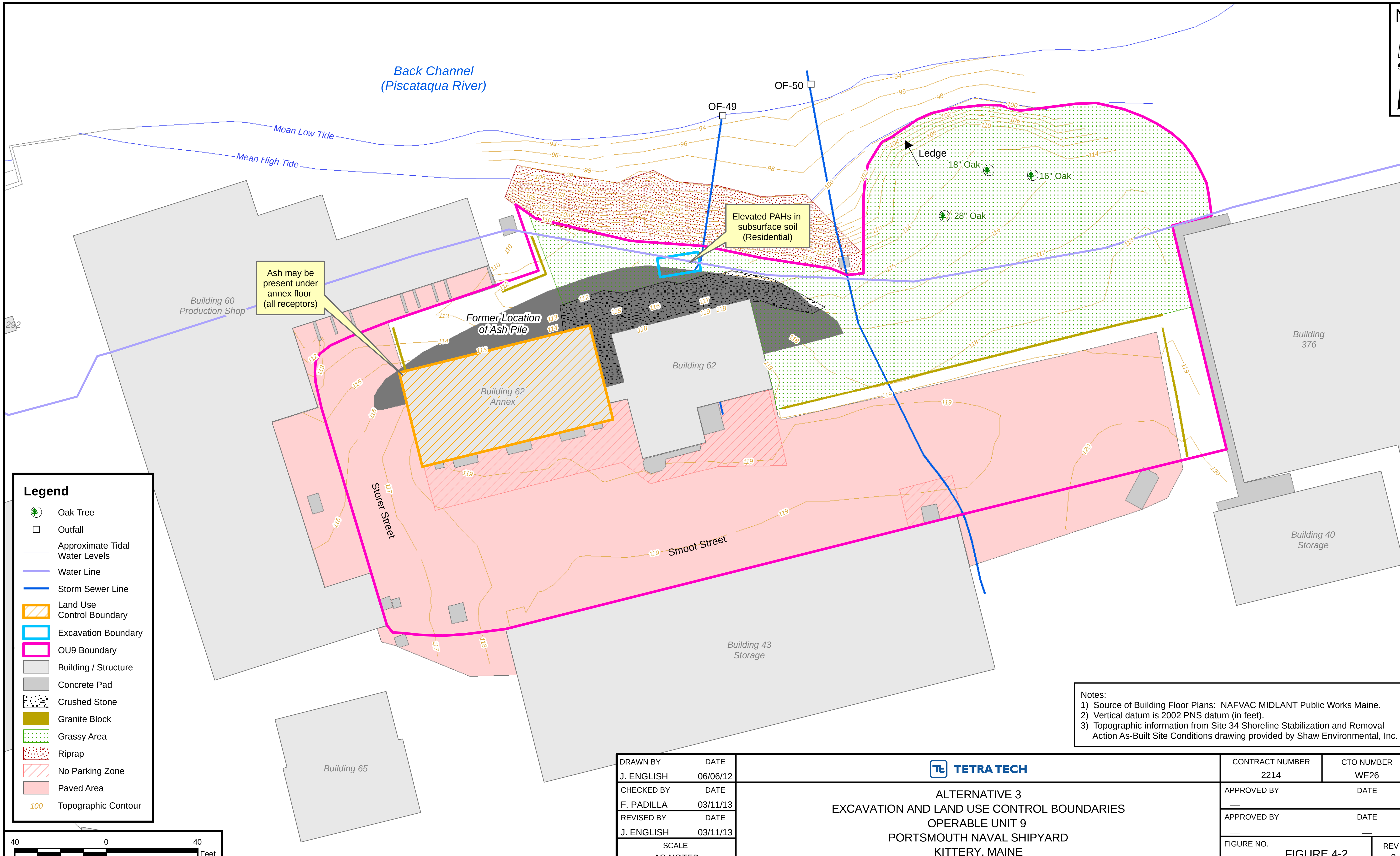

Notes:
1) Source of Building Floor Plans: NAFVAC MIDLANT Public Works Maine.
2) Vertical datum is 2002 PNS datum (in feet).
3) Topographic information from Site 34 Shoreline Stabilization and Removal Action As-Built Site Conditions drawing provided by Shaw Environmental, Inc.

DRAWN BY	DATE	TETRA TECH	CONTRACT NUMBER	CTO NUMBER
J. ENGLISH	06/06/12		2214	WE26
CHECKED BY	DATE	ALTERNATIVE 3 EXCAVATION AND LAND USE CONTROL BOUNDARIES OPERABLE UNIT 9 PORTSMOUTH NAVAL SHIPYARD KITTERY, MAINE	APPROVED BY	DATE
F. PADILLA	03/11/13		—	—
REVISED BY	DATE		APPROVED BY	DATE
J. ENGLISH	03/11/13		—	—
SCALE			FIGURE NO. FIGURE 4-2	REV 0
AS NOTED				

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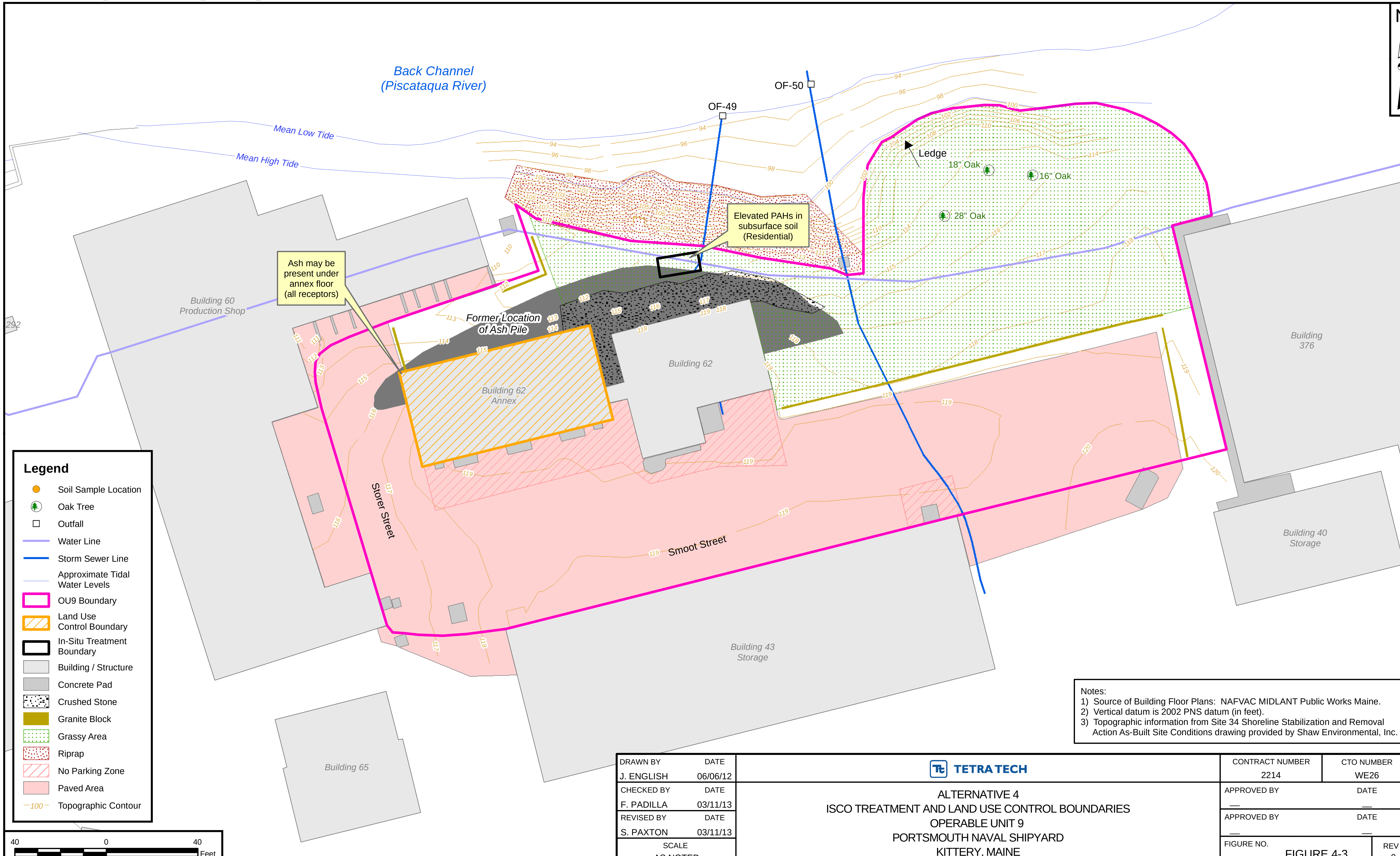

Notes:
1) Source of Building Floor Plans: NAFVAC MIDLANT Public Works Maine.
2) Vertical datum is 2002 PNS datum (in feet).
3) Topographic information from Site 34 Shoreline Stabilization and Removal Action As-Built Site Conditions drawing provided by Shaw Environmental, Inc.

DRAWN BY	DATE		CONTRACT NUMBER	CTO NUMBER
J. ENGLISH	06/06/12	TETRA TECH	2214	WE26
CHECKED BY	DATE	ALTERNATIVE 4	APPROVED BY	DATE
F. PADILLA	03/11/13	ISCO TREATMENT AND LAND USE CONTROL BOUNDARIES	—	—
REVISED BY	DATE	OPERABLE UNIT 9	APPROVED BY	DATE
S. PAXTON	03/11/13	PORTSMOUTH NAVAL SHIPYARD	—	—
SCALE		KITTERY, MAINE	FIGURE NO.	REV
AS NOTED			FIGURE 4-3	0

5.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section compares the analyses for each of the remedial alternatives presented in Section 4.0 of this FS. The criteria for comparison are identical to those used for the detailed analysis of individual alternatives.

TABLE 5-1 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

EVALUATION CRITERION	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: LUCS FOR ELEVATED PAH AREA AND BUILDING 62 ANNEX	ALTERNATIVE 3: EXCAVATION OF ELEVATED PAH AREA AND BUILDING 62 ANNEX LUCS	ALTERNATIVE 4: ISCO TREATMENT OF ELEVATED PAH AREA AND BUILDING 62 ANNEX LUCS
Overall Protection of Human Health and Environment	Would not be protective of human health and would not meet the RAOs because no action would be conducted to ensure that exposure to site contamination does not occur.	Would be protective of human health by implementing LUCs to prevent exposure to contamination. LUCs would restrict residential land use for the elevated PAH area and Building 62 Annex and prevent unrestricted exposure to potential contamination beneath the floor of Building 62 Annex.	Would be protective of human health by removing contaminated soil from the elevated PAH area and implementing LUCs to prevent unrestricted exposure to potential contamination beneath the floor of Building 62 Annex.	Would be protective of human health by treating contaminated soil in the elevated PAH area and implementing LUCs to prevent unrestricted exposure to potential contamination beneath the floor of Building 62 Annex.
Compliance with ARARs	There are no ARARs.	Would comply with ARARs.	Would comply with ARARs.	Would comply with ARARs.
Long-Term Effectiveness and Performance	Would not provide long-term effectiveness and permanence because no action would occur to prevent exposure to site contamination.	Would provide long-term effectiveness and permanence so long as the LUCs are active and maintained. Periodic inspections would be conducted to ensure LUCs are being maintained.	Would provide long-term effectiveness and permanence by removing contamination in the elevated PAH area and implementing LUCs for potential contamination beneath Building 62 Annex. Periodic inspections would be conducted to ensure LUCs are being maintained.	Would provide long-term effectiveness and permanence by treating (with ISCO) contamination in the elevated PAH area and implementing LUCs for potential contamination beneath Building 62 Annex. Periodic inspections would be conducted to ensure LUCs are being maintained.

TABLE 5-1 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES				
EVALUATION CRITERION	**ALTERNATIVE 1: NO ACTION**	**ALTERNATIVE 2: LUCS FOR ELEVATED PAH AREA AND BUILDING 62 ANNEX**	**ALTERNATIVE 3: EXCAVATION OF ELEVATED PAH AREA AND BUILDING 62 ANNEX LUCS**	**ALTERNATIVE 4: ISCO TREATMENT OF ELEVATED PAH AREA AND BUILDING 62 ANNEX LUCS**
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	Would not reduce contaminant toxicity, mobility, or volume through treatment because no treatment would occur.	Would not reduce contaminant toxicity, mobility, or volume through treatment because no treatment would occur.	Would not reduce contaminant toxicity, mobility, or volume through treatment because no treatment would occur.	Would reduce contaminant toxicity, mobility, and volume through treatment in the elevated PAH area. Would not reduce contaminant toxicity, mobility, or volume for contamination, if present, beneath Building 62 Annex.
Short-Term Effectiveness	Would not result in any short-term risk to onsite workers or adversely impact the surrounding community or environment because no construction actions would occur. RAOs would not be attained.	Would not result in any short-term risk to onsite workers or adversely impact the surrounding community or environment because no construction actions would occur. Could be implemented within 12 months and would attain RAOs upon implementation.	Would require appropriate use of PPE and best management practices to prevent exposing onsite workers, the surrounding community, and the environment to contaminated materials during excavation and off-yard disposal activities. Could be implemented within 12 months and would attain RAOs within one month of implementation.	Would require appropriate use of PPE and best management practices to prevent exposing onsite workers, the surrounding community, and the environment to contaminated materials during installation of injection wells and operation of the treatment system in the elevated PAH area. Could be implemented within 12 to 18 months and would attain RAOs within one month of implementation.

TABLE 5-1 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

EVALUATION CRITERION	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: LUCS FOR ELEVATED PAH AREA AND BUILDING 62 ANNEX	ALTERNATIVE 3: EXCAVATION OF ELEVATED PAH AREA AND BUILDING 62 ANNEX LUCS	ALTERNATIVE 4: ISCO TREATMENT OF ELEVATED PAH AREA AND BUILDING 62 ANNEX LUCS
Implementability	Readily implementable because there would be no action to implement.	Readily implementable because there would be no technical implementation and administrative controls for LUCs are easily implemented.	Moderately implementable. Technical implementation of this alternative would include excavation and off-yard transportation and disposal of contaminated soil, backfilling and regrading the excavated area. The main implementability concern for excavation is related to protecting the main water line that is within the excavation area. Administrative controls for Building 62 Annex are easily implemented.	Moderately implementable. Technical implementation of this alternative would include installation and operation of an ozone treatment system in the elevated PAH area. The main implementability concern is for the protection of a main water line within the treatment area. Administrative controls for Building 62 Annex are easily implemented.
Costs (rounded to $1,000):				
Capital	$0	$15,000	$423,000	$356,000
Annual	$0	$3,000/yr plus $25,000/5 yr	$3,000/yr plus $25,000/5 yr	$3,000/yr plus $25,000/5 yr
NPW	$0	$197,000	$605,000	$538,000

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APPENDIX A

PRG DEVELOPMENT AND POST-REMEDIAL RISK EVALUATION

APPENDIX A.1

DEVELOPMENT OF RISK-BASED PRELIMINARY REMEDIATION GOALS

APPENDIX A.1

DEVELOPMENT OF RISK-BASED PRELIMINARY REMEDIATION GOALS

Methodology used to develop risk-based preliminary remediation goals (PRGs) for chemicals of concern (COCs) for Operable Unit 9 is described herein. Risk-based PRGs were calculated for carcinogenic polycyclic aromatic hydrocarbons (PAHs) [i.e., benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene]. A PRG was developed for carcinogenic PAHs based on equivalency of toxicity to benzo(a)pyrene (BAP) expressed as a single concentration called the BAP toxicity equivalency quotient (TEQ). An example calculation for the BAP TEQ is included at the end of this appendix. Hypothetical future child and lifetime residents were identified as the receptors of concern based on hypothetical future land uses.

DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS FOR DIRECT CONTACT WITH SOIL

PRGs may be calculated based on exposures to carcinogenic or noncarcinogenic COCs. No noncarcinogenic contaminants were selected as COCs for Operable Unit 9; therefore, this appendix only focuses on development of PRGs for a carcinogenic COC. The assumption was made that exposure to chemicals in soil occurred through incidental ingestion, dermal contact, and inhalation of fugitive dust and volatiles. The incremental lifetime cancer risk (ILCR) is calculated from:

$$ILCR = C_S\left[(Intake_{ing})(CSF_{oral}) + (Intake_{derm})(CSF_{derm}) + (Intake_{inh})(CSF_{inh})\right]$$

where:	C_S	=	chemical concentration in soil (mg/kg)
	$Intake_{ing}$	=	intake through incidental ingestion (kg/kg/day)
	$Intake_{derm}$	=	dermally absorbed dose (kg/kg/day)
	$Intake_{inh}$	=	intake through inhalation (kg/kg/day)
	CSF_{oral}	=	oral cancer slope factor $(mg/kg/day)^{-1}$
	CSF_{derm}	=	dermal cancer slope factor $(mg/kg/day)^{-1}$
	CSF_{inh}	=	inhalation cancer slope factor $(mg/kg/day)^{-1}$

A soil PRG (PRG_{Soil}) corresponding to a target cancer risk (TCR) can be calculated by rearranging the above equation and solving for the soil concentration. The PRG_{Soil} for carcinogens is calculated from:

$$PRG_{Soil} = \frac{TCR}{\left[(Intake_{Ing})(CSF_{oral}) + (Intake_{derm})(CSF_{derm}) + (Intake_{inh})(CSF_{inh})\right]}$$

The intake through incidental ingestion of soil is calculated from:

$$Intake_{ing} = \frac{(IR_s)(FI)(EF)(ED)(CF)}{(BW)(AT)}$$

where:	$Intake_{ing}$	=	intake of contaminant from soil (kg/kg/day)
	IR_s	=	ingestion rate (mg/day)
	FI	=	fraction ingested from contaminated source (dimensionless)
	EF	=	exposure frequency (days/yr)
	ED	=	exposure duration (yr)
	CF	=	conversion factor (1 x10^{-6} kg/mg)
	BW	=	body weight (kg)
	AT	=	averaging time (days); for noncarcinogens, AT = ED x 365 days/yr; for carcinogens, AT = 70 yr x 365 days/yr

Exposure assumptions used to calculate the intake through incidental ingestion of soil are presented in the PRG calculations spreadsheets and in Appendix D of the RI Report for OU9 (Tetra Tech, June 2012).

The intake from dermal contact with soil is calculated from:

$$Intake_{derm} = \frac{(SA)(AF)(ABS)(CF)(EF)(ED)}{(BW)(AT)}$$

where:	$Intake_{derm}$	=	amount of chemical absorbed during contact with soil (kg/kg/day)
	SA	=	skin surface area available for contact (cm^2/day)
	AF	=	skin adherence factor (mg/cm^2)
	ABS	=	absorption factor (dimensionless)
	CF	=	conversion factor (1 x 10^{-6} kg/mg)
	EF	=	exposure frequency (days/yr)
	ED	=	exposure duration (yr)
	BW	=	body weight (kg)
	AT	=	averaging time (days); for noncarcinogens, AT = ED x 365 days/yr; for carcinogens, AT = 70 yr x 365 days/yr

Exposure assumptions used to calculate the intake through dermal contact of soil are presented in the PRG calculations spreadsheets and in Appendix D of the RI Report for OU9 (Tetra Tech, June 2012).

The intake through inhalation of chemicals that have volatilized from soil is calculated from:

$$Intake_{inh} = \frac{(IR_a)(ET)EF)(ED)}{(BW)(AT)}\left[\frac{1}{VF} + \frac{1}{PEF}\right]$$

where:	$Intake_{inh}$	=	intake of chemical from air via inhalation (kg/kg/day)
	IR_a	=	inhalation rate (m^3/hr)
	ET	=	exposure time (hours/day)
	EF	=	exposure frequency (days/yr)
	ED	=	exposure duration (yr)
	VF	=	volatilization factor (m^3/kg)
	PEF	=	particulate emission factor (m^3/kg)
	BW	=	body weight (kg)
	AT	=	averaging time (days); for noncarcinogens, AT = ED x 365 days/yr; for carcinogens, AT = 70 yr x 365 days/yr

The particulate emissions factor, PEF, relates the concentration of the chemical in soil with the concentration of dust particles in air. A PEF value of 9.37 x 10^{+9} m^3/kg was obtained from USEPA's Soil Screening Internet site located at http://rais.ornl.gov/epa/ssl1.shtml. This is the default value for Portland, Maine, which is the closest city to Portsmouth listed on the Internet site. Because air emissions resulting from fugitive dust emissions settings will be different than dust emissions generated during construction activities, a separate PEF was used for construction activities. The PEF for construction workers (1.43x10^{+6} m^3/kg) was calculated using the equations presented in the USEPA's Supplemental Guidance for Developing Soil Screening Levels for Superfund sites (USEPA, December 2002). The volatilization factor (VF) is chemical specific factor and was also calculated using the methodology present in the Soil Screening guidance. Exposure assumptions used to calculate the intake through inhalation of fugitive dust and volatiles are presented in the PRG calculations spreadsheets and in Appendix D of the RI Report for OU9 (Tetra Tech, June 2012).

A PRG for BAP TEQ of 1.5 mg/kg was developed based on a TCR of 1X10^{-4}. The PRG is presented in Section 2.4 of the FS report.

The methodology for calculating carcinogenic PRGs was performed in accordance with USEPA risk assessment guidance (USEPA, March 2005a and March 2005b).

DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS FOR PAHS

A PRG for PAHs was calculated for lifetime residents following the methodology described above. Calculation spreadsheets are included in this appendix.

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USEPA, December 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, Office of Solid Waste and Emergency Response Washington, D.C.

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RISK ASSESSMENT SPREADSHEET - CALCULATION OF RISK-BASED CONCENTRATIONS FOR SOIL

SITE NAME: PORTSMOUTH NAVAL SHIPYARD
EXPOSURE POINT: OU9
EXPOSURE SCENARIO: LIFELONG RESIDENTS
MEDIA: SURFACE/SUBSURFACE SOIL
DATE: OCTOBER 25, 2012

THIS SPREADSHEET CALCULATES SCREENING LEVELS FOR EXPOSURES TO SOIL
VIA INCIDENTAL INGESTION, DERMAL CONTACT, AND INHALATION

RELEVANT EQUATIONS:

Carcinogens

$$RBC_{soil} = \frac{TCR}{Intake_{oral} \cdot CSF_{oral} + Intake_{derm} \cdot CSF_{derm} + EC_{air} \cdot IUR}$$

Noncarcinogens

$$RBC_{soil} = \frac{THI}{\left(\frac{Intake_{oral}}{RfD_{oral}}\right) + \left(\frac{Intake_{derm}}{RfD_{derm}}\right) + \left(\frac{EC_{air}}{RfC}\right)}$$

$$Intake_{oral} = \frac{IR \times EF \times ED \times FI \times CF}{BW \times AT} \times ADAF$$

$$Intake_{derm} = \frac{SA \times AF \times ABS \times EF \times ED \times CF}{BW \times AT} \times ADAF$$

$$EC_{air} = \frac{ET \times EF \times ED \times [1/PEF + 1/VF]}{AT \times 24\ hours/day} \times ADAF$$

Mutagenic

$$RBC_{soil} = \frac{TCR}{Intake_{ages0-2} + Intake_{ages2-6} + Intake_{ages6-16} + Intake_{ages16-30}}$$

INPUT ASSUMPTIONS:

	Parameter	Child Ages 0 - 2	Child Ages 2 - 6	Adult Ages 6 - 16	Adult Ages 16 - 30	Definition
General	TCR = :	1E-04				Target Cancer Risk
	THI = :	1				Target Hazard Index
	EF = :	350	350	350	350	Exposure Frequency (days/year)
	ED =:	2	4	10	14	Exposure Duration (years)
	BW = :	15	15	70	70	Body Weight (kg)
	ATc = :	25,550				Averaging time for carcinogenic exposures (days)
	ATn = :	730	1,460	3,650	5,110	Averaging time for noncarcinogenic exposures (days)
	CF = :	1.0E-06				Conversion Factor (kg/mg)
	ADAF = :	Chemical Specific				Age Dependent Adjustment Factor
Incidental Ingestion	IR = :	200	200	100	100	Soil Ingestion Rate (mg/day)
	FI = :	1	1	1	1	Fraction from contaminated source (unitless)
Dermal Contact	SA = :	2,800	2,800	5,700	5,700	Skin surface available for contact (cm^2/day)
	AFc = :	0.2	0.2	0.07	0.07	Soil to skin adherence factor (mg/cm^2)
	ABS = :	Chemical Specific				Absorption factor (unitless)
Inhalation	ETc = :	24	24	24	24	Exposure time (hours/day)
	PEF = :	9.37E+09				Particulate emission factor (m^3/kg)
	VF = :	Chemical Specific				Volatilization factor (m^3/kg)

CHEMICAL	ABS	Cancer Slope Factor			Reference Dose		
		Oral $(mg/kg/day)^{-1}$	Dermal $(mg/kg/day)^{-1}$	Inhalation $(ug/m^3)^{-1}$	Oral (mg/kg/day)	Dermal (mg/kg/day)	Inhalation (mg/m^3)
BAP TEQ	0.13	7.3E+00	7.3E+00	1.1E-03	NA	NA	NA

CHEMICAL	Age Dependent Adjustment Factor			
	Ages 0 - 2	Ages 2 - 6	Ages 6 - 16	Ages >16
BAP TEQ	10	3	3	1

CHEMICAL	Carcinogenic Intake Factors			Noncarcinogenic Intake Factors		
	Oral (kg/kg/day)	Dermal (kg/kg/day)	Inhalation (kg/m^3)	Oral (kg/kg/day)	Dermal (kg/kg/day)	Inhalation (kg/m^3)
BAP TEQ	6.71E-06	2.57E-06	1.11E-10	1.28E-05	4.65E-06	1.02E-10

CHEMICAL	Soil Concentration	
	Carcinogenic (mg/kg)	Noncarcinogenic (mg/kg)(1)
BAP TEQ	1.5	NA

1 - Noncarcinogenic concentration is based on the child resident.

RISK ASSESSMENT SPREADSHEET - CALCULATION OF RISK-BASED CONCENTRATIONS FOR SOIL (PAGE TWO OF TWO)

CALCULATION OF AMBIENT AIR CONCENTRATION
SOURCE: USEPA SOIL SCREENING GUIDANCE (DECEMBER 2002)

Purpose: To calculate ambient air concentrations resulting from fugitive dust and volatilization from soil.

Relevant Equations:

$$Cair = Cs \times (1/PEF + 1/VF)$$

$$VF = \frac{Q/C \times (3.14 \times DA \times T)^{1/2} \times 10^{-4}\ m^2/cm^2}{2 \times pb \times DA}$$

$$PEF = \frac{3600}{0.036 \times (1-V) \times (U_m/U_t)^3 \times F(x)}$$

$$DA = \frac{[(\theta a^{10/3} \times Di \times H + \theta w^{10/3} \times Dw)/n^2)]}{pb \times Kd + \theta w + \theta a \times H}$$

$$Csat = S/pb \times (Kd \times pb + \theta w + H \times \theta a)$$

INPUT PARAMTERS		
Parameter	**Value**	**Definition**
Q/C = :	73.95045	Inverse of mean conc. at center of source (g/m^2-s per kg/m^3).
T = :	9.5E+08	Exposure interval (seconds).
pb = :	1.5	Dry soil bulk density (g/cm^3).
ps = :	2.65	soil particle density (g/cm^3).
n = :	0.434	Total soil porosity (L_{pore}/L_{soil}).
θw = :	0.15	Water-filled soil porosity (L_{pore}/L_{soil}).
θa = :	0.284	Air-filled soil porosity (L_{air}/L_{soil}).
Di = :	Chemical specific	Diffusivity in air (cm^2/sec).
H' = :	Chemical specific	Dimensionless Henry's Law Constant.
Dw = :	Chemical specific	Diffusivity in water (cm^2/sec).
DA = :	Chemical specific	Apparent diffusivity (cm^2/sec).
Kd = :	Chemical specific	Soil-water partition coefficient (cm^3/g).
Koc = :	Chemical specific	Soil organic carbon partition coefficient (cm^3/g).
foc = :	0.006	Fraction organic carbon in soil (g/g).

Chemical	Volatile	Chemical Properties					Intermediate Calculations			
		Koc (cm^3/g)	Di (cm^2/sec)	Dw (cm^2/sec)	S (mg/L)	H'	Kd (cm^3/g)	Da (cm^2/sec)	VF (m^3/kg)	Csat (mg/kg)
Surface Soil										
BAP TEQ	N	NA	NA	NA	NA	NA	NA	NA	1E+99	NA

Example Calculation - Benzo(a)pyrene (BAP) Toxicity Equivalency Quotient (TEQ)
Units = ug/kg
Sample = OU9-SB-13-0406

Sample Results	
Chemical	**Concentration (with qualifier)**
BENZO(A)ANTHRACENE	36000
BENZO(A)PYRENE	36000
BENZO(B)FLUORANTHENE	32000
BENZO(K)FLUORANTHENE	19000
CHRYSENE	31000
DIBENZO(A,H)ANTHRACENE	7800
INDENO(1,2,3-CD)PYRENE	18000

Assumptions:
- Positive results accepted
- Non-detected results are assumed to be 1/2 quantitation limit
- Rejected results (R) are not used
- If all individual cPAHs are non-detected, BAP Equivalent = the quantitation limit for benzo(a)pyrene

BAP TEQ = Σ(Sample Result$_{chemical\ 1}$ x TEF$_{chemical\ 1}$ + Sample Result$_{chemical\ 2}$ x TEF$_{chemical\ 2}$...)

= 0.01 x 570 + 1 x 426 + 0.1 x 847 + 0.01 x NA + 0.001 x 380 + 1 x 82.7 + 0.1 x 2364

= 52621 ug/kg

Used in Calculation:

Carcinogenic PAH	TEF	Concentration
BENZO(A)ANTHRACENE	0.1	3600
BENZO(A)PYRENE	1	36000
BENZO(B)FLUORANTHENE	0.1	3200
BENZO(K)FLUORANTHENE	0.01	190
CHRYSENE	0.001	31
DIBENZO(A,H)ANTHRACENE	1	7800
INDENO(1,2,3-CD)PYRENE	0.1	1800

TEF = Toxicity Equivalence Factor
TEF Source = USEPA, July 1993.

APPENDIX A.2

POST-REMEDIAL RISK EVALUATION

APPENDIX A.2
POST-REMEDIAL RISK EVALUATION
FOR SOIL REMEDIATION ALTERNATIVES 3 AND 4

This section presents the methodology used to evaluate potential human health risks to hypothetical future residential receptors at Operable Unit (OU) 9 following the implementation of either soil remediation Alternative 3 or 4 described in Sections 4.2.3 and 4.2.4, respectively of this Feasibility Study (FS). This evaluation does not consider potential risks for exposure to ash under the floor of Building 62 Annex, if present, because land use controls (LUCs) would be used to prevent exposure to this potential contamination for all receptors. The purpose of this evaluation is to compare the estimated post-remedial carcinogenic polycyclic aromatic hydrocarbon (PAH) exposure point concentration (EPC) represented by the benzo(a)pyrene toxicity equivalency quotient (BAP TEQ) to the carcinogenic PAH residential preliminary remediation goal (PRG). The carcinogenic PAH PRG is 1.5 mg/kg BAP TEQ. Figure A-1 shows the samples with concentrations exceeding the PRG.

Estimated Post-Remedial Exposure Point Concentrations

Elevated carcinogenic PAH concentrations [i.e., concentrations greater than 10 milligrams per kilogram (mg/kg)] were detected in subsurface soil samples. The sample locations with the greatest carcinogenic PAH concentrations are located north of Building 62 and south of the riprap. Locations OU9-13, OU9-14, OU9-15, and OU9-22, were selected for excavation (Alternative 3) or treatment (Alternative 4) because those locations have the greatest concentrations of carcinogenic PAHs and are in close proximity to one another. No other locations were targeted for subsurface soil excavation or treatment.

The post-remedial EPC for carcinogenic PAHs was calculated by substituting concentrations for those sample locations in the proposed excavation (Alternative 3) and treatment (alternative 4) areas (i.e., OU9-13, OU9-14, OU9-15, and OU9-22) with the BAP TEQ PRG of 1.5 mg/kg to reflect carcinogenic PAH concentrations following the proposed remedial actions. Using the BAP TEQ PRG as the substitution concentration to represent post-remedial carcinogenic PAH concentrations is considered conservative because fill (Alternative 3) or post treatment (Alternative 4) carcinogenic PAH concentrations would likely be less than the BAP TEQ PRG for OU9.

The estimated post-remedial exposure point concentration (EPC) for carcinogenic PAHs expressed as BAP TEQ in subsurface soil at OU9 was calculated by ProUCL Version 4.1 (output attached) using the post-remediation concentration dataset in Table A.1. The estimated post-remedial EPC for carcinogenic PAHs at OU9 is 1.2 mg/kg which is less than the PRG of 1.5 mg/kg indicating that subsurface soil risks to hypothetical future residents would be acceptable after implementing either remedial action Alternative 3 or 4 proposed in this FS. For Alternative 2, LUCs would prevent exposure to potential unacceptable residential risks in subsurface soil.

TABLE A.1
SUMMARY OF PRE-REMEDIATION CONCENTRATIONS AND ESTIMATED POST-REMEDIAL CONCENTRATIONS
OPERABLE UNIT 9 FEASABILITY STUDY
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE
PAGE 1 OF 1

Medium	Sample Location	Sample ID[1]	Chemical of Concern	Concentration (mg/kg)	
				Pre-Remediation	Post-Remediation[2]
Subsurface Soil	OU9-01	OU9-SB-01-0204	Carcinogenic PAHs (expressed as BAP TEQ)	0.005	0.005
	OU-04	OU9-SB-04-0205		0.03	0.03
		OU9-SB-04-0508-AVG		0.07	0.07
	OU9-05	OU9-SB-05-0205		0.01	0.01
		OU9-SB-05-0507		0.004 U	0.004 U
	OU9-06	OU9-SB-06-0205		0.35	0.35
		OU9-SB-06-0508		0.12	0.12
	OU9-10	OU9-SB-10-0608		0.03	0.03
	OU9-11	OU9-SB-11-0206-AVG		0.21	0.21
	OU9-12	OU9-SB-12-0204		0.79	0.79
		OU9-SB-12-0406		0.14	0.14
		OU9-SB-12-0608		0.02	0.02
	OU9-13	OU9-SB-13-0406		53	1.5
		OU9-SB-13-0608		230	1.5
	OU9-14	OU9-SB-14-0406		1.4	1.4
		OU9-SB-14-0608		0.09	0.09
		OU9-SB-14-0810		7	1.5
	OU9-15	OU9-SB-15-0406		14	1.5
		OU9-SB-15-0608		12	1.5
		OU9-SB-15-0810		3.9	1.5
	OU9-16	OU9-SB-16-0205		0.004 U	0.004 U
		OU9-SB-16-0508		0.004 U	0.004 U
	OU9-17	OU9-SB-17-0205-AVG		0.004 U	0.004 U
		OU9-SB-17-0508		0.004 U	0.004 U
	OU9-18	OU9-SB-18-0205		0.21	0.21
		OU9-SB-18-0508-AVG		0.004 U	0.004 U
	OU9-19	OU9-SB-19-0205		0.05	0.05
		OU9-SB-19-0508		0.005	0.005
	OU9-20	OU9-SB-20-0205		6	6
		OU9-SB-20-0508		0.04	0.04
	OU9-21	OU9-SB-21-0205		0.01	0.01
		OU9-SB-21-0508		0.01	0.01
	OU9-22	OU9-SB-22-0205		77	1.5
		OU9-SB-22-0508		610	1.5
	OU9-23	OU9-SB-23-0204		0.006	0.006
	OU9-24	OU9-SB-24-0204		0.004	0.004
	OU9-25	OU9-SB-25-0205		0.004 U	0.004 U
		OU9-SB-25-0508		0.007	0.007

Footnotes:
1 - When there are duplicate pairs, the average result is shown.
2 - Pre-remediation concentrations that exceed the preliminary remediation goal (PRG) are presented at the concentration of the PRG to represent post-remediation concentrations.

J = Estimated value
mg/kg = milligram per kilogram
NA - Not applicable; Not analyzed
U = Non-detected result

Shaded cells indicate the PRG was used as the substitution concentration to represent post-remedial carcinogenic PAH concentrations.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options	
From File	Sheet2.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzo(a)pyrene toxicity equivalency quotient (BAP TEQ)

General Statistics

Number of Valid Data	57	Number of Detected Data	49
Number of Distinct Detected Data	32	Number of Non-Detect Data	8
		Percent Non-Detects	14.04%

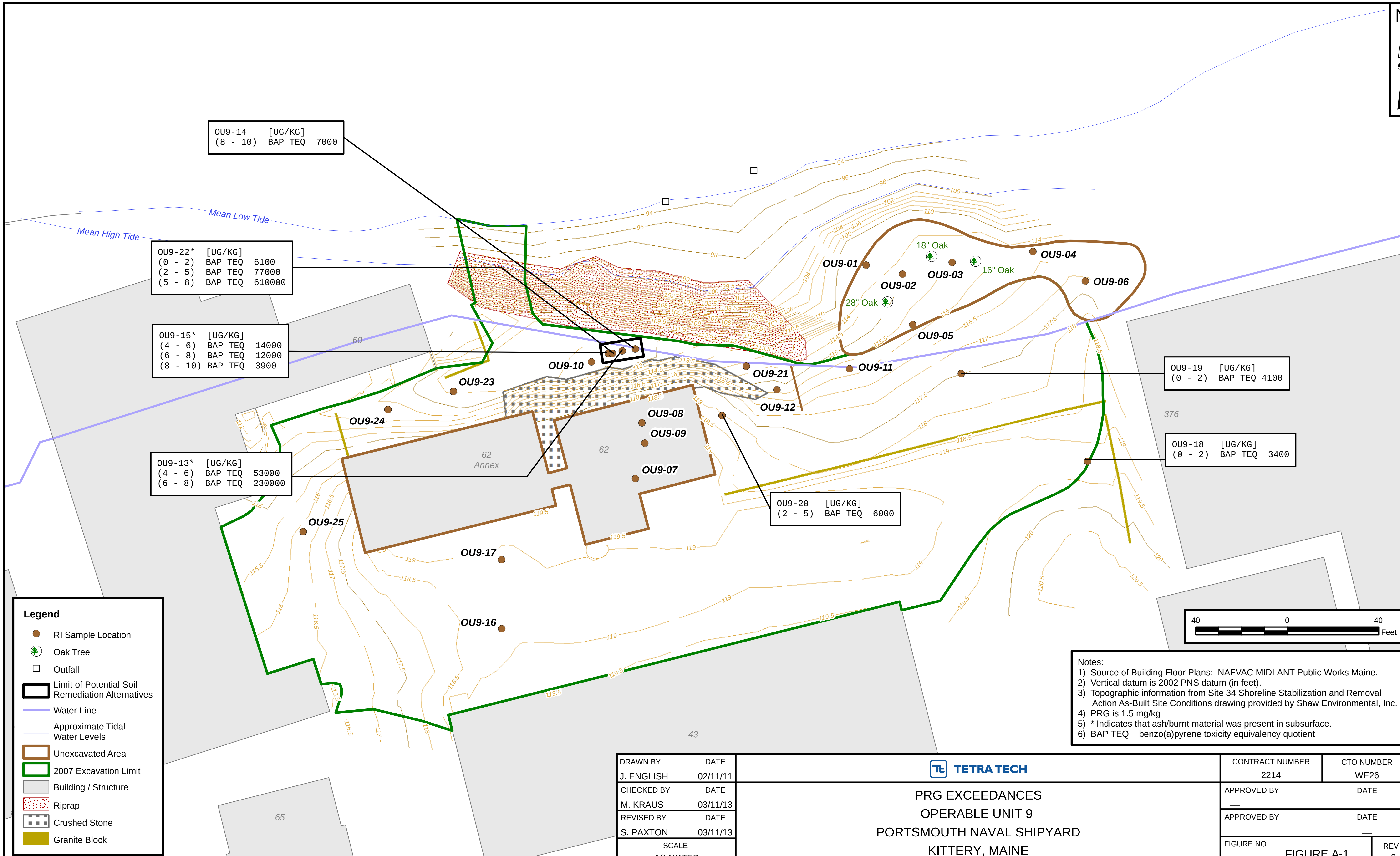
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.004	Minimum Detected	-5.521
Maximum Detected	6	Maximum Detected	1.792
Mean of Detected	0.71	Mean of Detected	-1.82
SD of Detected	1.163	SD of Detected	2.052
Minimum Non-Detect	0.004	Minimum Non-Detect	-5.521
Maximum Non-Detect	0.004	Maximum Non-Detect	-5.521

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.635	Shapiro Wilk Test Statistic	0.937
5% Shapiro Wilk Critical Value	0.947	5% Shapiro Wilk Critical Value	0.947
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.61	Mean	-2.437
SD	1.105	SD	2.445
95% DL/2 (t) UCL	0.855	95% H-Stat (DL/2) UCL	7.752
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.497	Mean in Log Scale	-2.47
SD	1.214	SD in Log Scale	2.518
95% MLE (t) UCL	0.766	Mean in Original Scale	0.61
95% MLE (Tiku) UCL	0.753	SD in Original Scale	1.105
		95% t UCL	0.855
		95% Percentile Bootstrap UCL	0.861
		95% BCA Bootstrap UCL	0.933
		95% H UCL	9.846
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.426	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	1.668		
nu star	41.71		
A-D Test Statistic	0.991	**Nonparametric Statistics**	
5% A-D Critical Value	0.829	Kaplan-Meier (KM) Method	

K-S Test Statistic	0.829	Mean	0.611
5% K-S Critical Value	0.135	SD	1.095
Data follow Appr. Gamma Distribution at 5% Significance Level		SE of Mean	0.146
		95% KM (t) UCL	0.856
Assuming Gamma Distribution		95% KM (z) UCL	0.852
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.855
Minimum	0.000001	95% KM (bootstrap t) UCL	0.999
Maximum	6	95% KM (BCA) UCL	0.869
Mean	0.61	95% KM (Percentile Bootstrap) UCL	0.853
Median	0.12	95% KM (Chebyshev) UCL	1.249
SD	1.105	97.5% KM (Chebyshev) UCL	1.526
k star	0.237	99% KM (Chebyshev) UCL	2.068
Theta star	2.574		
Nu star	27.03	**Potential UCLs to Use**	
AppChi2	16.17	95% KM (Chebyshev) UCL	1.249
95% Gamma Approximate UCL	1.02		
95% Adjusted Gamma UCL	1.034		
Note: DL/2 is not a recommended method.			
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
For additional insight, the user may want to consult a statistician.			

PGH P:\GIS\PORTSMOUTH_NSY\MAPDOCS\MXD\SITE34_SUB_BAP_TAGS_SHALLOW_REV.MXD 03/11/13 JEE



APPENDIX B

ALTERNATIVE-SPECIFIC ARARs

TABLE B-1

ALTERNATIVE 1: NO ACTION
CHEMICAL-, LOCATION-, AND ACTION-SPECIFIC ARARs
OPERABLE UNIT 9 FEASIBILITY STUDY REPORT
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

REQUIREMENT	CITATION	STATUS	SYNOPSIS	EVALUATION/ACTION TO BE TAKEN
FEDERAL CHEMICAL-SPECIFIC ARARS AND TBCS				
Soil/Risk Assessment	USEPA Human Health Assessment Group CSFs from IRIS	TBC	CSFs present the most up-to-date information on cancer risk potency for known and suspected carcinogens.	CSFs were used to develop risk-based soil cleanup goals for carcinogenic PAHs.
	Guidelines for Carcinogen Risk Assessment EPA/630/P-03/001F (2005a)	TBC	These guidelines are used to perform the HHRA. They provide a framework for assessing possible cancer risks from exposures to pollutants or other agents in the environment.	These guidelines were used to develop risk-based soil cleanup goals for carcinogenic PAHs.
	Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (2005b)	TBC	These guidelines are used to perform the HHRA and address a number of issues pertaining to cancer risks associated with early-life exposures in general and provide specific guidance on potency adjustment for carcinogens acting through a mutagenic mode of action.	This guidance was used to develop risk-based soil cleanup goals for carcinogenic PAHs.
STATE CHEMICAL-SPECIFIC ARARS AND TBCS				
Soil/Risk Assessment	Maine Remedial Action Guidelines (RAGs) for Soil Contaminated with Hazardous Substances (Section V.H) (MEDEP, 2010)	TBC	The Maine RAGs provide procedures to determine soil cleanup levels unless site-specific risk-based cleanup levels are calculated. Chemical-specific guidelines that may assist in making remedial decisions are also provided. Guidelines are presented for four exposure scenarios.	Per Section V.H, site-specific risk-based cleanup levels were used for OU9 instead of RAGs table values.
FEDERAL LOCATION-SPECIFIC ARARS AND TBCS : NO ARARS OR TBCS				
STATE LOCATION-SPECIFIC ARARS AND TBCS : NO ARARS OR TBCS				
FEDERAL ACTION-SPECIFIC ARARS AND TBCS : NO ARARS OR TBCS				
STATE ACTION-SPECIFIC ARARS AND TBCS : NO ARARS OR TBCS				

TABLE B-2

ALTERNATIVE 2: LUCs FOR ELEVATED PAH AREA AND BUILDING 62 ANNEX
CHEMICAL-, LOCATION-, AND ACTION-SPECIFIC ARARs
OPERABLE UNIT 9 FEASIBILITY STUDY REPORT
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

REQUIREMENT	CITATION	STATUS	SYNOPSIS	EVALUATION/ACTION TO BE TAKEN
FEDERAL CHEMICAL-SPECIFIC ARARS AND TBCS				
Soil/Risk Assessment	USEPA Human Health Assessment Group CSFs from IRIS	TBC	CSFs present the most up-to-date information on cancer risk potency for known and suspected carcinogens.	CSFs were used to develop risk-based soil cleanup goals for carcinogenic PAHs.
	Guidelines for Carcinogen Risk Assessment EPA/630/P-03/001F (2005a)	TBC	These guidelines are used to perform the HHRA. They provide a framework for assessing possible cancer risks from exposures to pollutants or other agents in the environment.	These guidelines were used to develop risk-based soil cleanup goals for carcinogenic PAHs.
	Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (2005b)	TBC	These guidelines are used to perform the HHRA and address a number of issues pertaining to cancer risks associated with early-life exposures in general and provide specific guidance on potency adjustment for carcinogens acting through a mutagenic mode of action.	This guidance was used to develop risk-based soil cleanup goals for carcinogenic PAHs.
STATE CHEMICAL-SPECIFIC ARARS AND TBCS				
Soil/Risk Assessment	Maine Remedial Action Guidelines (RAGs) for Soil Contaminated with Hazardous Substances (Section V.H) (MEDEP, 2010)	TBC	The Maine RAGs provide procedures to determine soil cleanup levels unless site-specific risk-based cleanup levels are calculated. Chemical-specific guidelines that may assist in making remedial decisions are also provided. Guidelines are presented for four exposure scenarios.	Per Section V.H, site-specific risk-based cleanup levels were used for OU9 instead of RAGs table values.
FEDERAL LOCATION-SPECIFIC ARARS AND TBCS: NO ARARS OR TBCS				
STATE LOCATION-SPECIFIC ARARS AND TBCS: NO ARARS OR TBCS				
FEDERAL ACTION-SPECIFIC ARARS AND TBCS: NO ARARS OR TBCS				
STATE ACTION-SPECIFIC ARARS AND TBCS: NO ARARS OR TBCS				

TABLE B-3

ALTERNATIVE 3: EXCAVATION OF ELEVATED PAH AREA AND BUILDING 62 ANNEX LUCS
CHEMICAL-, LOCATION-, AND ACTION-SPECIFIC ARARs
OPERABLE UNIT 9 FEASIBILITY STUDY REPORT
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

REQUIREMENT	CITATION	STATUS	SYNOPSIS	EVALUATION/ACTION TO BE TAKEN
FEDERAL CHEMICAL-SPECIFIC ARARs AND TBCs				
Soil/Risk Assessment	USEPA Human Health Assessment Group CSFs from IRIS	TBC	CSFs present the most up-to-date information on cancer risk potency for known and suspected carcinogens.	CSFs were used to develop risk-based soil cleanup goals for carcinogenic PAHs.
	Guidelines for Carcinogen Risk Assessment EPA/630/P-03/001F (2005a)	TBC	These guidelines are used to perform the HHRA. They provide a framework for assessing possible cancer risks from exposures to pollutants or other agents in the environment.	These guidelines were used to develop risk-based soil cleanup goals for carcinogenic PAHs.
	Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (2005b)	TBC	These guidelines are used to perform the HHRA and address a number of issues pertaining to cancer risks associated with early-life exposures in general and provide specific guidance on potency adjustment for carcinogens acting through a mutagenic mode of action.	This guidance was used to develop risk-based soil cleanup goals for carcinogenic PAHs.
STATE CHEMICAL-SPECIFIC ARARs AND TBCs				
Soil/Risk Assessment	Maine Remedial Action Guidelines (RAGs) for Soil Contaminated with Hazardous Substances (Section V.H) (MEDEP, 2010)	TBC	The Maine RAGs provide procedures to determine soil cleanup levels unless site-specific risk-based cleanup levels are calculated. Chemical-specific guidelines that may assist in making remedial decisions are also provided. Guidelines are presented for four exposure scenarios.	Per Section V.H, site-specific risk-based cleanup levels were used for OU9 instead of RAGs table values.

REQUIREMENT	CITATION	STATUS	SYNOPSIS	EVALUATION/ACTION TO BE TAKEN
FEDERAL LOCATION-SPECIFIC ARARS AND TBCS				
Coastal Zone Management	Coastal Zone Management Act [16 USC 1451 *et seq*]	Applicable	This act provides for the preservation and protection of coastal zone areas. Federal activities that are in or directly affecting the coastal zone must be consistent, to the maximum extent practicable, with a federally approved state management program.	Excavation near the shoreline would be controlled according to the requirements of the MEDEP program. MEDEP would review remedial action documents to ensure that they meet the substantive requirements of this act.
Other Natural Resources	The Endangered Species Act of 1973 (16 USC 1531 *et seq*.; 50 CFR Parts 17 and 402)	Applicable	Provides for consideration of the impacts on endangered and threatened species and their critical habitats. Requires federal agencies to ensure that any action carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species or adversely affect its critical habitat. The entire state of Maine is considered a habitat of the federally-listed endangered short-nosed sturgeon. The Gulf of Maine population of Atlantic sturgeon are listed as threatened species.	There are no known endangered, threatened, or protected species or critical habitats within the boundaries of PNS. However, short-nosed and Atlantic sturgeon are present in the Piscataqua River. Excavation and backfilling conducted adjacent to the offshore area would be conducted so as to avoid any adverse effect under the Act to these sturgeon.
STATE LOCATION-SPECIFIC ARARS AND TBCS				
Natural Resources	Maine Natural Resources Protection Act Permit by Rule Standards [38 MRSA 480 *et seq.*; 06-096 Code of Maine Rules (CMR) Part 305, 1, 2, and 8]	Applicable	This act regulates activity conducted in, on, or over any protected natural resource or any activity conducted adjacent to and operated in such a way that material or soil may be washed into any freshwater or coastal wetland, great pond, river, stream or brook.	Excavation that may disturb soil adjacent to the shoreline would be conducted so as to avoid washing any soil into the nearby Piscataqua River. Stormwater management and erosion control practices would be used to prevent excavated soil from entering the river during the remedial activities.

REQUIREMENT	CITATION	STATUS	SYNOPSIS	EVALUATION/ACTION TO BE TAKEN
Coastal Zone	Maine Coastal Management Policies (38 MRSA 1801 *et seq*.) (06-096 CMR chapter 1000)	Applicable	Regulates activities near great ponds, rivers and larger streams, coastal areas, and wetlands. Regulates shoreland activities and development, including (but not limited to) water pollution prevention and control, wildlife habitat protection, and freshwater and coastal wetlands protection. The law is administered at the local government level. Shoreland areas include areas within 250 feet of the normal high-water line of any river or saltwater body and areas within 75 feet of the high-water line of a stream.	Excavation and backfilling that may affect storm water runoff, erosion and sedimentation, and surface water quality would be controlled according to these regulations.
FEDERAL ACTION-SPECIFIC ARARs AND TBCs: NO ARARs OR TBCs				
STATE ACTION-SPECIFIC ARARs AND TBCs				
Hazardous Waste	Identification of Hazardous Wastes 06-096 Part 850	Applicable	These standards establish requirements for determining whether wastes are hazardous based on either characteristic or listing.	Wastes generated as part of remedial activities would be analyzed to determine whether they are RCRA characteristic hazardous wastes. If determined to be hazardous waste, then the waste would be managed in accordance with regulatory requirements.
	Standards for Generators of Hazardous Waste (38 MRSA 1301 *et seq.*, 06-096 Part 851 (5) and (8))	Applicable	These regulations contain pre-transport and accumulation requirements for the generators of hazardous waste.	Waste determined to be hazardous would be managed onsite according to the regulation until disposal offsite.

TABLE B-3

ALTERNATIVE 3: EXCAVATION OF ELEVATED PAH AREA AND BUILDING 62 ANNEX LUCS CHEMICAL-, LOCATION-, AND ACTION-SPECIFIC ARARs OPERABLE UNIT 9 FEASIBILITY STUDY REPORT PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

REQUIREMENT	CITATION	STATUS	SYNOPSIS	EVALUATION/ACTION TO BE TAKEN
Erosion and Sedimentation Control	Erosion and Sedimentation Control (38 MRSA Part 420-C)	Applicable	Erosion control measures must be in place before activities such as filling, displacing, or exposing soil or other earthen materials occur. Prior MEDEP approval is required if the disturbed area is in the direct watershed of a body of water most at risk for erosion or sedimentation.	These controls would be applicable to excavation and backfill activities. Applicable plans would be coordinated with MEDEP before implementation.
Air Emissions	Visible Emissions Regulation (38 MRSA Part 584; 06-096 CMR Part 101)	Applicable	These regulations establish opacity limits for emissions from several categories of air contaminant sources, including general fugitive emissions.	These standards would be met if excavation or backfilling activities could result in emission of particulate matter and fugitive matter to the atmosphere (e.g., dust generation).

TABLE B-4

ALTERNATIVE 4: IN-SITU CHEMICAL OXIDATION (ISCO) TREATMENT OF ELEVATED PAH AREA AND BUILDING 62 ANNEX LUCS CHEMICAL-, LOCATION-, AND ACTION-SPECIFIC ARARs OPERABLE UNIT 9 FEASIBILITY STUDY REPORT PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

REQUIREMENT	CITATION	STATUS	SYNOPSIS	EVALUATION/ACTION TO BE TAKEN
FEDERAL CHEMICAL-SPECIFIC ARARS AND TBCS				
Soil/Risk Assessment	USEPA Human Health Assessment Group CSFs from IRIS	TBC	CSFs present the most up-to-date information on cancer risk potency for known and suspected carcinogens.	CSFs were used to develop risk-based soil cleanup goals for carcinogenic PAHs.
	Guidelines for Carcinogen Risk Assessment EPA/630/P-03/001F (2005a)	TBC	These guidelines are used to perform the HHRA. They provide a framework for assessing possible cancer risks from exposures to pollutants or other agents in the environment.	These guidelines were used to develop risk-based soil cleanup goals for carcinogenic PAHs.
	Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (2005b)	TBC	These guidelines are used to perform the HHRA and address a number of issues pertaining to cancer risks associated with early-life exposures in general and provide specific guidance on potency adjustment for carcinogens acting through a mutagenic mode of action.	This guidance was used to develop risk-based soil cleanup goals for carcinogenic PAHs.
STATE CHEMICAL-SPECIFIC ARARS AND TBCS				
Soil/Risk Assessment	Maine Remedial Action Guidelines (RAGs) for Soil Contaminated with Hazardous Substances (Section V.H) (MEDEP, 2010)	TBC	The Maine RAGs provide procedures to determine soil cleanup levels unless site-specific risk-based cleanup levels are calculated. Chemical-specific guidelines that may assist in making remedial decisions are also provided. Guidelines are presented for four exposure scenarios.	Per Section V.H, site-specific risk-based cleanup levels were used for OU9 instead of RAGs table values.

TABLE B-4

ALTERNATIVE 4: IN-SITU CHEMICAL OXIDATION (ISCO) TREATMENT OF ELEVATED PAH AREA AND BUILDING 62 ANNEX LUCS CHEMICAL-, LOCATION-, AND ACTION-SPECIFIC ARARs OPERABLE UNIT 9 FEASIBILITY STUDY REPORT PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

REQUIREMENT	CITATION	STATUS	SYNOPSIS	EVALUATION/ACTION TO BE TAKEN
FEDERAL LOCATION-SPECIFIC ARARS AND TBCS				
Coastal Zone Management	Coastal Zone Management Act [16 USC 1451 *et seq*]	Applicable	This act provides for the preservation and protection of coastal zone areas. Federal activities that are in or directly affecting the coastal zone must be consistent, to the maximum extent practicable, with a federally approved state management program.	Remedial activities associated with in-situ treatment would be controlled according to the requirements of the MEDEP program. MEDEP would review remedial action documents to ensure that they meet the substantive requirements of this act.
Other Natural Resources	The Endangered Species Act of 1973 (16 USC 1531 *et seq.*; 50 CFR Parts 17 and 402)	Applicable	Provides for consideration of the impacts on endangered and threatened species and their critical habitats. Requires federal agencies to ensure that any action carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species or adversely affect its critical habitat. The entire state of Maine is considered a habitat of the federally-listed endangered short-nosed sturgeon. The Gulf of Maine population of Atlantic sturgeon are listed as threatened species.	There are no known endangered, threatened, or protected species or critical habitats within the boundaries of PNS. However, short-nosed and Atlantic sturgeons are present in the Piscataqua River. Remedial activities would be conducted so as to avoid any adverse effect under the Act to these sturgeon.

REQUIREMENT	CITATION	STATUS	SYNOPSIS	EVALUATION/ACTION TO BE TAKEN
STATE LOCATION-SPECIFIC ARARS AND TBCS				
Natural Resources	Maine Natural Resources Protection Act Permit by Rule Standards [38 MRSA 480 *et seq.*; 06-096 Code of Maine Rules (CMR) Part 305, 1, 2, and 8]	Applicable	This act regulates activity conducted in, on, or over any protected natural resource or any activity conducted adjacent to and operated in such a way that material or soil may be washed into any freshwater or coastal wetland, great pond, river, stream or brook.	Remedial activities associated with in-situ treatment that may disturb soil adjacent to the shoreline would be conducted so as to avoid washing any soil into the nearby Piscataqua River. Stormwater management and erosion control practices would be used to prevent distrubed soil from entering the river during the remedial activities.
Coastal Zone	Maine Coastal Management Policies (38 MRSA 1801 *et seq.*) (06-096 CMR chapter 1000)	Applicable	Regulates activities near great ponds, rivers and larger streams, coastal areas, and wetlands. Regulates shoreland activities and development, including (but not limited to) water pollution prevention and control, wildlife habitat protection, and freshwater and coastal wetlands protection. The law is administered at the local government level. Shoreland areas include areas within 250 feet of the normal high-water line of any river or saltwater body and areas within 75 feet of the high-water line of a stream.	Remedial activities associated with in-situ treatment that may affect storm water runoff, erosion and sedimentation, and surface water quality would be controlled according to these regulations.

REQUIREMENT	CITATION	STATUS	SYNOPSIS	EVALUATION/ACTION TO BE TAKEN
FEDERAL ACTION-SPECIFIC ARARS AND TBCS: NO ARARS OR TBCS				
STATE ACTION-SPECIFIC ARARS AND TBCS				
Hazardous Waste	Identification of Hazardous Wastes 06-096 Part 850	Applicable	These standards establish requirements for determining whether wastes are hazardous based on either characteristic or listing.	Wastes generated as part of remedial activities would be analyzed to determine whether they are RCRA characteristic hazardous wastes. If determined to be hazardous waste, then the waste would be managed in accordance with regulatory requirements.
	Standards for Generators of Hazardous Waste (38 MRSA 1301 *et seq.*, 06-096 Part 851 (5) and (8))	Applicable	These regulations contain pre-transport and accumulation requirements for the generators of hazardous waste.	Waste determined to be hazardous would be managed onsite according to the regulation until disposal offsite.
Erosion and Sedimentation Control	Erosion and Sedimentation Control (38 MRSA Part 420-C)	Applicable	Erosion control measures must be in place before activities such as filling, displacing, or exposing soil or other earthen materials occur. Prior MEDEP approval is required if the disturbed area is in the direct watershed of a body of water most at risk for erosion or sedimentation.	These controls would be applicable to remedial activities associated with in-situ treatment that disturbs soil. Applicable plans would be coordinated with MEDEP before implementation.
Air Emissions	Visible Emissions Regulation (38 MRSA Part 584; 06-096 CMR Part 101)	Applicable	These regulations establish opacity limits for emissions from several categories of air contaminant sources, including general fugitive emissions.	These standards would be met if remedial activities associated with in-situ treatment result in emission of particulate matter and fugitive matter to the atmosphere (e.g., dust generation).

TABLE B-4

ALTERNATIVE 4: IN-SITU CHEMICAL OXIDATION (ISCO) TREATMENT OF ELEVATED PAH AREA AND BUILDING 62 ANNEX LUCS CHEMICAL-, LOCATION-, AND ACTION-SPECIFIC ARARs OPERABLE UNIT 9 FEASIBILITY STUDY REPORT PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

REQUIREMENT	CITATION	STATUS	SYNOPSIS	EVALUATION/ACTION TO BE TAKEN
Underground Injection Wells	Underground Injection Control (UIC) – Class IV Wells 06-096 CMR Part 543 (2)(D)(3)	Applicable	These regulations describe the regulatory requirements for subsurface discharges of all fluids. Injection wells for remediation would be classified under (2)(D)(3)- wells used to discharge solutions to remediate in situ. Maine has primacy of the UIC program.	Ozone injection wells would be constructed and operated in accordance with the substantive requirements for Class IV wells.
Well Abandonment	Guidance for Well and Boring Abandonment, MEDEP, Bureau of Remediation and Waste Management, Division of Technical Services, January 7, 2009	TBC	These guidelines are applicable for the abandonment of borings and monitoring wells.	Abandonment of any injection wells installed as part of this action would be conducted in accordance with these guidelines.

APPENDIX C

COST ESTIMATES

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU9 FS
Alternative 2 - Land Use Controls For Elevated PAH Area and Building 62 Annex
Capital Cost

	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
1	**PROJECT PLANNING & DOCUMENTS**											
1.1	Prepare LUC Documents	200	hr			$39.00		$0	$0	$7,800	$0	$7,800
	Subtotal							$0	$0	$7,800	$0	$7,800
	Overhead on Labor Cost @ 30%									$2,340		$2,340
	G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$0	$0	$780	$0	$780
	Tax on Materials and Equipment Cost @ 6%								$0		$0	$0
	Total Direct Cost							$0	$0	$10,920	$0	$10,920
	Indirects on Total Direct Cost @ 0%											$0
	Profit on Total Direct Cost @ 10%											$1,092
	Subtotal											$12,012
	Health & Safety Monitoring @ 0%											$0
	Total Field Cost											$12,012
	Contingency on Total Field Costs @ 25%											$3,003
	Engineering on Total Field Cost @ 0%											$0
	TOTAL CAPITAL COST											**$15,015**

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU9 FS
Alternative 2 - Land Use Controls For Elevated PAH Area and Building 62 Annex
Annual Cost

Item	Item Cost years 1 - 30	Item Cost every 5 years	Notes
Annual Site Inspection & Report	$2,950		Labor and supplies once a year to inspect Land Use Controls with Report.
Five Year Site Review		$23,000	Labor and supplies to evaluate site every five years for 5-year review
SUBTOTAL	$2,950	$23,000	
Contingency @ 10%	$295	$2,300	
TOTAL	**$3,245**	**$25,300**	

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU9 FS
Alternative 2 - Land Use Controls For Elevated PAH Area and Building 62 Annex
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.0%	Present Worth
0	$15,015		$15,015	1.000	$15,015
1		$3,245	$3,245	0.980	$3,181
2		$3,245	$3,245	0.961	$3,119
3		$3,245	$3,245	0.942	$3,058
4		$3,245	$3,245	0.924	$2,998
5		$28,545	$28,545	0.906	$25,854
6		$3,245	$3,245	0.888	$2,881
7		$3,245	$3,245	0.871	$2,825
8		$3,245	$3,245	0.853	$2,770
9		$3,245	$3,245	0.837	$2,715
10		$28,545	$28,545	0.820	$23,417
11		$3,245	$3,245	0.804	$2,610
12		$3,245	$3,245	0.788	$2,559
13		$3,245	$3,245	0.773	$2,508
14		$3,245	$3,245	0.758	$2,459
15		$28,545	$28,545	0.743	$21,209
16		$3,245	$3,245	0.728	$2,364
17		$3,245	$3,245	0.714	$2,317
18		$3,245	$3,245	0.700	$2,272
19		$3,245	$3,245	0.686	$2,227
20		$28,545	$28,545	0.673	$19,210
21		$3,245	$3,245	0.660	$2,141
22		$3,245	$3,245	0.647	$2,099
23		$3,245	$3,245	0.634	$2,058
24		$3,245	$3,245	0.622	$2,017
25		$28,545	$28,545	0.610	$17,399
26		$3,245	$3,245	0.598	$1,939
27		$3,245	$3,245	0.586	$1,901
28		$3,245	$3,245	0.574	$1,864
29		$3,245	$3,245	0.563	$1,827
30		$28,545	$28,545	0.552	$15,759
				TOTAL PRESENT WORTH	**$196,574**

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU9 FS
Alternative 3 -Excavation of Elevated PAH Area & Building 62 Annex LUCs
Capital Cost

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
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare LUC Documents	200	hr			$39.00		$0	$0	$7,800	$0	$7,800
1.2 Prepare Documents & Plans including Permits	400	hr			$39.00		$0	$0	$15,600	$0	$15,600
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilization	5	ea			$183.00	$518.00	$0	$0	$915	$2,590	$3,505
3 FIELD SUPPORT AND SITE ACCESS											
3.1 Office Trailer	1	mo				$360.00	$0	$0	$0	$360	$360
3.2 Field Office Equipment, Utilities, & Support	1	mo		$519.00			$0	$519	$0	$0	$519
3.3 Storage Trailer	1	mo				$94.00	$0	$0	$0	$94	$94
3.4 Survey Support	2	day	$1,125.00				$2,250	$0	$0	$0	$2,250
3.5 Site Superintendent	15	day		$153.00	$420.00		$0	$2,295	$6,300	$0	$8,595
3.6 Site Health & Safety and QA/QC	15	day		$153.00	$370.00		$0	$2,295	$5,550	$0	$7,845
3.7 Underground Utility Clearance	1	ls	$9,500.00				$9,500	$0	$0	$0	$9,500
4 DECONTAMINATION											
4.1 Decontamination Services	1	mo		$1,220.00	$2,245.00	$1,550.00	$0	$1,220	$2,245	$1,550	$5,015
4.2 Equipment Decon Pad	1	ls		$4,500.00	$3,000.00	$725.00	$0	$4,500	$3,000	$725	$8,225
4.3 Decon Water	1,000	gal		$0.20			$0	$200	$0	$0	$200
4.4 Decon Water Storage Tank, 6,000 gallon	1	mo				$780.00	$0	$0	$0	$780	$780
4.5 Clean Water Storage Tank, 4,000 gallon	1	mo				$702.00	$0	$0	$0	$702	$702
4.6 Disposal of Decon Waste (liquid & solid)	1	mo	$985.00				$985	$0	$0	$0	$985
5 ELEVATED PAH AREA EXCAVATION AND DISPOSAL											
5.1 Temporary Fence	100	lf	$8.65				$865	$0	$0	$0	$865
5.2 Excavator, 2.5 cy (2 each)	10	day			$362.80	$1,613.00	$0	$0	$3,628	$16,130	$19,758
5.3 Waterline Support	1	ls		$1,000.00		$1,500.00	$0	$1,000	$0	$1,500	$2,500
5.4 Sliding Rail Shoring (20' by 10' by 8' deep) 5 days	1	ls	$28,400.00				$28,400	$0	$0	$0	$28,400
5.5 Site Labor, (3 laborers)	30	day			$274.80		$0	$0	$8,244	$0	$8,244
5.6 Confirmation Sampling, PAHs	5	ea	$120.00	$30.00	$50.00	$30.00	$600	$150	$250	$150	$1,150
5.7 T & D of Excavated Soil, hazardous	78	ton	$245.00				$19,110	$0	$0	$0	$19,110
5.8 Waste Disposal Characterization / Analytical	1	ea	$850.00	$30.00	$50.00	$30.00	$850	$30	$50	$30	$960
6 BACKFILL AND RESTORATION											
6.1 Common Fill	49	cy		$18.91			$0	$927	$0	$0	$927
6.2 Topsoil	3	cy		$27.91			$0	$84	$0	$0	$84
6.3 Seed Disturbed Areas	200	sy	$3.61				$722	$0	$0	$0	$722
6.4 Excavator, 2.5 cy	2	day			$362.80	$1,613.00	$0	$0	$726	$3,226	$3,952
6.5 Compactor Attachment	2	day				$271.00	$0	$0	$0	$542	$542
6.6 Compactor, 75 hp	2	day			$362.80	$498.80	$0	$0	$726	$998	$1,723
6.7 Site Labor, (3 laborers)	9	day			$274.80		$0	$0	$2,473	$0	$2,473
7 POST CONSTRUCTION COST											
7.1 Contractor Completion Report	150	hr			$39.00		$0	$0	$5,850	$0	$5,850
7.2 Remedial Action Closeout Report	200	hr			$39.00		$0	$0	$7,800	$0	$7,800
Subtotal							$63,282	$14,219	$71,156	$32,877	$181,534
Overhead on Labor Cost @ 30%									$21,347		$21,347
G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$6,328	$1,422	$7,116	$3,288	$18,153
Tax on Materials and Equipment Cost @ 6%								$853		$1,973	$2,826
Total Direct Cost							$69,610	$16,494	$99,619	$38,137	$223,860

Item	Quantity	Unit	Unit Cost Subcontract	Material	Labor	Equipment	Extended Cost Subcontract	Material	Labor	Equipment	Subtotal
Indirects on Total Direct Cost @ 30%			(excluding transportation and disposal cost)								$61,130
Profit on Total Direct Cost @ 10%											$22,386
Subtotal											$307,376
Health & Safety Monitoring @ 2%											$6,148
Total Field Cost											$313,524
Contingency on Total Field Costs @ 20%											$62,705
Engineering on Total Field Cost @ 15%											$47,029
TOTAL CAPITAL COST											**$423,257**

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU9 FS
Alternative 3 -Excavation of Elevated PAH Area & Building 62 Annex LUCs
Annual Cost

Item	Item Cost years 1 - 30	Item Cost every 5 years	Notes
Annual Site Inspection & Report	$2,950		Labor and supplies once a year to inspect Land Use Controls with Report.
Five Year Site Review		$23,000	Labor and supplies to evaluate site every five years for 5-year review
SUBTOTAL	$2,950	$23,000	
Contingency @ 10%	$295	$2,300	
TOTAL	**$3,245**	**$25,300**	

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU9 FS
Alternative 3 -Excavation of Elevated PAH Area & Building 62 Annex LUCs
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.0%	Present Worth
0	$423,257		$423,257	1.000	$423,257
1		$3,245	$3,245	0.980	$3,181
2		$3,245	$3,245	0.961	$3,119
3		$3,245	$3,245	0.942	$3,058
4		$3,245	$3,245	0.924	$2,998
5		$28,545	$28,545	0.906	$25,854
6		$3,245	$3,245	0.888	$2,881
7		$3,245	$3,245	0.871	$2,825
8		$3,245	$3,245	0.853	$2,770
9		$3,245	$3,245	0.837	$2,715
10		$28,545	$28,545	0.820	$23,417
11		$3,245	$3,245	0.804	$2,610
12		$3,245	$3,245	0.788	$2,559
13		$3,245	$3,245	0.773	$2,508
14		$3,245	$3,245	0.758	$2,459
15		$28,545	$28,545	0.743	$21,209
16		$3,245	$3,245	0.728	$2,364
17		$3,245	$3,245	0.714	$2,317
18		$3,245	$3,245	0.700	$2,272
19		$3,245	$3,245	0.686	$2,227
20		$28,545	$28,545	0.673	$19,210
21		$3,245	$3,245	0.660	$2,141
22		$3,245	$3,245	0.647	$2,099
23		$3,245	$3,245	0.634	$2,058
24		$3,245	$3,245	0.622	$2,017
25		$28,545	$28,545	0.610	$17,399
26		$3,245	$3,245	0.598	$1,939
27		$3,245	$3,245	0.586	$1,901
28		$3,245	$3,245	0.574	$1,864
29		$3,245	$3,245	0.563	$1,827
30		$28,545	$28,545	0.552	$15,759
				TOTAL PRESENT WORTH	**$604,816**

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU9 FS
Alternative 4 -ISCO Treatment of Elevated PAH Area & Building 62 Annex LUCs
Capital Cost

Item	Quantity	Unit	Unit Cost				Extended Cost				
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare LUC Documents	200	hr			$39.00		$0	$0	$7,800	$0	$7,800
1.2 Prepare Documents & Plans including Permits	400	hr			$39.00		$0	$0	$15,600	$0	$15,600
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilization	3	ea			$183.00	$518.00	$0	$0	$549	$1,554	$2,103
3 FIELD SUPPORT AND SITE ACCESS											
3.1 Office Trailer	1	mo				$360.00	$0	$0	$0	$360	$360
3.2 Field Office Equipment, Utilities, & Support	1	mo		$519.00			$0	$519	$0	$0	$519
3.3 Storage Trailer	1	mo				$94.00	$0	$0	$0	$94	$94
3.4 Survey Support	2	day	$1,125.00				$2,250	$0	$0	$0	$2,250
3.5 Site Superintendent	15	day		$153.00	$420.00		$0	$2,295	$6,300	$0	$8,595
3.6 Site Health & Safety and QA/QC	15	day		$153.00	$370.00		$0	$2,295	$5,550	$0	$7,845
3.7 Underground Utility Clearance	1	ls	$9,500.00				$9,500	$0	$0	$0	$9,500
4 DECONTAMINATION											
4.1 Decontamination Services	1	mo		$1,220.00	$2,245.00	$1,550.00	$0	$1,220	$2,245	$1,550	$5,015
4.2 Equipment Decon Pad	1	ls		$4,500.00	$3,000.00	$725.00	$0	$4,500	$3,000	$725	$8,225
4.3 Decon Water	1,000	gal		$0.20			$0	$200	$0	$0	$200
4.4 Decon Water Storage Tank, 6,000 gallon	1	mo				$780.00	$0	$0	$0	$780	$780
4.5 Clean Water Storage Tank, 4,000 gallon	1	mo				$702.00	$0	$0	$0	$702	$702
4.6 Disposal of Decon Waste (liquid & solid)	1	mo	$985.00				$985	$0	$0	$0	$985
5 ELEVATED PAH AREA TREATMENT EQUIPMENT											
5.1 Borings, 1" dia (10 borings)	80	lf	$55.00				$4,400	$0	$0	$0	$4,400
5.2 Oxidation Unit Rental	1	mo				$7,000.00	$0	$0	$0	$7,000	$7,000
5.3 Shipping & Security Deposit	1	ls				$8,000.00	$0	$0	$0	$8,000	$8,000
5.4 Piping & Materials	1	ls		$4,985.00			$0	$4,985	$0	$0	$4,985
5.5 Site Labor, (2 laborers)	20	day			$274.80		$0	$0	$5,496	$0	$5,496
5.6 Electric Generator, 20 kW	36	day				$117.00	$0	$0	$0	$4,212	$4,212
6 TREATMENT SYSTEM O & M											
6.1 Generator Fuel	600	gal		$3.50			$0	$2,100	$0	$0	$2,100
6.2 System Labor, 2 hr per day	24	hr			$69.85		$0	$0	$1,676	$0	$1,676
6.3 Start-Up Assistance	1	ls	$4,000.00				$4,000	$0	$0	$0	$4,000
6.4 Start-Up Kit	1	ls		$1,560.00			$0	$1,560	$0	$0	$1,560
6.5 Sampling Equipment	1	ls	$2,300.00				$2,300	$0	$0	$0	$2,300
6.6 Confirmation Sampling, PAHs	8	ea	$120.00	$30.00	$50.00	$30.00	$960	$240	$400	$240	$1,840
7 SYSTEM REMOVAL AND RESTORATION											
7.1 Topsoil	16	cy		$27.91			$0	$447	$0	$0	$447
7.2 Seed Disturbed Areas	100	sy	$3.61				$361	$0	$0	$0	$361
7.3 Backhoe/Loader, 80 hp	5	day			$362.80	$349.40	$0	$0	$1,814	$1,747	$3,561
7.4 Site Labor, (2 laborers)	10	day			$274.80		$0	$0	$2,748	$0	$2,748
7.5 T & D of Treatment Equipment	20	ton	$36.00				$720	$0	$0	$0	$720
7.6 Abandon System Wells	80	lf	$10.00				$800	$0	$0	$0	$800
7.7 Oxidation Unit Deposit Return	1	ls				-$3,000.00	$0	$0	$0	-$3,000	-$3,000
7.8 Oxidation Unit Return Shipping	1	ls				$5,000.00	$0	$0	$0	$5,000	$5,000
8 POST CONSTRUCTION COST											
8.1 Contractor Completion Report	150	hr			$39.00		$0	$0	$5,850	$0	$5,850
8.2 Remedial Action Closeout Report	200	hr			$39.00		$0	$0	$7,800	$0	$7,800
Subtotal							$26,276	$21,361	$66,828	$32,464	$146,929
Overhead on Labor Cost @ 30%									$20,049		$20,049
G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$2,628	$2,136	$6,683	$3,246	$14,693
Tax on Materials and Equipment Cost @ 6%								$1,282		$1,948	$3,229
Total Direct Cost							$28,904	$24,778	$93,560	$37,658	$184,900

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
Indirects on Total Direct Cost @ 30%											$55,470
Profit on Total Direct Cost @ 10%											$18,490
Subtotal											$258,860
Health & Safety Monitoring @ 2%											$5,177
Total Field Cost											$264,037
Contingency on Total Field Costs @ 20%											$52,807
Engineering on Total Field Cost @ 15%											$39,606
TOTAL CAPITAL COST											**$356,450**

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU9 FS
Alternative 4 -ISCO Treatment of Elevated PAH Area & Building 62 Annex LUCs
Annual Cost

Item	Item Cost years 1 - 30	Item Cost every 5 years	Notes
Annual Site Inspection & Report	$2,950		Labor and supplies once a year to inspect Land Use Controls with Report.
Five Year Site Review		$23,000	Labor and supplies to evaluate site every five years for 5-year review
SUBTOTAL	$2,950	$23,000	
Contingency @ 10%	$295	$2,300	
TOTAL	**$3,245**	**$25,300**	

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU9 FS
Alternative 4 -ISCO Treatment of Elevated PAH Area & Building 62 Annex LUCs
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.0%	Present Worth
0	$356,450		$356,450	1.000	$356,450
1		$3,245	$3,245	0.980	$3,181
2		$3,245	$3,245	0.961	$3,119
3		$3,245	$3,245	0.942	$3,058
4		$3,245	$3,245	0.924	$2,998
5		$28,545	$28,545	0.906	$25,854
6		$3,245	$3,245	0.888	$2,881
7		$3,245	$3,245	0.871	$2,825
8		$3,245	$3,245	0.853	$2,770
9		$3,245	$3,245	0.837	$2,715
10		$28,545	$28,545	0.820	$23,417
11		$3,245	$3,245	0.804	$2,610
12		$3,245	$3,245	0.788	$2,559
13		$3,245	$3,245	0.773	$2,508
14		$3,245	$3,245	0.758	$2,459
15		$28,545	$28,545	0.743	$21,209
16		$3,245	$3,245	0.728	$2,364
17		$3,245	$3,245	0.714	$2,317
18		$3,245	$3,245	0.700	$2,272
19		$3,245	$3,245	0.686	$2,227
20		$28,545	$28,545	0.673	$19,210
21		$3,245	$3,245	0.660	$2,141
22		$3,245	$3,245	0.647	$2,099
23		$3,245	$3,245	0.634	$2,058
24		$3,245	$3,245	0.622	$2,017
25		$28,545	$28,545	0.610	$17,399
26		$3,245	$3,245	0.598	$1,939
27		$3,245	$3,245	0.586	$1,901
28		$3,245	$3,245	0.574	$1,864
29		$3,245	$3,245	0.563	$1,827
30		$28,545	$28,545	0.552	$15,759
				TOTAL PRESENT WORTH	**$538,009**

APPENDIX D

AREA AND QUANTITY CALCULATIONS

CLIENT: PORTSMOUTH NAVAL SHIPYARD		JOB NUMBER: 112G02214 - FS.DR
SUBJECT: OU9 FS - QUANTITY CALCULATIONS		
BASED ON:		DRAWING NUMBER:
BY: Matt Kaus Date: 10/12/2012	CHECKED BY: Fer Padlila Date: 10/22/2012	APPROVED BY: DATE:

PURPOSE:

The purpose of this calculation is to determine the volumes, areas, and quantities of materials associated with the remedial action alternatives presented in the OU9 FS. These material and volume quantities are presented within the FS text and are used to support the cost estimates provided in Appendix C.

DISCUSSION:

The volume, area, and quantity calculations presented below are based on the descriptions of the alternatives presented in Section 4.0 of the text and FS Figures 4-1 through 4-3.

CALCULATIONS:

Alternative 2 - Land Use Controls (LUCs) for Elevated PAH Area and Building 62 Annex

Alternative 2 includes the implementation of LUCs over the areas identified in Figure 4-1.

Land use control area

Area of the LUC limits on Fig. 4-1 = 3,500 sf

Inspections would be required for the LUCs at the site.

Five year reviews would also be required under this alternative.

Alternative 3 - Excavation of Elevated PAH Area and Building 62 Annex LUCs

Alternative 3 includes excavation in the elevated PAH area north of Building 62 and LUCs for the Building 62 Annex area. All excavated soil would be characterized and disposed off-site. The excavation area would be backfilled to existing grade and surface conditions would be returned to pre-excavation conditions.

Excavation of Elevated PAH Area

There is a water line in the elevated PAH area. Therefore, it is assumed that a slide rail system would be used for the excavation

Area =	175	sf
Depth =	8	ft
Volume =	1400	cf
=	52	cy

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BY: Matt Kaus Date: 10/12/2012	CHECKED BY: Fer Padlila Date: 10/22/2012	APPROVED BY: DATE:

Confirmation samples would be collected from the floor and sidewalls of the excavation area.

Number of Confirmation Samples = 5 samples

Characterization sampling for off-site disposal would be collected at a rate of 1 sample for every 500 cy of material going off-site for disposal.

Number of Characterization Samples = 1 sample

Assume the excavated material would be disposed as hazardous waste.

Following excavation and off-site disposal, the excavated area would need to be backfilled and restored to site condition. The following presents the volume of material needed to backfill the excavation areas and the volume of material needed to restore the surface conditions.

Total Volume of Backfill Material = 52 cy
Volume of 6'' top soil = 3 cy
Volume of clean fill = 49 cy

LUCs for Building 62 Annex Area
Building 62 Annex would require LUCs no that potential future residents are not exposure to subsurface soil.

Land use control area

Area of the LUC limits on Fig. 4-2 = 3,500 sf

Inspections would be required for the LUCs at the site.

Five year reviews would also be required under this alternative.

Alternative 4 - In-situ Chemical Oxidation Treatment of Elevated PAH Area and Building 62 Annex LUCs

Alternative 4 includes in-situ treatment of the contaminated subsurface soil using ozone in the elevated PAH area north of Building 62 and LUCs in the Building 62 Annex area.

In-situ Chemical Oxidation Treatment at the Elevated PAH Area

Area = 175 sf
Depth = 8 ft
Volume = 1,400 cf
= 39,620 L
Bulk Density = 1.8 g/cm3
Total Soil Mass = 71,316 kg

Assume ten 1-in diamter oxidation points would be installed in this area to 8 ft bgs.

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SUBJECT: OU9 FS - QUANTITY CALCULATIONS			
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BY: Matt Kaus Date: 10/12/2012	CHECKED BY: Fer Padlila Date: 10/22/2012	APPROVED BY:	DATE:

Assume a hollow-stem auger rig would be used to advance each boring and facilitate construction of the oxidation points.

No. of injection wells =	10	
Ave. drilling depth =	8	ft
Total drilling depth =	80	ft

There are 4 sampling locations with PAHs concentrations exceeding the PRG in this area, including OU9-13, OU9-14, OU9-15, and OU9-22.

Conc. (mg/kg)		cPAH based on BAP TEQ
PRG		1.5
OU9-13	4 to 6 feet	53
	6 to 8 feet	230
OU9-14	4 to 6 feet	0.14
	6 to 8 feet	0.09
	8 to 10 feet	7
OU9-15	4 to 6 feet	14
	6 to 8 feet	12
	8 to 10 feet	3.9
OU9-22	0 to 2 feet	6.1
	2 to 5 feet	77
	5 to 8 feet	610
Geomean (mg/kg)		10.66
Total Mass (lb)		1.67
Num. Mean (mg/kg)		92.11
Total Mass (lb)		14.45

Assume 6 lb of ozone would be needed to break down each lb of cPAHs

Using the estimated total mass of PAHs based on numeric mean, the total amount of ozone needed is

lb Ozone/lb PAHs =	6	
mass of Ozone needed =	87	lb

Assume 25% more ozone would be needed for consumption by inorganic compounds in

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unsaturated zone

Additional percentage of ozone needed =	25%	
Total mass of ozone needed =	108	lb
Ozone Generator Output (max.) =	10.9	lb/day

Assume the system would be programmed to inject ozone alternating between each oxidation point for 20 to 30 minutes each and then shutting down for system cool down for 60 minutes before restarting the next cycle.

Assume	Ozone injection time =	30	min/point/cycle
	No. of oxidation points =	10	
	System cool down time =	60	min/cycle
	Operation time =	360	min/cycle
	=	6	hr/cycle
	No. of cycles per day =	4	
	Total injection time =	1200	min/day
	=	20	hr/day
	Total ozone injected =	9.1	lb/day
	Total time needed for ozone injection =	12	days
	=	0.4	months

Assume a towable generator would be needed on-site to provide 3-phase power to the ozone generator

Assume its fuel consumption is	2.5	gal diesel/hr
Total fuel consumption =	597	gal diesel

Assume that a soil vapor extraction system would NOT be needed.

Assume confirmation soil samples would be collected from the treatment area after ozone treatment for analysis of PAHs

No. of confirmation samples = 8

Land Use Controls at the Building 62 Annex Area

Land use control area

Area of the LUC limits on Fig. 4-3 = 3,500 sf

Inspections would be required for the LUCs at the site.

Five year reviews would also be required under this alternative.

APPENDIX E

ENVIRONMENTAL FOOTPRINT EVALUATION

APPENDIX E-1 ENVIRONMENTAL FOOTPRINT REPORT

APPENDIX E

Environmental Footprint Evaluation
Feasibility Study
Operable Unit 9
Portsmouth Naval Shipyard
Kittery, Maine
October 2012

OBJECTIVE

This Environmental Footprint Evaluation of remedial alternatives is provided as an Appendix to the Feasibility Study (FS) for the Operable Unit 9 (OU9) located at Portsmouth Naval Shipyard located in Kittery, ME. The purpose of the footprint evaluation is to assess the environmental impacts of the four remedial alternatives using the metrics of greenhouse gas (GHG) and criteria pollutant emissions, energy use, water consumption, and worker safety. The results of this footprint evaluation are intended to provide additional information for consideration during remedy selection, design, and to enhance the understanding of the environmental impacts throughout the remedy life-cycle for each of the proposed alternatives.

POLICY BACKGROUND

Department of Defense (DOD) and Navy policies require continual optimization of remedies in every phase from remedy selection through site closeout (NAVFAC, 2010a).

In January 2007, Executive Order 13423 set targets for sustainable practices for (i) energy efficiency, greenhouse gas emissions avoidance or reduction, and petroleum products use reduction, (ii) renewable energy, including bioenergy, (iii) water conservation, (iv) acquisition, (v) pollution and waste prevention and recycling, etc. In October 2009, Executive Order 13514 was issued, which reinforced these sustainability requirements and established specific goals for federal agencies to meet by 2020.

In August 2009 DOD issued a policy for “Consideration of Green and Sustainable Remediation Practices in the Defense Environmental Restoration Program.” The DOD policy and related Navy guidance state that opportunities to increase sustainability should be considered throughout all phases of remediation (i.e., site investigation, remedy selection, remedy design and construction, operation, monitoring, and site closeout). In response to this policy, the Department of the Navy (DON) issued an updated Navy Guidance for “Optimizing Remedy Evaluation, Selection, and Design” (NAVFAC, 2010b), which includes environmental footprint evaluations as part of the traditional DON optimization review process for remedy selection, design, and remedial action operation. In August 2010, the Naval Facilities Engineering Command (NAVFAC) issued policy requiring use of the SiteWise™ tool to perform environmental impact reviews as part of all Feasibility Studies. As such, this environmental footprint evaluation of remedial alternatives is being performed to estimate the environmental footprint associated with each alternative in the interest of reducing the environmental impact of remedial action at OU9, Portsmouth Naval Shipyard.

Applying the DON optimization concepts with an environmental footprint evaluation within the remedy selection and design phases allows for the following benefits:

- Determining factors in each remedial alternative with the greatest environmental impacts and gathering insight into how to reduce these impacts;
- Evaluating remedial alternatives with optimized or reduced environmental footprints in conjunction with other selection criteria;
- Designing and implementing a more robust remedy while balancing the impact to the environment; and
- Ensuring efficient, cost-effective and sustainable site closeout.

EVALUATION TOOLS

This evaluation was performed using a hybrid model of the Navy's SiteWise™ tool supplemented with Tetra Tech developed model as appropriate for some site-specific items.

SiteWise™ is a life-cycle footprint assessment tool developed jointly by the U.S. Navy, U.S. Army Corps of Engineers (USACE), and Battelle. SiteWise™ assesses the environmental footprint of a remedial alternative/technology using a consistent set of metrics. The assessment is conducted using a building block approach, where each remedial alternative is first broken down into modules that follow the phases for most remedial actions, including remedial investigation (RI), remedial action construction (RA-C), remedial action operation (RA-O), and long-term monitoring (LTM). Once broken down by remedial phase, the footprint of each phase is calculated. The phase-specific footprints are then combined to estimate the overall footprint of the remedial alternative. This building block approach reduces redundancy in the footprint assessment and facilitates the identification of specific impact drivers that contribute to the environmental footprint. The inputs that need to be considered include (1) production of material required by the activity; (2) transportation of the required materials to the site, transportation of personnel; (3) all site activities to be performed; and (4) management of the waste produced by the activity.

GSRx builds off of SiteWise™ and allows for a flexible, detailed analysis, particularly for materials and equipment use. GSRx was used to account for materials and activities not readily input into SiteWise™

and where equipment usage assumptions built into SiteWise™ were not consistent with site-specific requirements.

ENVIRONMENTAL FOOTPRINT EVALUATION FRAMEWORK AND LIMITATIONS

The environmental footprint evaluation performed for OU9 Portsmouth Naval Shipyard FS considered life-cycle quantitative metrics for global warming potential (through greenhouse gas emissions), criteria air pollutant emissions, energy consumption, water usage, and worker safety.

Life cycle impacts were calculated for energy consumption, emissions of GHG (carbon dioxide [CO_2], methane [CH_4], and nitrous oxide [N_2O]) and criteria pollutants (nitrogen oxides [NO_x], sulfur oxides [SO_x] and particulate matter [PM_{10}]), water usage, and energy consumption, and worker safety.

Life cycle inventory inputs in SiteWise™ were divided into four categories – 1) materials production; 2) transportation of personnel, materials and equipment; 3) equipment use and miscellaneous; and 4) residual handling and disposal. Cost estimates from the RI/FS and design calculations were used as a basis for inventory quantities and related assumptions. Emission factors, energy consumption, and water usage data were correlated to material quantities, equipment, transportation distances, and installation time frames in order to calculate life-cycle emissions, energy consumption, water usage, and worker safety. Default SiteWise™ emission, energy usage, water consumption, and worker fatality and accident risk factors were utilized.

Although GSRx was used to minimize limitations resulting within SiteWise™, elimination of all limitations was not possible while using a hybrid model of SiteWise™ and GSRx. For example, several materials and construction equipment inventoried were input into GSRx and these impacts were incorporated into SiteWise™ within the "Equipment Use and Miscellaneous" sector. This sector in SiteWise™ does not differentiate into the specific equipment usage or material consumption items that are input in GSRx, but rather are considered miscellaneous items. However, impact drivers for items input in GSRx can be identified and evaluated directly within the respective GSRx evaluation and output summary sheets. In addition, worker safety results in general do not include worker safety related to equipment usage that was input within GSRx because GSRx was not developed to evaluate worker safety.

EVALUATION RESULTS

The following are the alternatives that were analyzed with SiteWise™ and GSRx for the OU9 Portsmouth Naval Shipyard FS:

- Alternative 2: Land Use Controls for Elevated PAH Area and Building 62 Annex

- Alternative 3: Excavation of Elevated PAH Area and Building 62 Annex Land Use Controls
- Alternative 4: In-situ Chemical Oxidation Treatment of Elevated PAH Area and Building 62 Annex Land Use Controls

The following sections summarize the relative environmental impacts and primary impact drivers for the three alternatives and their respective metrics. In addition, the attachment includes the inventory and output sheets that were used for the SiteWise™/GSRx hybrid model. An evaluation of SiteWise™ and GSRx output summary sheets and related figures included in the footprint evaluation attachments (Appendix E-2 and E-3), provides detailed information on the contribution to each metric from each phase of the remedial process (RI, RAC, RAO, and LTM) and for each respective input category (materials production, transportation, equipment usage, etc). Further inspection of related inventory sheets provide information on the specific contribution to a metric from each item of material, transportation, equipment, etc. This level of detail also helps clarify results that could be misinterpreted based on SiteWise™ data entry limitations mentioned previously. The environmental impacts of the alternatives analyzed are summarized quantitatively in Table E1.

Greenhouse Gas Emissions

Emissions of CO_2, CH_4, and N_2O were normalized to CO_2 equivalents (CO_2e), which is a cumulative method of weighing GHG emissions relative to global warming potential. Figure E1 shows the overall GHG emissions of each of the alternatives analyzed; the x-axis represents the three alternatives evaluated and the y-axis represents the GHG emissions in metric ton of CO_2e.

The total amount of GHG emissions that would result from Alternative 2 is 0.69 metric ton of CO_2e. The driver for these emissions is the transportation of personnel during the yearly site visit and the five-year review visit.

The emissions of GHG that would result from Alternative 3 are 21.28 metric ton of CO_2e. The activity with the highest emissions of GHG is the use of the excavator; contributing 35 percent of the total GHG emissions (approximately 7.4 metric ton of CO_2e). The activity with the second highest contribution to GHG emissions is the residual handling operation for hazardous materials, emitting 4.3 metric ton of CO_2e, approximately 20 percent of the total GHG emissions for Alternative 3. The activity with the third highest contribution to the GHG emissions is the transportation of personnel contributing with 11 percent of the total GHG emissions, approximately 1.6 metric ton of CO_2e.

Alternative 4 would emit 9.89 metric ton of CO_2e related to all the activities that take place during this remedial alternative. The activity with the highest contribution to GHG emissions is the diesel power generator that produces electricity for the treatment, where 3.09 metric ton of CO_2e are emitted to the atmosphere (approximately 32 percent of the total GHG emissions). The second largest contributor to GHG emissions is the transportation of personnel, where 1.92 metric ton of CO_2e are emitted to the atmosphere, approximately 20 percent of the total GHG emissions. The production of HDPE emits 1.56 metric ton of CO_2e, corresponding to approximately 16 percent of the total GHG emissions.

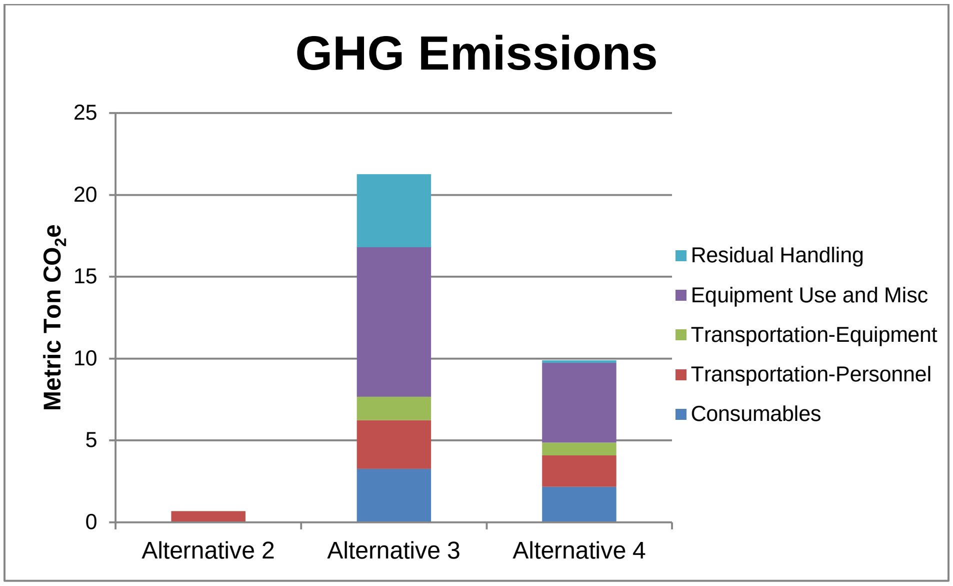


Figure E1: GHG Emissions for Remedial Alternatives for OU9, Portsmouth Naval Shipyard

Figure E2 shows the breakdown of the percent that each of main activities of each alternative (x-axis) contributes to the GHG emissions (y-axis).

For Alternative 2, the total amount of GHG emissions that would be emitted to the atmosphere is 0.69 metric ton of CO_2e, and all GHG emissions are attributed to the transportation of personnel.

For Alternative 3, the total amount of GHG emissions would be released to the atmosphere is 21.28 metric tons of CO_2e. The activity sector with the highest contribution to GHG emissions is the equipment use and miscellaneous, where 9.15 metric ton of CO_2e are released to the atmosphere, approximately 43 percent of the total GHG emissions. Residual handling operations is the sector with the second highest contribution to these emissions, with 4.46 metric ton of CO_2e, approximately 21 percent of the total emissions. The activity sector with the third highest contribution is the manufacture of raw materials, where 3.27 metric tons of CO_2e are released, approximately 15 percent of total GHG emissions.

The total amount of GHG emissions resulting from Alternative 4 would be 9.89 metric ton of CO_2e. The activity sector with the highest contribution to GHG emissions is the equipment use and miscellaneous. This activity sector contributes with 4.86 metric ton of CO_2e, corresponding to approximately 49 percent of the total GHG emissions. The activity group with the second highest contribution to GHG emissions is the production of raw materials. The production of raw material activity group emits 2.17 metric ton of CO_2e which corresponds to approximately 22 percent of the total GHG emissions for this Alternative. The activity sector with the third highest contribution is the transportation of personnel, where 1.92 metric ton of CO_2e are released, approximately 19 percent of the total GHG emissions.

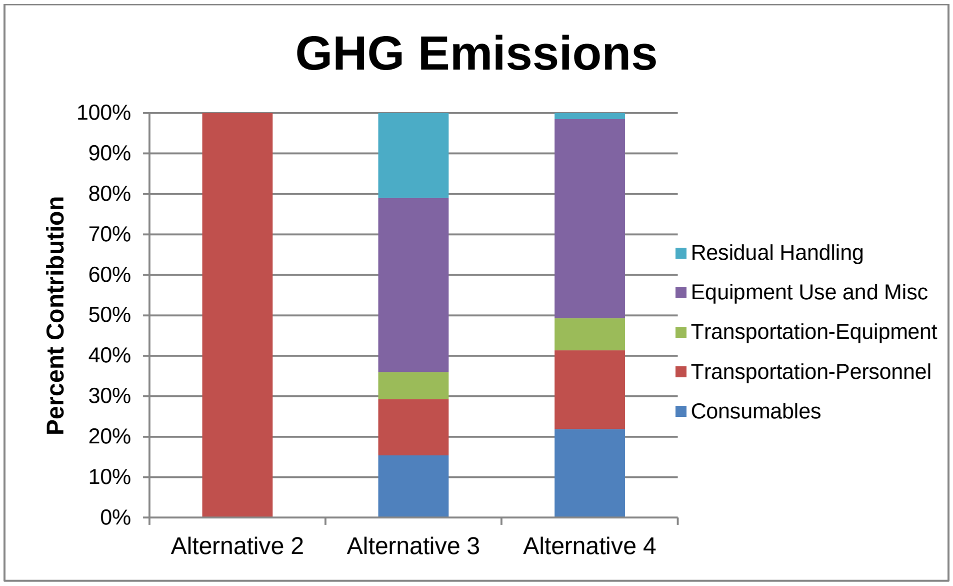


Figure E2: GHG Emissions percentage breakdown for Remedial Alternatives for OU9, Portsmouth Naval Shipyard

Criteria Pollutant Emissions

NO_X

Figure E3 shows the breakdown of the NO_X emissions for the two alternatives evaluated. The x–axis of this figure represents Alternatives 2, 3 and 4; the y-axis represents the NO_X emissions in metric ton.

The total amount of NO_X emissions from Alternative 2 would be $2.5x10^{-4}$ metric ton. The activity that contributes to these emissions is the transportation of personnel.

The total NO_X emissions resulting from Alternative 3 would be $6.5x10^{-2}$ metric ton. The activity with the highest contribution of NO_X emissions is the use of the excavator, releasing $4.7x10^{-2}$ metric ton, approximately 73 percent of the total NO_X emissions. The activity with the second highest contribution of NO_X emissions is the residual handling operations for hazardous materials, emitting $6.5x10^{-3}$ metric ton of NO_X, corresponding to approximately 10 percent of the total NO_X emissions. The activity with the third highest contribution of NO_X emissions to the atmosphere is the use of the tractor, used mainly for site restoration activities, emitting $4x10^{-3}$ metric ton of NO_X, approximately 6 percent of the total NO_X emissions.

Alternative 4 would emit $3.3x10^{-2}$ metric ton of NO_X to the atmosphere. The activity with the highest contribution to NO_X emissions is use of the diesel power generator, emitting $2.0x10^{-2}$ metric ton of NO_X, corresponding to approximately 60 percent of the total NO_X emissions for this alternative. The activity with the second highest contribution to NO_X emissions is the use of the loader, contributing $4.3x10^{-3}$ metric ton of NO_X (approximately 13 percent of the total NO_X emissions). The use of the tractor emits $4.0x10^{-3}$ metric ton of NO_X, approximately 12 percent of the total NO_X emissions.

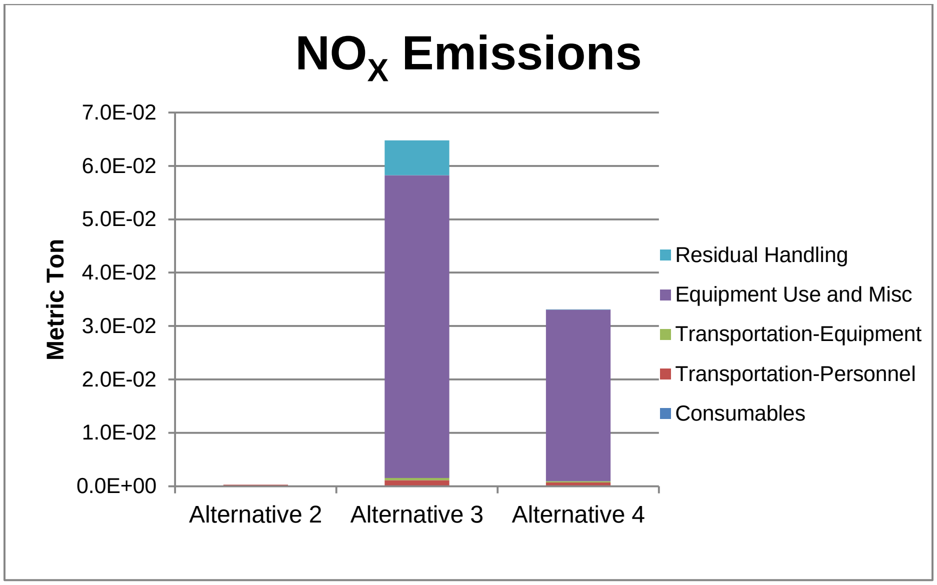


Figure E3 NO_X Emissions for Remedial Alternatives for OU9, Portsmouth Naval Shipyard

Figure E4 shows the percentage contribution from each of the main activity sectors.

The total amount of NO_X emissions for Alternative 2 would be $2.5x10^{-4}$ metric ton, where all emissions can be allocated to the transportation of personnel during the lifetime of the Alternative.

Alternative 3 would emit a total of $6.5x10^{-2}$ metric ton of NO_X. The activity sector with the highest contribution to NO_X emissions is the equipment use and miscellaneous with approximately 88 percent of the total of NO_X emissions (which corresponds to $5.7x10^{-2}$ metric ton of NO_X). The activity sector with the second highest contribution to these emissions is the residual handling operations, where $6.5x10^{-2}$ metric ton of NO_X are emitted to the atmosphere (approximately 10 percent of the total NO_X emissions). Transportation of personnel is the activity group with the third highest contribution to NO_X emissions. The amount of NO_X emitted by transportation of personnel is $1.1x10^{-3}$ metric ton of NO_X, which corresponds to approximately two percent of the total NO_X emissions.

Alternative 4 would emit a total of $3.3x10^{-2}$ metric ton of NO_X. The activity sector with the highest contribution to NO_X emissions is the equipment use and miscellaneous with approximately 97 percent of the total NO_X emissions, corresponding to $3.2x10^{-2}$ metric ton of NO_X. The activity with the second highest contribution to these emissions is the transportation of personnel, where $7.1x10^{-4}$ metric ton of NO_X are emitted, corresponding to approximately two percent of the total NO_X emissions. Transportation of equipment and materials is the activity sector with the third highest contribution to NO_X emissions with $2.5x10^{-4}$ metric ton, corresponding to approximately one percent of the total NO_X emission resulting from this Alternative.

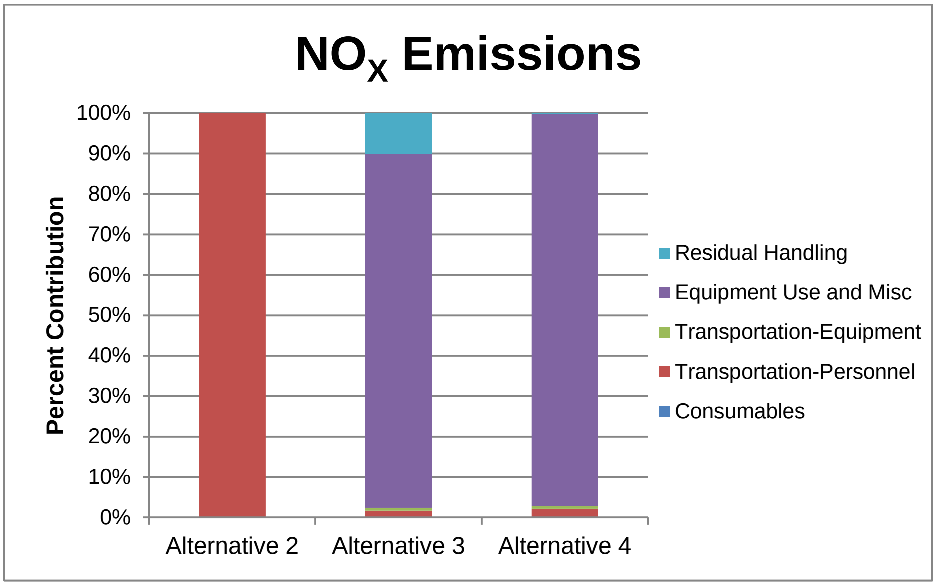


Figure E4: NO_X Emissions percentage breakdown for Remedial Alternatives for OU9, Portsmouth Naval Shipyard

SO_X

Figure E5 contains the distribution of the SO_X emissions resulting from the activities related to Alternatives 2, 3 and 4. The x-axis of this graph represents the alternatives evaluated; the y-axis represents the SO_X emissions in metric ton.

The total amount of SO_X emissions resulting from Alternative would be 2 is $8.9x10^{-6}$ metric ton of SO_X. Transportation of personnel is the activity that to contributes the SO_X emissions.

Alternative 3 would emit a total of $2.2x10^{-2}$ metric ton of SO_X. The use of the excavator is the activity with the highest SO_X emissions, $1.4x10^{-2}$ metric ton of SO_X, approximately 62 percent of the total SO_X emissions. The production of HDPE, is the activity with the second highest SO_X contribution emitting

$3.5x10^{-3}$ metric ton of SO_X, corresponding to approximately 16 percent of the total SO_X emissions. The activity with the third highest contribution to these emissions is the residual handling operations for hazardous wastes, where $2.9x10^{-3}$ metric ton of SO_X are emitted, contributing approximately 13 percent of the total SO_X emissions to the atmosphere.

The amount of SO_X released to the atmosphere by Alternative 4 would be $1.0x10^{-2}$ metric ton. The use of the diesel power generator is the activity that has the highest contribution to SO_X emissions, $4.1x10^{-3}$ metric ton, approximately 40 percent of the total SO_X emissions. The activity with the second highest contribution to SO_X emissions is the production of HDPE, where $3.5x10^{-3}$ metric ton of SO_X are released (approximately 35 percent of the total SO_X emissions). Laboratory analytical services emit $1.3x10^{-3}$ metric ton of SO_X, corresponding to 13 percent of the total SO_X emissions.

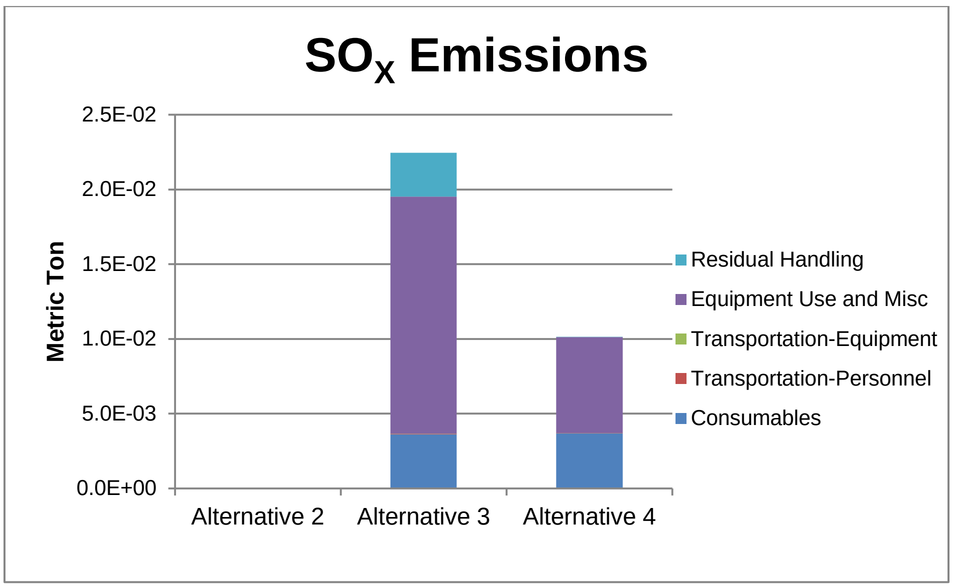


Figure E5: SO_X Emissions for Remedial Alternatives for OU9, Portsmouth Naval Shipyard

Figure E6 shows the percentage breakdown of the activities contributing to SO_X emissions.

Alternative 2 would emit $8.9x10^{-6}$ metric ton of SO_X, where the transportation of personnel is the activity sector responsible for such emissions.

The total amount of SO_X emissions resulting from Alternative 3 would be $2.2x10^{-2}$ metric ton. The activity group with the highest contribution to SO_X emissions is the equipment use and miscellaneous, where $1.6x10^{-2}$ metric ton of SO_X are released to the atmosphere, approximately 71 percent of the total SO_X emissions. The production of materials is the activity sector with the second highest contribution to SO_X emissions with $3.6x10^{-3}$ metric ton of SO_X, approximately 16 percent of the total SO_X emissions. The third highest contribution to SO_X emissions is from the residual handling operations, where $2.9x10^{-3}$ metric ton of SO_X are released, corresponding to approximately 13 percent of the total SO_X emissions resulting from this alternative.

The total SO_X emissions for Alternative 4 would be $1.0x10^{-2}$ metric ton. The equipment use and miscellaneous sector is the one that contributes the most to the SO_X emissions with $6.4x10^{-3}$ metric ton, approximately 63 percent of the total SO_X emissions. Production of materials is the activity sector with the second highest contribution of these emissions to the atmosphere, releasing $3.7x10^{-3}$ metric ton, approximately 36 percent of the total SO_X emissions. Transportation of personnel is the third highest contributor to SO_X emissions with $2.5x10^{-5}$ metric ton, corresponding to less than one percent of the total SO_X emissions.

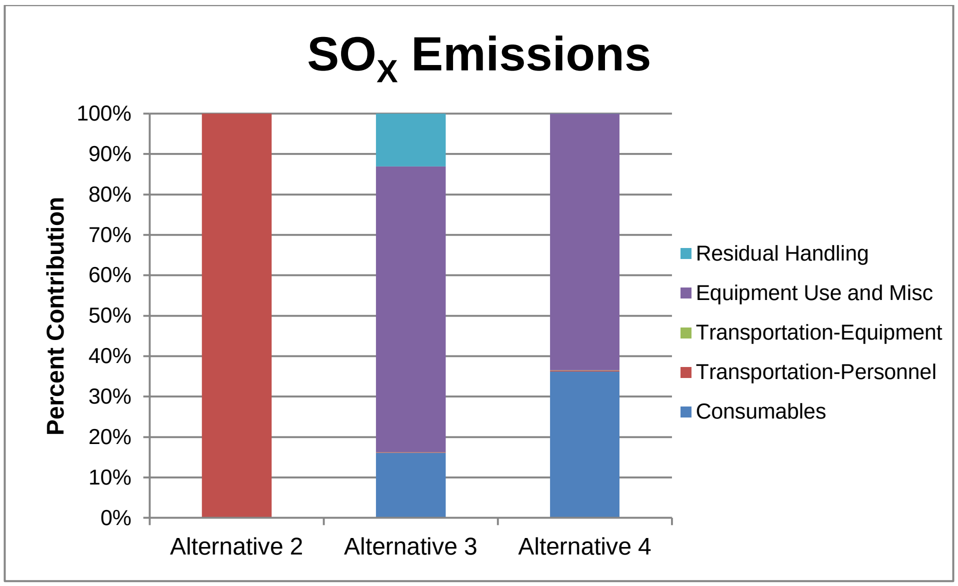


Figure E6: SO_X Emissions percentage breakdown for Remedial Alternatives for OU9, Portsmouth Naval Shipyard

PM_{10}

The breakdown of the distribution of the PM_{10} emissions resulting from the activities involved in Alternatives 2, 3 and 4 are shown in Figure E7. The x-axis of this figure represents the three alternatives evaluated, while the y-axis represents the PM_{10} emissions in metric ton.

The total PM_{10} emissions resulting from Alternative 2 would be $5.1x10^{-5}$ metric ton. The activity with the highest contribution to these emissions is the transportation of personnel.

Alternative 3 would emit a total of $2.2x10^{-2}$ metric ton of PM_{10}. The activity with the highest PM_{10} contribution is the residual handling operation of hazardous wastes, with $1.6x10^{-2}$ metric ton of PM_{10}, corresponding to approximately 72 percent of the total PM_{10} emissions as a result from this alternative. The use of the excavator is the activity with the second highest contribution to PM_{10} emissions, emitting $4.5x10^{-3}$ metric ton of PM_{10}, contributing approximately 21 percent of the total PM_{10} emissions. The production of HDPE is the activity with the third highest contribution to PM_{10} emissions, contributing with two percent of the total PM_{10} emissions, approximately $5.1x10^{-4}$ metric tons.

The total amount of PM_{10} emissions resulting from Alternative 4 would be $4.5x10^{-3}$ metric ton. The use of the diesel power generator emits $2.4x10^{-3}$ metric ton of PM_{10}, contributing 53 percent of the total PM_{10} emissions. The use of the loader is the activity with the second highest contribution to PM_{10} emissions, contributing with 19 percent of the total PM_{10} emissions, approximately $8.4x10^{-4}$ metric tons. The production of HDPE used during the activities of this alternative emits $5.1x10^{-4}$ metric tons of PM_{10}, approximately 11 percent of the total PM_{10} emissions.

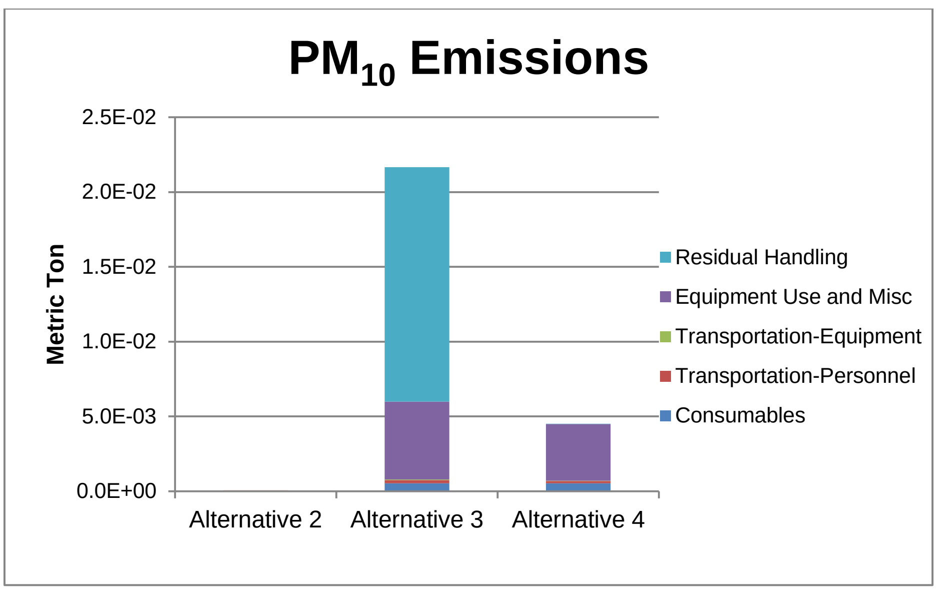


Figure E7: PM_{10} Emissions for Remedial Alternatives for OU9, Portsmouth Naval Shipyard

Figure E8 shows the percentage of PM_{10} emissions contributed by each of the activity sectors per alternative.

The total amount of PM_{10} emissions resulting from Alternative 2 would be $5.1x10^{-5}$ metric ton, and the transportation of personnel is the sector that is responsible for these alternatives being emitted to the atmosphere.

The total amount of PM_{10} emissions from Alternative 3 would be 2.2x10^{-2} metric ton. The activity sector with the highest contribution is the residual handling operations, where 1.6x10^{-2} metric ton are emitted, and represents 72 percent of the total PM_{10} emissions. The activity sector with the second highest contribution to these emissions is the equipment use and miscellaneous, where 5.2x10^{-3} metric ton of PM_{10} are emitted corresponds to approximately 24 percent of total PM_{10} emissions. The production of materials is the activity sector with the third highest contribution to PM_{10} emissions, where 5.2x10^{-4} metric ton are emitted, approximately two percent of the total PM_{10} emissions.

Alternative 4 would emit a total of 4.5x10^{-3} metric ton of PM_{10}. The activity sector with the highest contribution to these emissions is the equipment use and miscellaneous, where 3.8x10^{-3} metric ton of PM_{10} are released to the atmosphere, approximately 84 percent of the total PM_{10} emissions for this alternative. The activity with the second highest contribution is the production of raw materials, where 5.3x10^{-4} metric ton of PM_{10} are emitted, corresponding to approximately 12 percent of the total PM_{10} emissions. Transportation of personnel is the activity with the third highest contribution to PM_{10} emissions. Transportation of personnel emits 1.4x10^{-4} metric ton, approximately 3 percent of the total PM_{10} emissions.

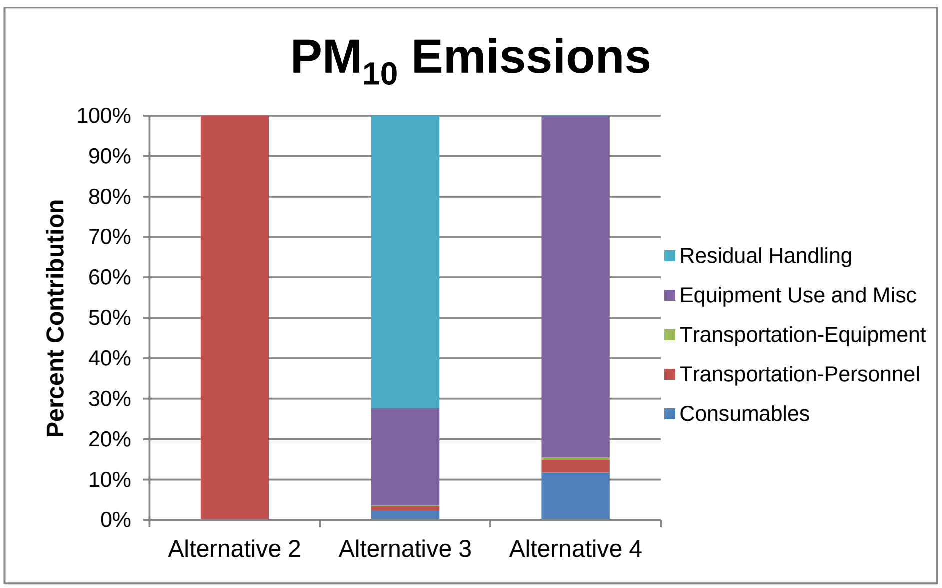


Figure E8: PM_{10} Emissions percentage breakdown for Remedial Alternatives for OU9, Portsmouth Naval Shipyard

Energy Consumption

The energy consumption for each of the alternatives evaluated is shown in Figure E9. The x-axis shows the three alternatives evaluated, and the y-axis shows the amount of energy consumed in units of million British Thermal Units (MMBTU).

The total amount of energy consumed by Alternative 2 would be 8.63 MMBTU. The activity that takes place during this alternative is the transportation of personnel.

The total energy consumption resulting from the activities that take place during Alternative 3 would be 442.35 MMBTU. The production of borrow soil, used as backfill for the treatment areas consumes 146.7 MMBTU, approximately 34 percent of all energy used during this alternative. The activity with the second highest energy consumption is the use of the excavator, where the energy consumption represents approximately 27 percent (115.3 MMBTU) of the total energy used for this remedial alternative. Residual handling operations of hazardous materials consumes 64.2 MMBTU, corresponding to approximately 15 percent of the total energy consumption during this Alternative.

Alternative 4 would consume 220.11 MMBTU. The use of the diesel power generator during the remediation treatment consumes 73.7 MMBTU, approximately 34 percent of all energy used during this alternative. The production of borrow soil consumes 45.1 MMBTU, corresponding to 21 percent of the total energy consumption. The activity with the third highest energy consumption is the production of HDPE, where the energy consumption represents approximately 14 percent (31.3 MMBTU) of the total energy used for this remedial alternative.

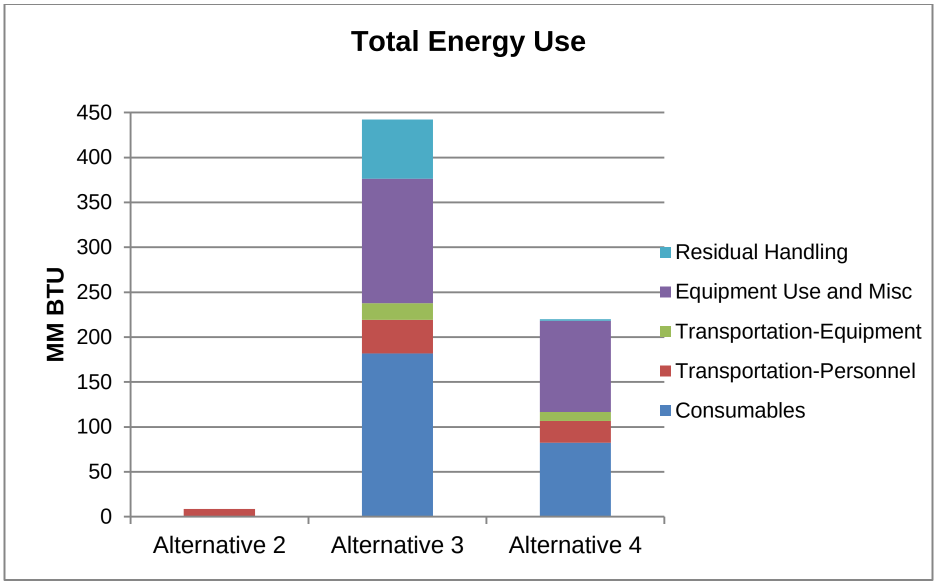


Figure E9: Energy Consumption for Remedial Alternatives for OU9, Portsmouth Naval Shipyard

Figure E10 shows the percentage breakdown contribution of energy consumption from the different activity groups.

The total amount of energy consumed by Alternative 2 would be 8.6 MMBTU. The activity that takes place during this alternative is the transportation of personnel.

The total amount of energy consumed by Alternative 3 would be 442.4 MMBTU. The activity sector with the highest energy consumption is the production of materials, where 181.9 MMBTU are consumed, approximately 41percent of the total energy use. The activity sector with the second highest energy consumption is the equipment use and miscellaneous, where 138.5 MMBTU are consumed, approximately 31 percent of the total energy consumption of this Alternative. The activity sector with the third highest energy consumption is the residual handling operations where 66.1 MMBTU are consumed, approximately 15 percent of the total energy consumption.

The total amount of energy used during Alternative 4 would be 220.1 MMBTU. The activity group with the highest consumption of energy is the equipment use and miscellaneous, where 101.4 MMBTU are consumed, approximately 46 percent of the total energy use of the alternative. Production of materials is the activity group that has the second highest energy consumption, 82.3 MMBTU are consumed through this activity, approximately 37 percent of the total energy use. Transportation of personnel is the activity with the third highest energy consumption, approximately 11 percent of the total energy consumed, which corresponds to 24.2 MMBTU.

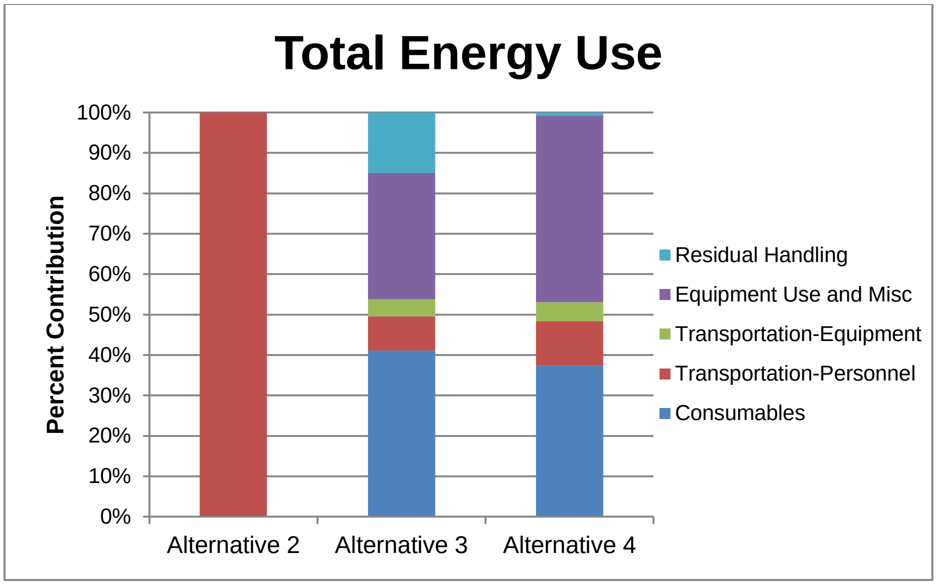


Figure E10: Energy Consumption percentage breakdown for Remedial Alternatives for OU9, Portsmouth Naval Shipyard

Water Usage

The water consumption of the evaluated alternatives is shown in Figure E11. The x-axis shows the four evaluated alternatives, and the y-axis show the amount of water consumed in thousands of gallons.

There would be no direct water consumption assumed for Alternative 2

The total water consumption for Alternative 3 would be 1,271 gallons of water. The amount of water used for decontamination purposes during the remedial alternative is 79 percent (one thousand gallons of water) of the total amount of water consumed. The water used to produce HDPE corresponds to 20 percent of the total water used (approximately 252 gallons of water). The water used to produce fertilizer for revegetation purposes is 16 gallons of water, approximately one percent of the total water consumption for this alternative.

The total water consumption for Alternative 4 would be 1,401 gallons of water. The amount of water used for decontamination purposes during the remedial alternative is 71 percent (one thousand gallons of water) of the total amount of water consumed. The water used to produce HDPE corresponds to 18 percent of the total water used (approximately 252 gallons of water). The water used to produce PVC for the construction of the wells consumes 138 gallons of water, approximately ten percent of the total water consumption for this alternative.

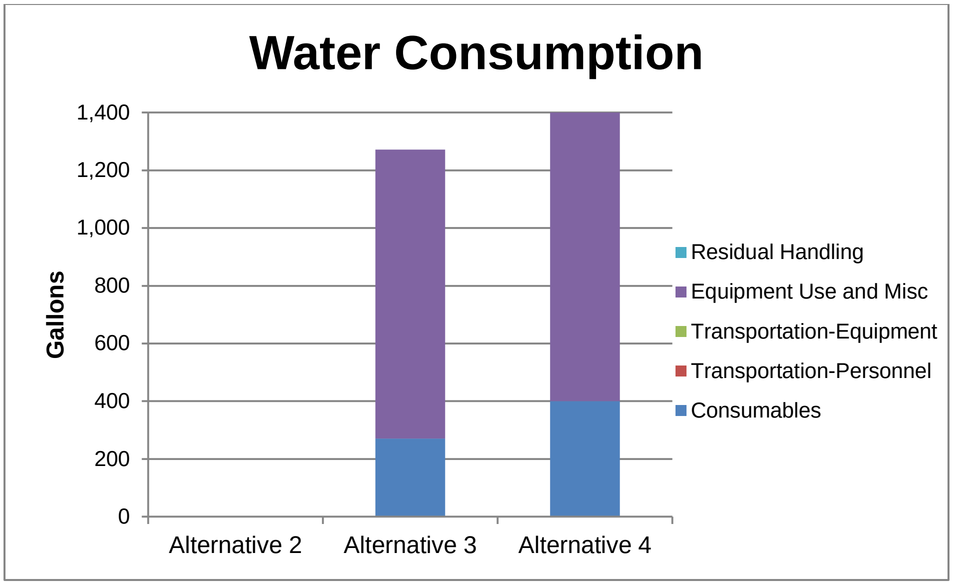


Figure E11: Water Consumption for Remedial Alternatives for OU9, Portsmouth Naval Shipyard

Figure E12 has a representation of the percentage breakdown of the contribution of the different sectors of the water use through the lifetime of the alternatives.

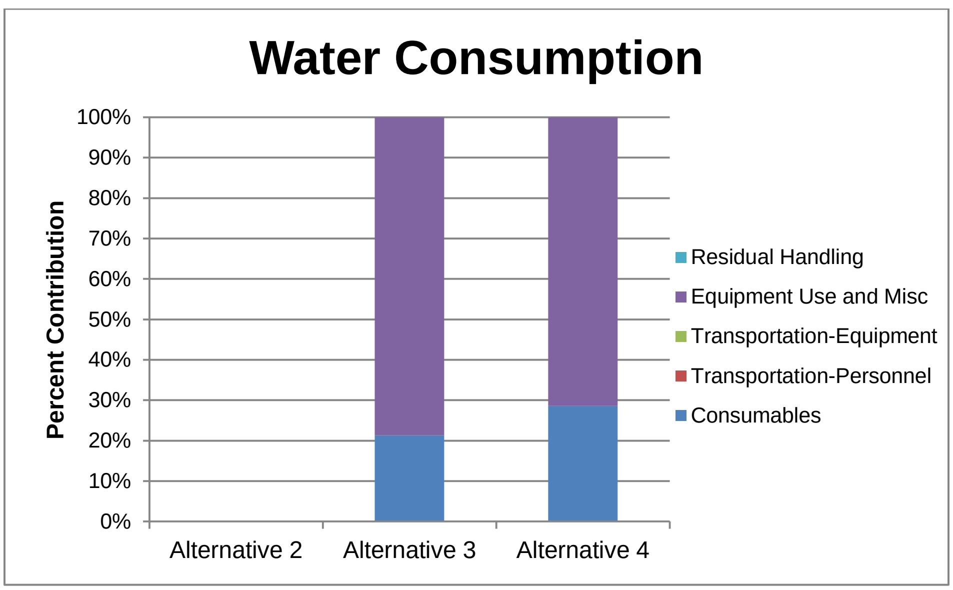


Figure E12: Water Consumption Percentage Breakdown for Remedial Alternatives for OU9, Portsmouth Naval Shipyard

Accident Risk

Accident Risk Fatality

Figure E13 shows the risk of fatality between the evaluated alternatives. The x-axis represents the three alternatives evaluated, and the y-axis represents the risk of fatality.

For all Alternatives, the activity with the highest risk of fatality would be the transportation of personnel. For Alternative 3, the residual handling operations would be the activity with the second highest risk of fatality. For Alternative 4, equipment use and miscellaneous would be the activity with the second highest risk of fatality.

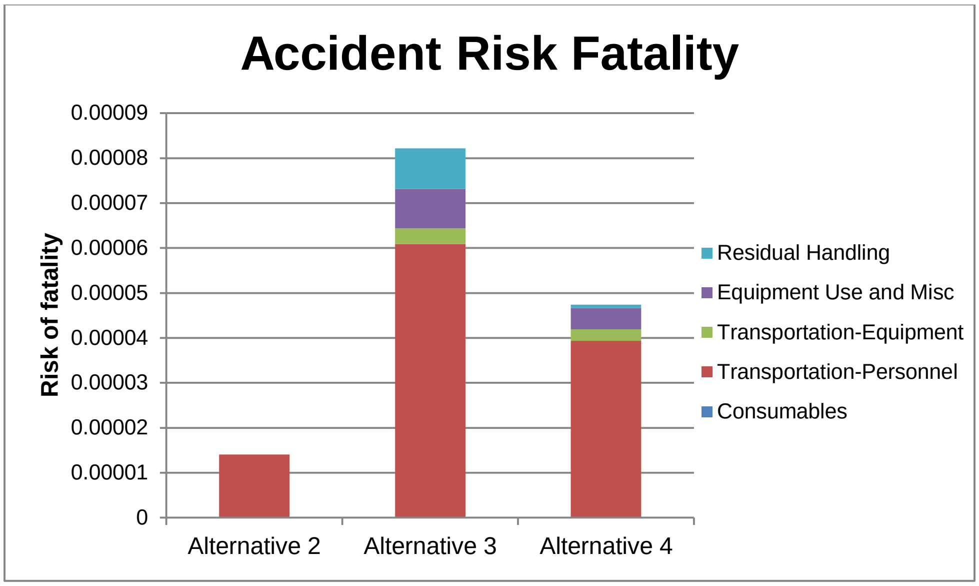


Figure E13 Risk of Fatality for Remedial Alternatives for OU9, Portsmouth Naval Shipyard

Accident Risk Injury

Figure E14 shows the risk of injury between the evaluated alternatives. The x-axis represents the three alternatives evaluated, and the y-axis represents the risk of injury.

For all Alternatives, the activity with the highest risk of injury would be the transportation of personnel. The activity with the second highest risk of injury for Alternatives 3 and 4 would be the equipment use and miscellaneous.

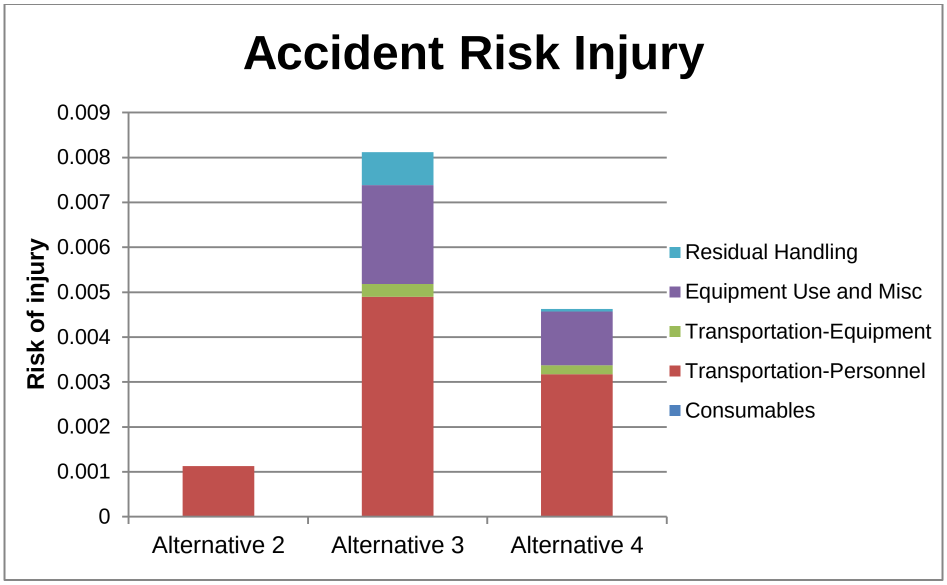


Figure E14 Risk of Injury for Remedial Alternatives for OU9, Portsmouth Naval Shipyard

CONCLUSIONS AND RECOMMENDATIONS

During selection and design of the remedy, a sensitivity analysis considering elements of the remedy that have the greatest impact on remedy effectiveness, life-cycle cost, and environmental footprint metrics may provide additional insight into appropriate optimization. To aid in the sensitivity analysis, an impact analysis summary was created to qualitatively highlight the relative impact of respective metrics for the two alternatives and to identify the primary drivers of emissions, energy consumption, and water usage for each alternative (see Table E2 for details).

Figures E2, E4, E6, E8, E10 and E12 show the percentage breakdown of each of the sectors that take place during the remedial alternatives. In these graphs, it is easy to identify the sector whose contribution is largest from all other sectors to that impact category. An advantage to identifying where the large contributions are, the optimization process for lowering the environmental impacts is faster and might be could be more efficient.

Measures identified in the evaluation that may reduce the environmental footprint of the alternatives are listed below for consideration.

- Alternatives 3 and 4: Some reduction of the environmental footprint, particularly GHG emissions and energy consumption, could be realized for these alternatives through the possible use of emission control measures such as alternate fuel sources (e.g. biodiesel), equipment exhaust controls (e.g. diesel), and equipment idle reduction.

- Alternatives 3 and 4: Consider optimizing of the use of equipment, and even the type of equipment used during operations.
- Alternative 3: Consider optimizing the amount of soil needed for backfill of the treatment areas.
- Alternative 3: Consider options of different modes of transportation for the soil residues as a result of the excavation purposes. The optimization of amount of residues and the mode of transportation could reduce impacts.
- Alternative 4: Consider the optimization of the electricity use through the generator. This optimization can be achieved by either changing generators (model, size) or considering another type of fuel. The use of renewable sources of energy (if possible) could be an option.
- All Alternatives: Consider ways to reduce vehicle mileage to reduce worker risk as well as energy use and emissions. Encourage site workers to carpool daily to the site to reduce total vehicle mileage.

<u>REFERENCES</u>

(a) NAVFAC, DON Guidance for Optimizing Remedy Evaluation, Selection, and Design, March 2010
(b) NAVFAC, DON Policy on SiteWise™ Optimization/GSR Tool Usage, email received from Brian Harrison/NAVFAC HQ dated 10 AUG 2010

Table E-1
Environmental Impact Results
OU9, Portsmouth Naval Shipyard
Kittery, Maine

Alternative	Activities	GHG Emissions	Total Energy Used	Water Impacts	NO_X Emissions	SO_X Emissions	PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
		Metric Ton CO_2e	MMBTU	Gallons	Metric Ton	Metric Ton	Metric Ton		
Alternative 2	Materials Production	0.00	0.00	0	0.0E+00	0.0E+00	0.0E+00	NA	NA
	Transportation-Personnel	0.69	8.63	NA	2.5E-04	8.9E-06	5.1E-05	1.40E-05	1.13E-03
	Transportation-Equipment	0.00	0.00	NA	0.0E+00	0.0E+00	0.0E+00	0.00E+00	0.00E+00
	Equipment Use and Misc	0.00	0.00	0	0.0E+00	0.0E+00	0.0E+00	0.00E+00	0.00E+00
	Residual Handling	0.00	0.00	NA	0.0E+00	0.0E+00	0.0E+00	0.00E+00	0.00E+00
	Total	0.69	8.63	0	2.5E-04	8.9E-06	5.1E-05	1.40E-05	1.13E-03
Alternative 3	Materials Production	3.27	181.89	271	1.7E-08	3.6E-03	5.2E-04	NA	NA
	Transportation-Personnel	2.97	37.39	NA	1.1E-03	3.9E-05	2.2E-04	6.08E-05	4.90E-03
	Transportation-Equipment	1.42	18.50	NA	4.5E-04	7.9E-06	4.0E-05	3.51E-06	2.83E-04
	Equipment Use and Misc	9.15	138.46	1,000	5.7E-02	1.6E-02	5.2E-03	8.78E-06	2.21E-03
	Residual Handling	4.46	66.11	NA	6.5E-03	2.9E-03	1.6E-02	9.05E-06	7.28E-04
	Total	21.28	442.35	1,271	6.5E-02	2.2E-02	2.2E-02	8.22E-05	8.12E-03
Alternative 4	Materials Production	2.17	82.31	401	8.5E-09	3.7E-03	5.3E-04	NA	NA
	Transportation-Personnel	1.92	24.21	NA	7.1E-04	2.5E-05	1.4E-04	3.94E-05	3.17E-03
	Transportation-Equipment	0.78	10.23	NA	2.5E-04	4.4E-06	2.2E-05	2.50E-06	2.01E-04
	Equipment Use and Misc	4.86	101.41	1,000	3.2E-02	6.4E-03	3.8E-03	4.76E-06	1.20E-03
	Residual Handling	0.15	1.95	NA	4.7E-05	8.3E-07	4.2E-06	7.80E-07	6.28E-05
	Total	9.89	220.11	1,401	3.3E-02	1.0E-02	4.5E-03	4.74E-05	4.63E-03

Table E-2
Environmental Impact Drivers
OU9, Portsmouth Naval Shipyard
Kittery, Maine

Remedial Alternatives	GHG Emissions	Total energy Used	Water Consumption	NO_X emissions	SO_X Emissions	PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
Alternative 2	Low	Low	Low	Low	Low	Low	Low	Low
	Transportation of personnel	Transportation of personnel	No direct consumption	Transportation of personnel	Transportation of personnel	Transportation of personnel	Transportation of personnel	Transportation of personnel
Alternative 3	High	High	High	High	High	High	High	High
	Use of excavator	Production of borrow soil	Decontamination water	Use of the excavator	Use of the excavator	Residual handling operations (hazardous residues)	Transportation of personnel	Transportation of personnel
Alternative 4	Moderate	Moderate	High	Moderate	Moderate	Low to moderate	Moderate	Moderate
	Use of diesel power generator	Use of diesel power generator	Decontamination water	Use of diesel power generator	Use of diesel power generator	Use of diesel power generator	Transportation of personnel	Transportation of personnel

APPENDIX E-2 INPUT INVENTORIES AND ASSUMPTIONS

Alternative 2: Land Use Controls for Elevated PAH Area and Building 62 Annex

LTM			
Transportation-Personnel			
Item	Quantity	Units	Comments
Annual Inspection	1,500	miles	1 visit per year, 1 day per visit, 50 miles per day, 1 person, for 30 years
Five year review inspection	300	miles	1 visit every five years, 1 day per vsit, 50 miles per day, 1 person, for years 5, 10, 15, 20 25 and 30

Alternative 3: Excavation of Elevated PAH Area and Building 62 Annex Land Use Controls

RAC

Materials

Item	Quantity	Units	Comments
Equipment Decon Pad	700.47	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	441.16	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Decon water	1,000	gallons	
Common fill	147,000	lb	Assume top soil, 49 cy, 1.5 ton/cy, 2000 lb/ton
Top Soil	9,000	lb	Assume top soil, 3 cy, 1.5 ton/cy, 2000 lb/ton
Seeding, mulch	90.00	lb	200 sy, assume mulch assume, 50 lb per msf
Seeding, fertilizer	36.00	lb	200 sy, assume fertilizer, assume 20 lb per msf

Transportation-Personnel

Item	Quantity	Units	Comments
Transportation of field support, site superintendant, site healtn and safety and QA/QC person	3,750	miles	25 days, 50 miles per day, 3 people
Site labor: hot spot excavation and disposal	1,500	miles	10 days, 50 miles per day, 3 people
Site Labor: backfill and restoration	750	miles	3 days, 50 miles per day, 3 people

Transportation-equipment

Item	Quantity	Units	Comments
Trailers	50.00	ton	5 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.90	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 ln per 500 gal capacity tank
Clean Water Storage Tank	0.60	ton	4000 gallons capacity HPDE, 100 miles round trip
Sliding Rain Shoring	10.00	ton	Assume 10 ton, 100 miles round trip
Excavator, 2.5 cy, 2 units	40.00	ton	2 excavator, 20 ton per excavator, 100 miles round trip
Truck tractor, 220 hp	13.29		26585 lb per tractor
Compactor attachment	1.00	ton	Assume 1 ton, 100 miles round trip
Excavator 2.5 CY	20.00	ton	1 excavator, 20 ton per excavator, 100 miles round trip
Compactor 75 hp	5.10	ton	1 unit, 10,190 lb per unit, 100 miles reound trip

Transportation-materials

Item	Quantity	Units	Comments
Equipment Decon Pad	0.35	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	0.22	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Common fill	74	ton	Assume top soil, 49 cy, 1.5 ton/cy, 2000 lb/ton
Top Soil	5	ton	Assume top soil, 3 cy, 1.5 ton/cy, 2000 lb/ton
Seeding, mulch	0.05	ton	200 sy, assume mulch assume, 50 lb per msf
Seeding, fertilizer	0.02	ton	200 sy, assume fertilizer, assume 20 lb per msf

Equipment Use

Item	Quantity	Units	Comments
Excavator, 2.5 cy, 2 units	64	hours	5 days, 8 hours per day, 80% utilization
Tractor, 220 hp	6.4	hours	1 day, 8 hours per day, 80% utilization
Excavator 2.5 CY	12.8	hours	2 days. 8 hours per day, 80% utilization
Item	Quantity	Units	Comments
Decon water	4.16	ton	1000 gallons, 8.32 ppg, 2000 lb per ton
Excavated Soil, hazardous	78	ton	

Transportation-residual handling

Item	Quantity	Units	Comments

Decon water	100	miles	2000 gallons, 8.32 ppg, 2000 lb per ton
Excavated Soil, hazardous	530	miles	

Analytical Laboratory Services			
Item	Quantity	Units	Comments
Confirmation samples	$600	dollars	5 samples, 120 dollars per sample
Waste Disposal Characterization	$850	dollars	1 sample, 850 dollars per sample

LTM			
Transportation-Personnel			
Item	Quantity	Units	Comments
Annual Inspection	1,500	miles	1 visit per year, 1 day per visit, 50 miles per day, 1 person, for 30 years
Five year review inspection	300	miles	1 visit every five years, 1 day per vsit, 50 miles per day, 1 person, for years 5, 10, 15, 20 25 and 30

Alternative 4: ISCO Treatment of Elevated PAH Area and Buidling 62 Annex Land Use Controls

RAC

Materials

Item	Quantity	Units	Comments
Equipment Decon Pad	700.47	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	441.16	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Decon water	1,000	gallons	
Borings	26.64	lb	10 borings, 80 lf, 1 in diameter, Assume PVC, 0.333 lb/ft
Topsoil	48000	lb	16 CY, 1.5 ton/cy, 2000 lb/ton, Assume top soil
Seeding, mulch	45	lb	100 sy, assume mulch assume, 50 lb per msf
Seeding, fertilizer	18	lb	100 sy, assume fertilizer, assume 20 lb per smf
Abandon of wells	209.42	lb	Assume sand, 80 lf, 2 in diameter, 1922 kg/m3 (gravel with sand)
Abandon of wells	209.42	lb	Assume gravel, 80 lf, 2 in diameter, 1922 kg/m3 (gravel with sand)

Transportation-Personnel

Item	Quantity	Units	Comments
Site Superintendent transportation	1,000	miles	20 days, 50 miles per day, 1 person
Site labor: hot spot treatment equipment	1,000	miles	10 days, 50 miles per day, 2 people
Site labor: system removal and restoration (seeding)	150	miles	1 day, 50 miles per day, 3 people
Site Labor: system removal and restoration	500	miles	5 days, 50 miles per day, 2 people

Transportation-equipment

Item	Quantity	Units	Comments
Trailers	30	ton	3 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.9	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 ln per 500 gal capacity tank
Clean Water Storage Tank	0.6	ton	4000 gallons capacity HPDE, 100 miles round trip
Oxidation Unit	10	ton	Assume 10 tons, 100 miles roundtrip
Electric Generator 20 kW	1.27	ton	2530 lb, 100 miles round trip
Truck tractor, 220 hp	13.29	ton	26585 lb per tractor, 100 miles round trip
Backhoe-loader, 80 hp, 1-1/4 CY Capacity	7.44	ton	1 unit, 14881 lb per unit, 100 miles round trip
Drill Rig, DPT	3.05	ton	1 drill rig, 6100 lb, 100 miles round trip

Transportation-materials

Item	Quantity	Units	Comments
Equipment Decon Pad	0.35	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	0.22	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Borings	0.01	ton	10 borings, 80 lf, 1 in diameter, Assume PVC, 0.333 lb/ft
Topsoil	24.00	ton	16 CY, 1.5 ton/cy, 2000 lb/ton, Assume top soil
Seeding, mulch	0.02	ton	100 sy, assume mulch assume, 50 lb per msf
Seeding, fertilizer	0.01	ton	100 sy, assume fertilizer, assume 20 lb per smf
Abandon of wells	0.10	ton	Assume sand, 80 lf, 2 in diameter, 1922 kg/m3 (gravel with sand)

Item	Quantity	Units	Comments
Drill Rig, DPT	12.8	hours	5 wells per day, 10 wells total, 8 hours per day, 80% utilization
Truck tractor, 220 hp	6.4	hours	1 day, 8 hours per day, 80% utilization
Bakchoe Loader, 80hp	32	hours	5 days, 8 hours per day, 80% utilization

Residual Handling			
Item	Quantity	Units	Comments
Decon water	4.16	ton	1000 gallons, 8.32 ppg, 2000 lb per ton

Transportation-residual handling			
Item	Quantity	Units	Comments
Decon water	100	miles	1000 gallons, 8.32 ppg, 2000 lb per ton

RAO

Transportation-Personnel			
Item	Quantity	Units	Comments
System Labor: treatement system O&M	600	miles	12 days, 50 miles per day, 1 person

Transportation-equipment			
Item	Quantity	Units	Comments
Generator fuel	0.43	ton	1 generator, 850 lb, 100 miles round trip

Transportation-materials			
Item	Quantity	Units	Comments

Equipment Use			
Item	Quantity	Units	Comments
Generator fuel	240	hours	Assume diesel, 600 gallons, Assume 2.5 gal/hour consumption

Laboratory Analytical Services			
Item	Quantity	Units	Comments
Confirmation Samples, PAHs	960	dollars	8 samples, 120 dollars per sample

LTM

Transportation of personnel			
Item	Quantity	Units	Comments
Annual site inspection	1500	miles	1 visit per year, 50 miles per visit, 30 years, 1 person
five year site review	300	miles	1 visit per year, 50 miles per visit, 6 years, 1 person

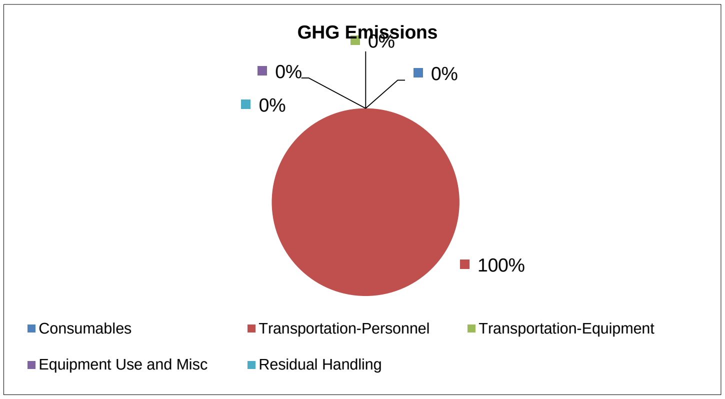
APPENDIX E-3 SITEWISE™ RESULTS

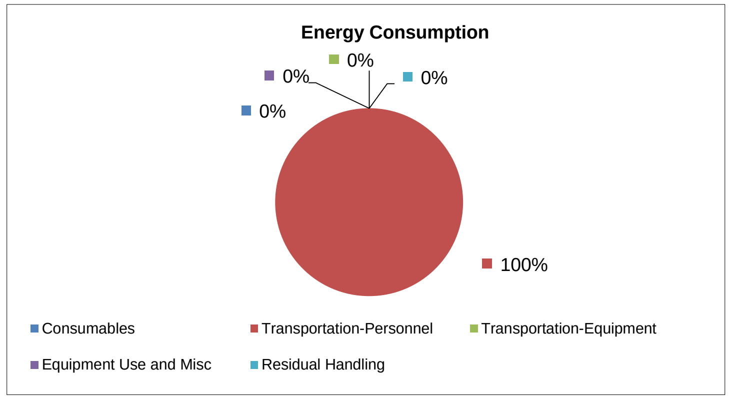
Sustainable Remediation - Environmental Footprint Summary
Alternative 2

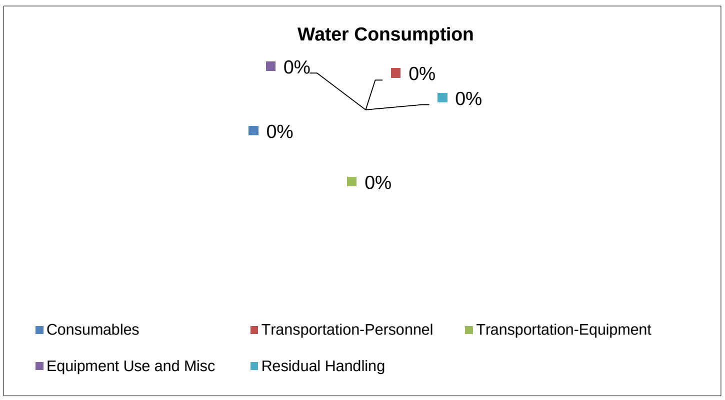
Phase	Activities	GHG Emissions (metric ton)	Total energy Used (MMBTU)	Water Consumption (gallons)	NOx emissions (metric ton)	SOx Emissions (metric ton)	PM10 Emissions (metric ton)	Accident Risk Fatality	Accident Risk Injury
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.69	8.6E+00	NA	2.5E-04	8.9E-06	5.1E-05	1.4E-05	1.1E-03
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.69	8.63E+00	0.00E+00	2.54E-04	8.94E-06	5.15E-05	1.40E-05	1.13E-03
Total		**6.9E-01**	**8.6E+00**	**0.0E+00**	**2.5E-04**	**8.9E-06**	**5.1E-05**	**1.4E-05**	**1.1E-03**

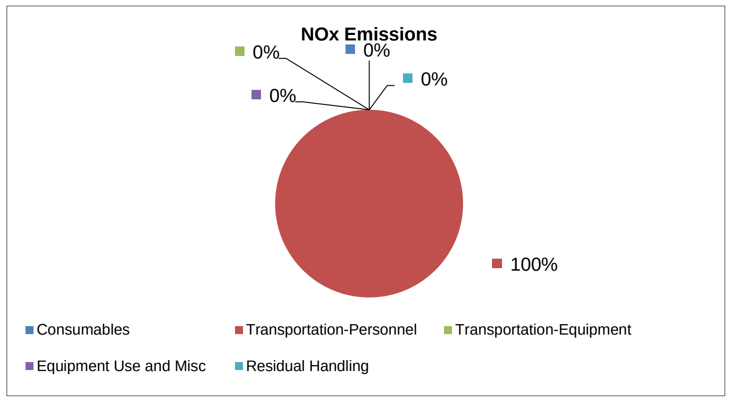
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space (tons)	Hazardous Waste Landfill Space (tons)	Topsoil Consumption (cubic yards)	Costing ($)	Lost Hours - Injury
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	9.0E-03
Total	**0.0E+00**	**0.0E+00**	**0.0E+00**	**$0**	**9.0E-03**

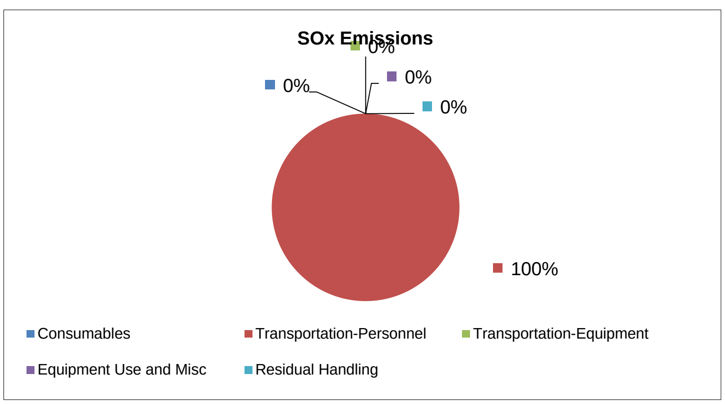
Total Cost with Footprint Reduction
$0

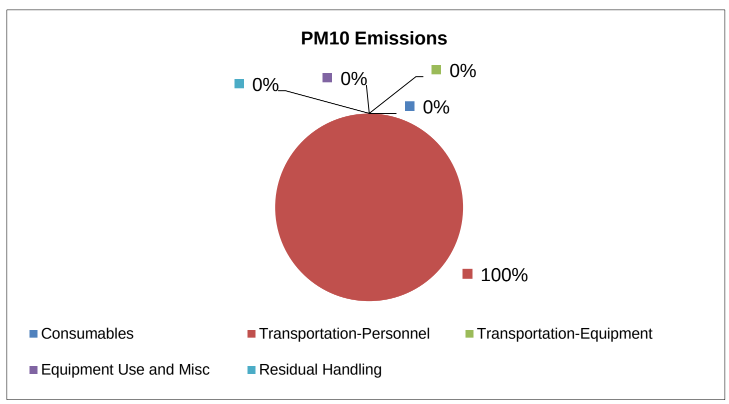

GHG Emissions
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

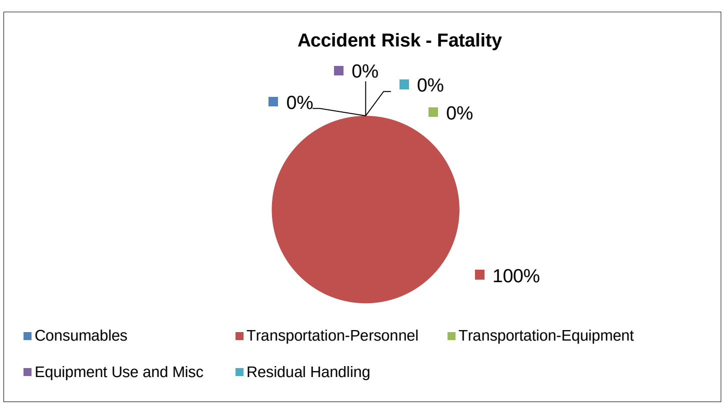

Energy Consumption
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

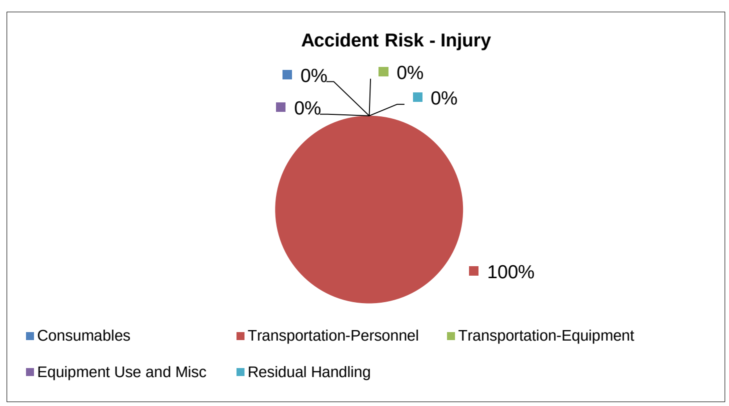

Water Consumption
0%
0%
0%
0%
0%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling


NOx Emissions
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

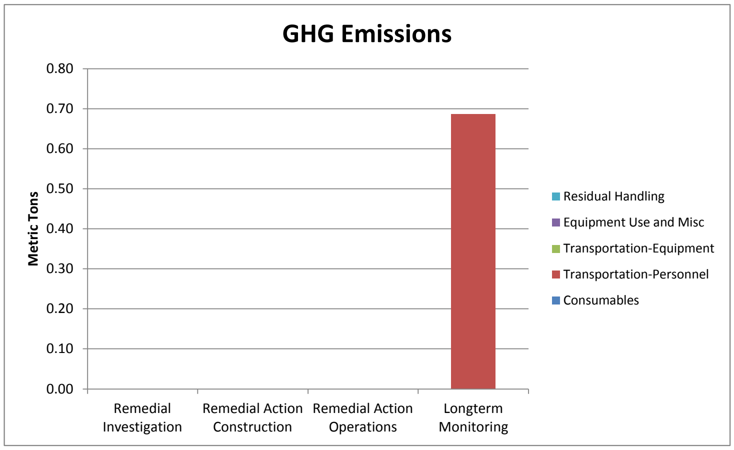

SOx Emissions
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

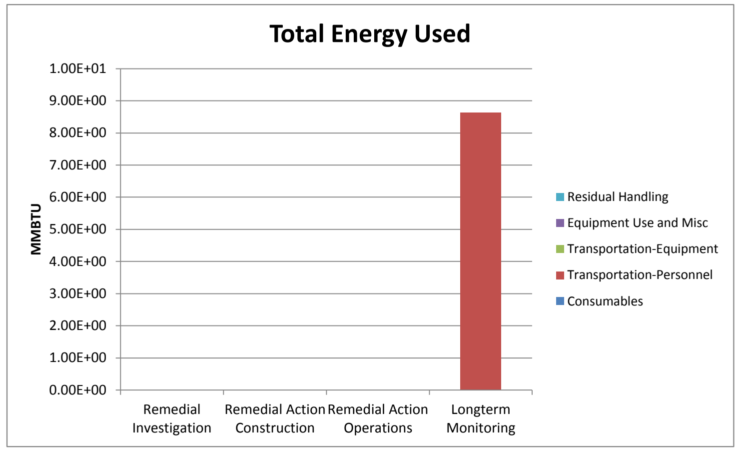

PM10 Emissions
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

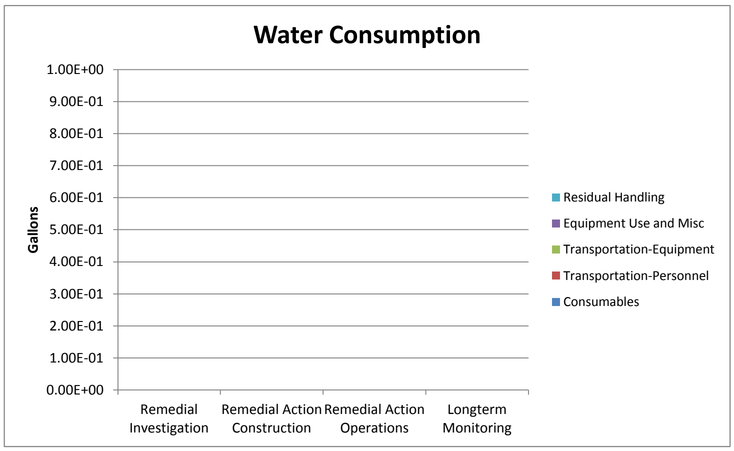

Accident Risk - Fatality
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

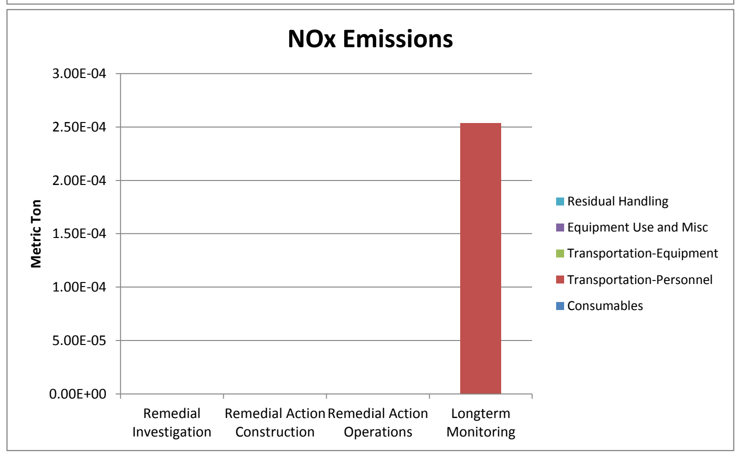

Accident Risk - Injury
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

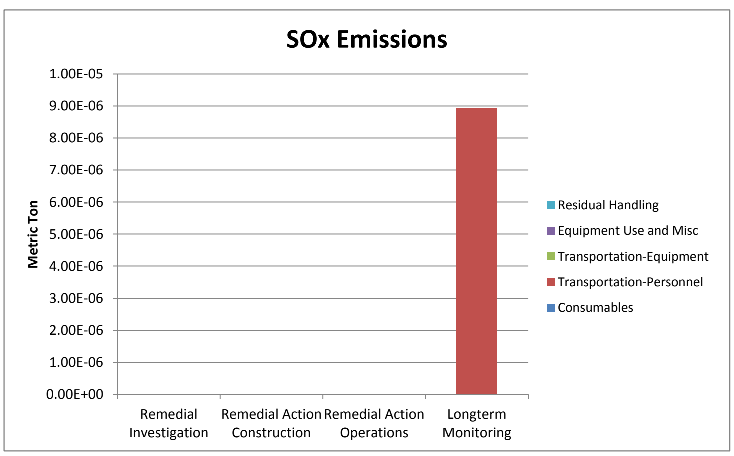
SiteWise™ Results Alternative 2
OU9, Portsmouth Naval Shipyard
Kittery, Maine

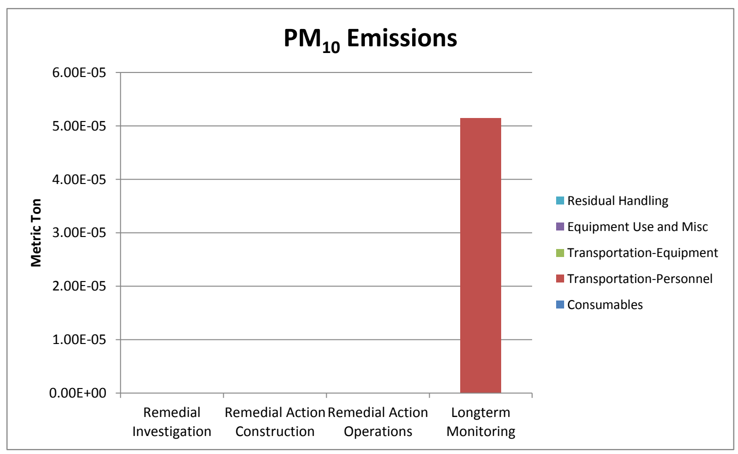


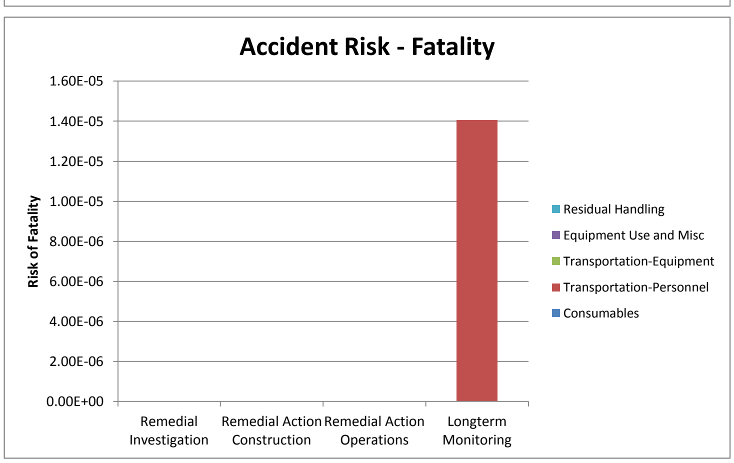


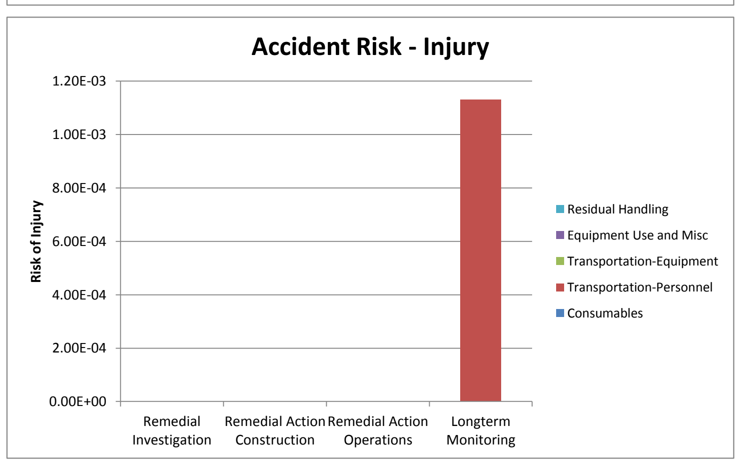










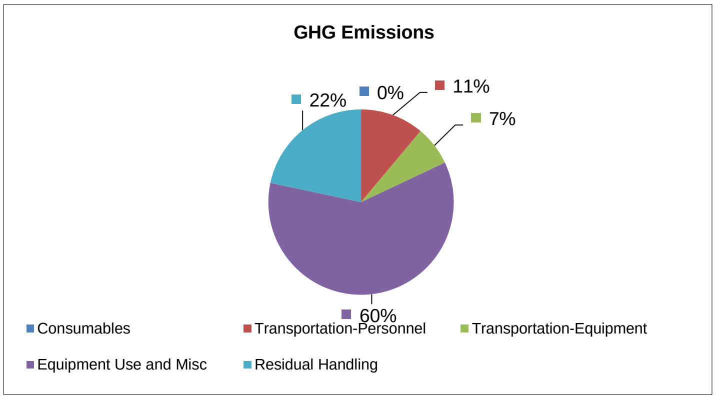


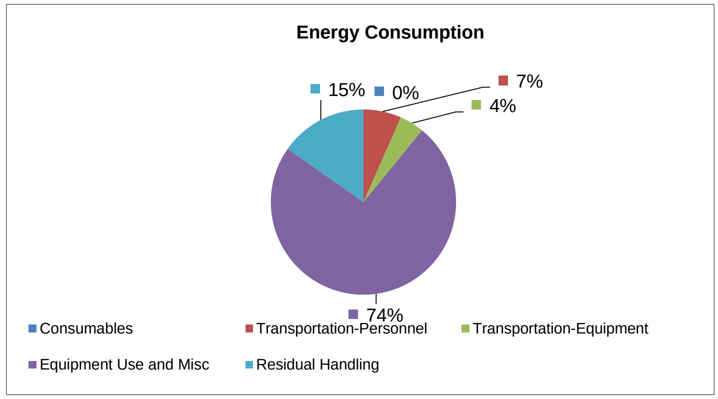
Sustainable Remediation - Environmental Footprint Summary Alternative 3

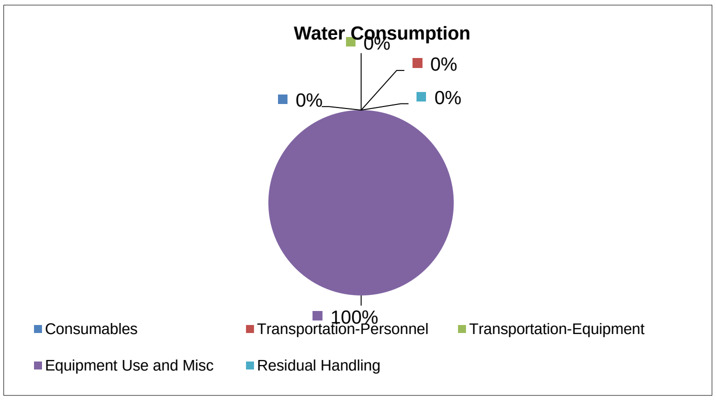
Phase	Activities	GHG Emissions (metric ton)	Total energy Used (MMBTU)	Water Consumption (gallons)	NOx emissions (metric ton)	SOx Emissions (metric ton)	PM10 Emissions (metric ton)	Accident Risk Fatality	Accident Risk Injury
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	2.29	2.9E+01	NA	8.5E-04	3.0E-05	1.7E-04	4.7E-05	3.8E-03
	Transportation-Equipment	1.42	1.9E+01	NA	4.5E-04	7.9E-06	4.0E-05	3.5E-06	2.8E-04
	Equipment Use and Misc	12.42	3.2E+02	1.3E+03	5.7E-02	1.9E-02	5.7E-03	8.8E-06	2.2E-03
	Residual Handling	4.46	6.6E+01	NA	6.5E-03	2.9E-03	1.6E-02	9.0E-06	7.3E-04
	Sub-Total	20.59	4.34E+02	1.27E+03	6.45E-02	2.24E-02	2.16E-02	6.81E-05	6.99E-03
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.69	8.6E+00	NA	2.5E-04	8.9E-06	5.1E-05	1.4E-05	1.1E-03
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.69	8.63E+00	0.00E+00	2.54E-04	8.94E-06	5.15E-05	1.40E-05	1.13E-03
Total		**2.1E+01**	**4.4E+02**	**1.3E+03**	**6.5E-02**	**2.2E-02**	**2.2E-02**	**8.2E-05**	**8.1E-03**

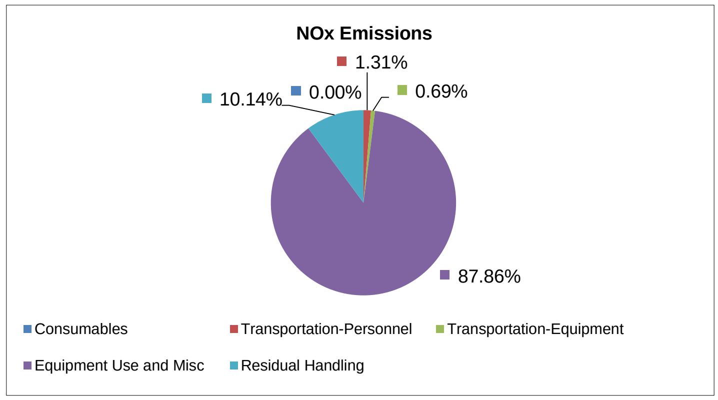
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space (tons)	Hazardous Waste Landfill Space (tons)	Topsoil Consumption (cubic yards)	Costing ($)	Lost Hours - Injury
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	7.8E+01	5.2E+01	0	5.6E-02
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	9.0E-03
Total	**0.0E+00**	**7.8E+01**	**5.2E+01**	**$0**	**6.5E-02**

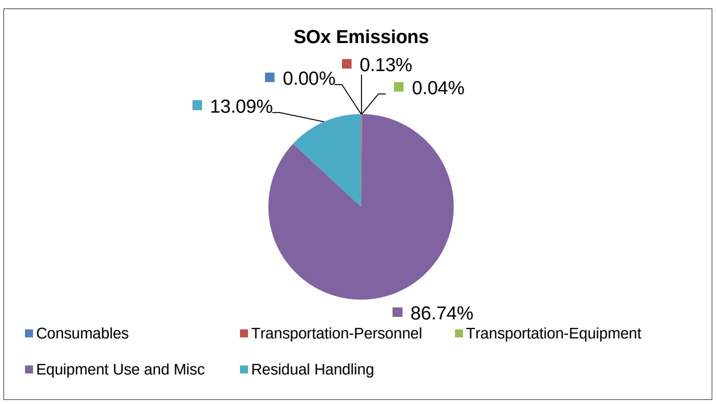
Total Cost with Footprint Reduction
$0

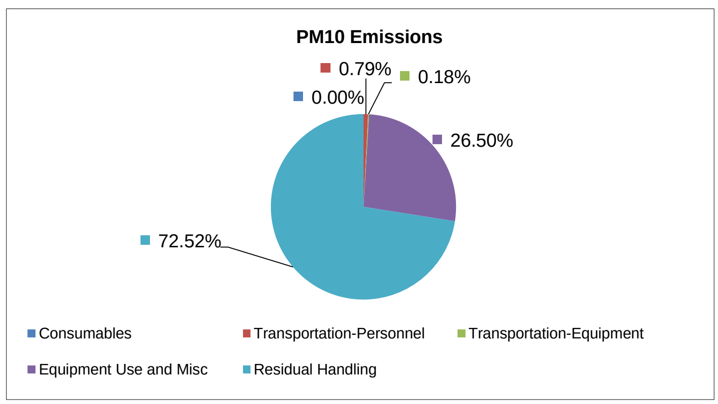

GHG Emissions
22%
0%
11%
7%
60%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

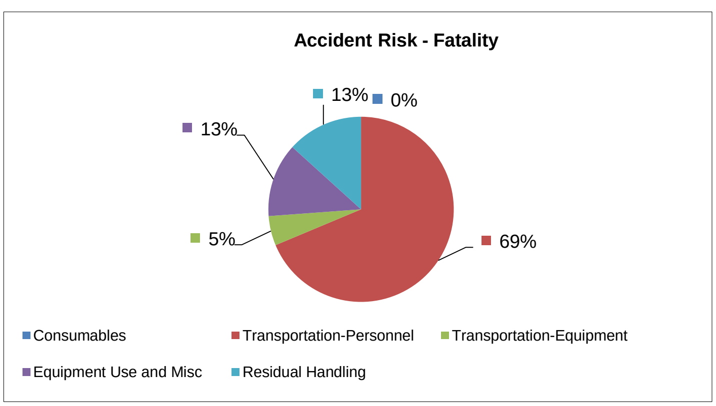

Energy Consumption
15%
0%
7%
4%
74%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

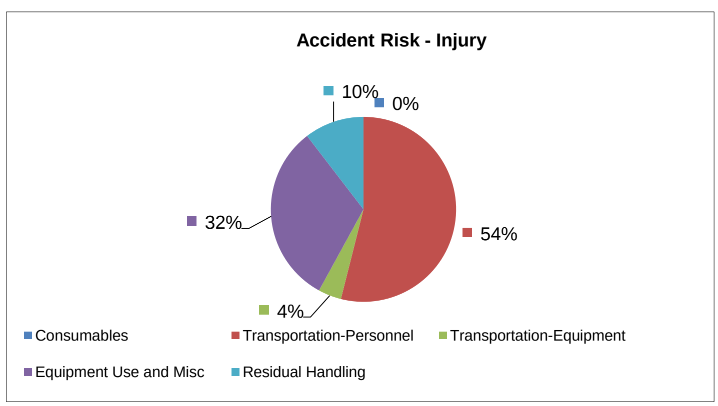

Water Consumption
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling


NOx Emissions
1.31%
10.14%
0.00%
0.69%
87.86%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

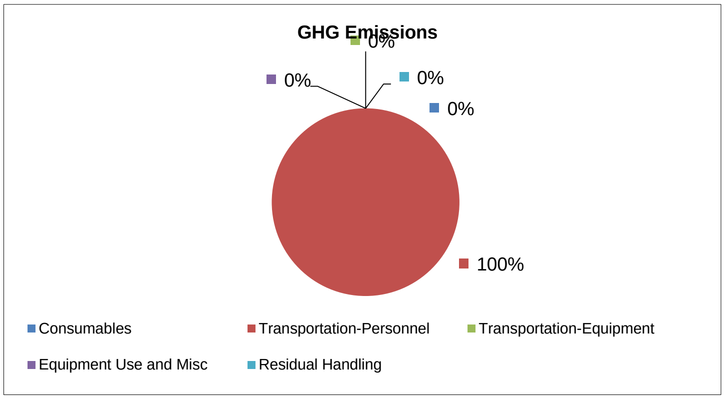

SOx Emissions
0.13%
0.00%
0.04%
13.09%
86.74%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

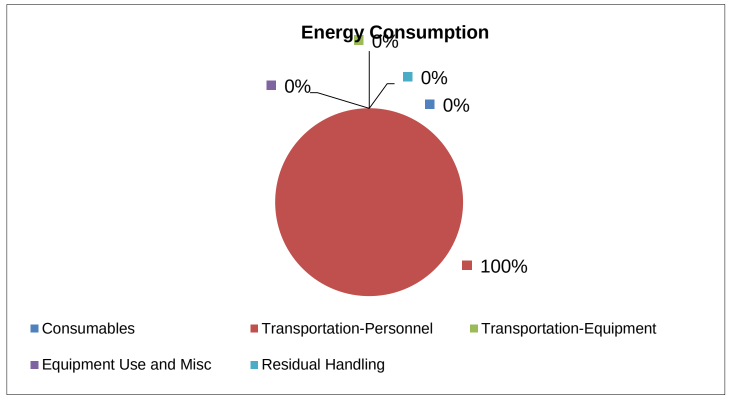

PM10 Emissions
0.79%
0.18%
0.00%
26.50%
72.52%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

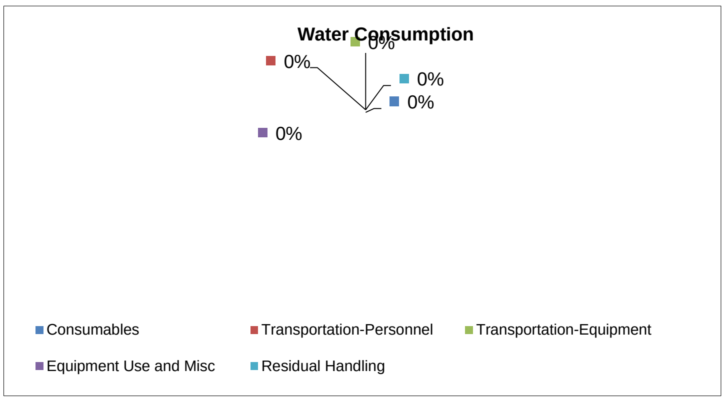

Accident Risk - Fatality
13%
0%
13%
5%
69%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

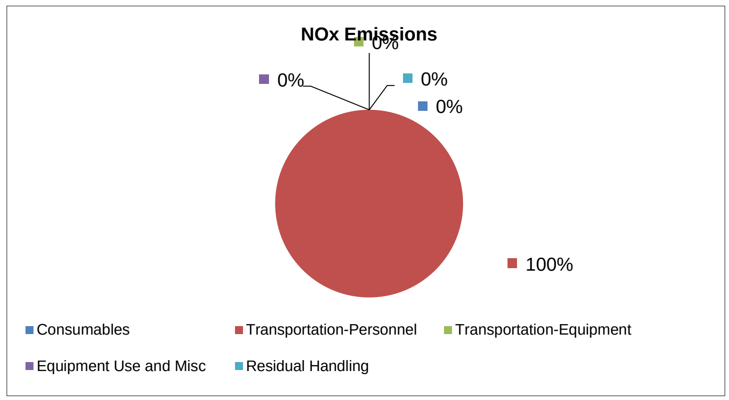

Accident Risk - Injury
10%
0%
32%
54%
4%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

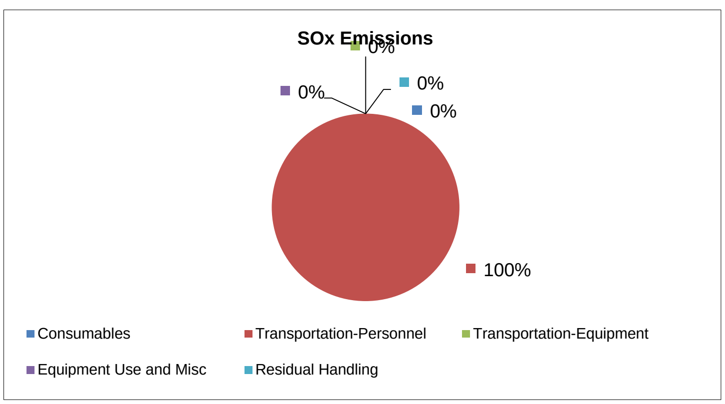
SiteWise™ Results Alternative 3
OU9, Portsmouth Naval Shipyard
Kittery, Maine

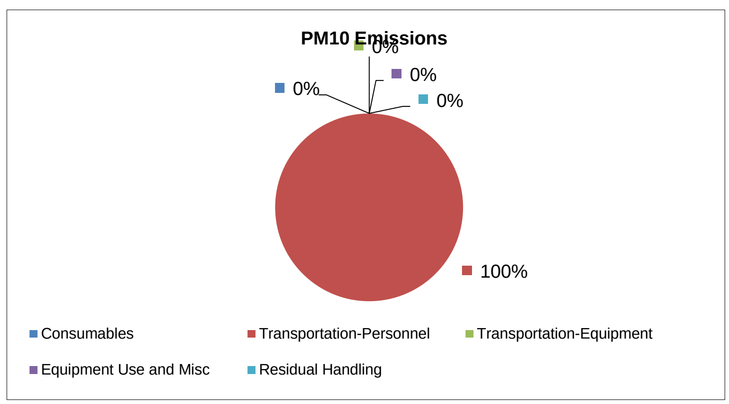


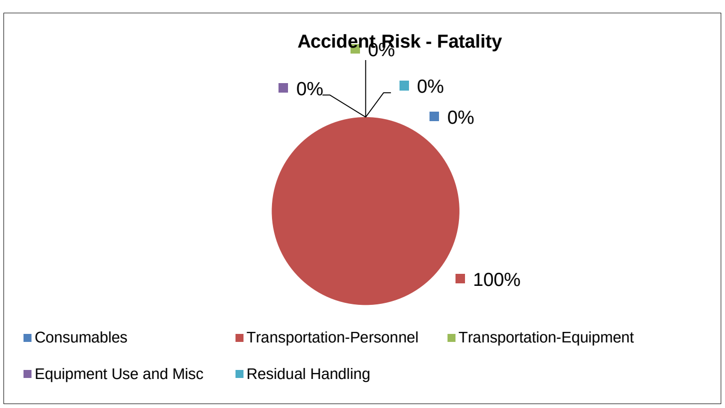


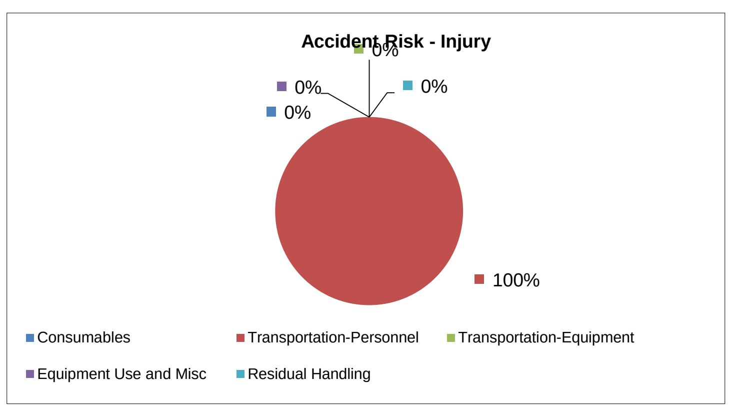


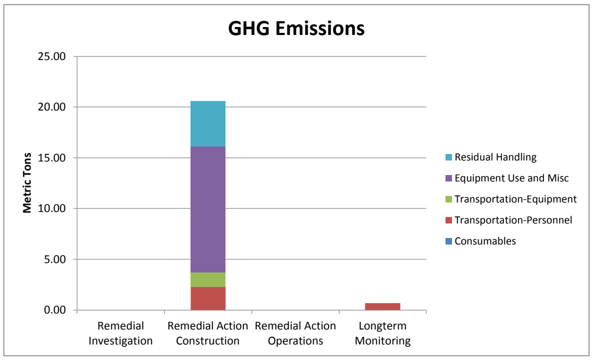


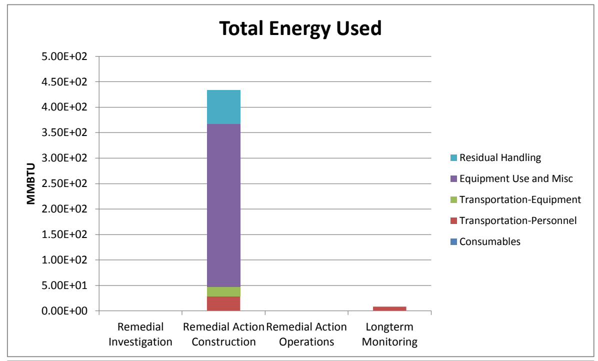


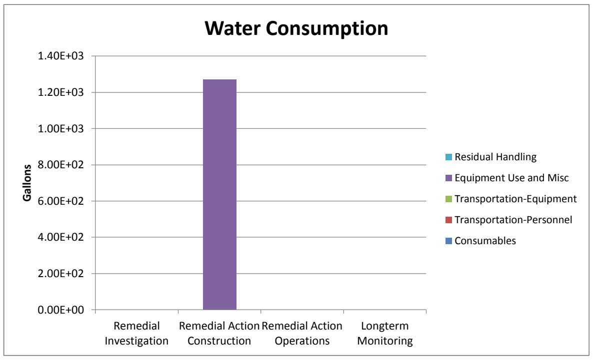


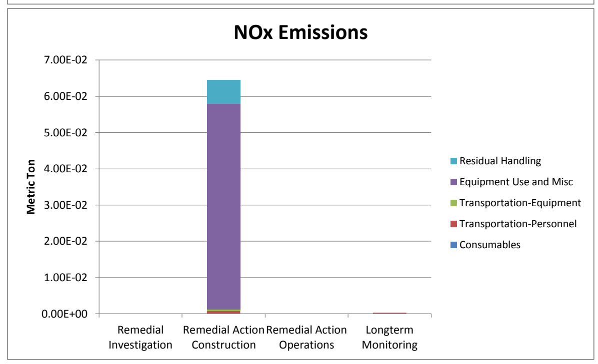


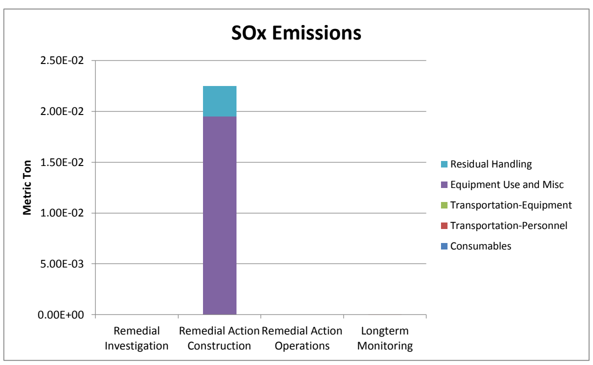


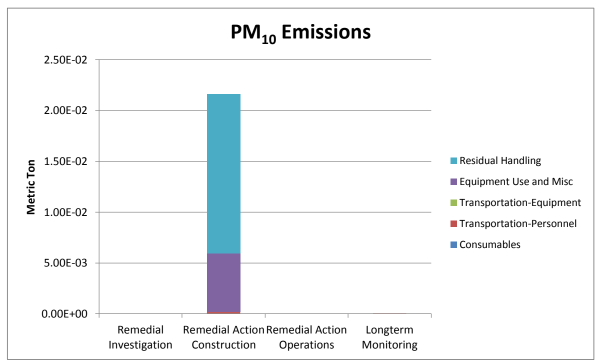

GHG Emissions
Metric Tons
25.00
20.00
15.00
10.00
5.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

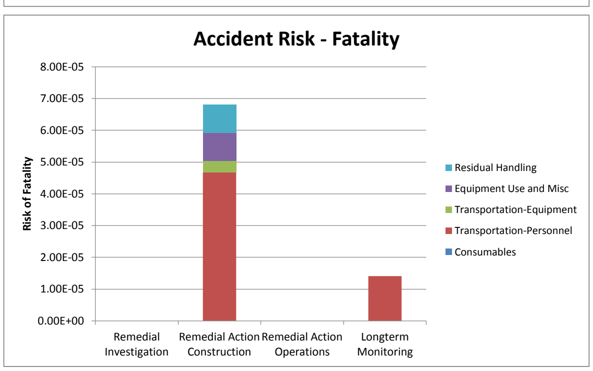

Total Energy Used
MMBTU
5.00E+02
4.50E+02
4.00E+02
3.50E+02
3.00E+02
2.50E+02
2.00E+02
1.50E+02
1.00E+02
5.00E+01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

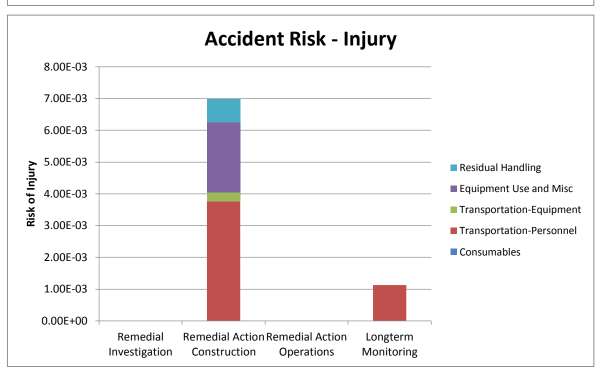

Water Consumption
Gallons
1.40E+03
1.20E+03
1.00E+03
8.00E+02
6.00E+02
4.00E+02
2.00E+02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

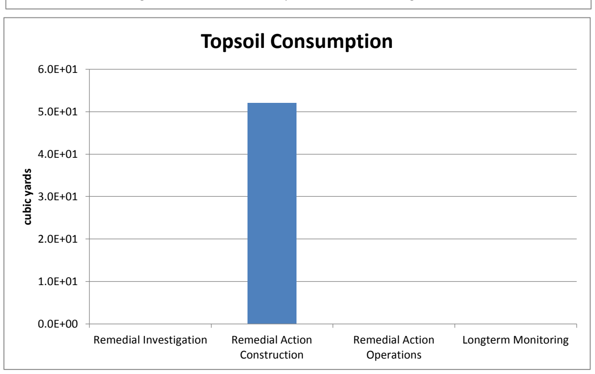

NOx Emissions
Metric Ton
7.00E-02
6.00E-02
5.00E-02
4.00E-02
3.00E-02
2.00E-02
1.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

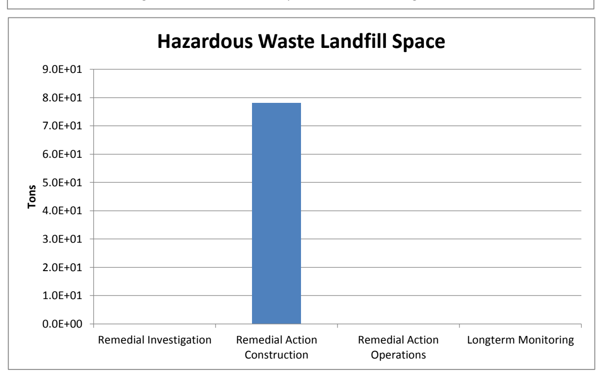

SOx Emissions
Metric Ton
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM_{10} Emissions
Metric Ton
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
8.00E-05
7.00E-05
6.00E-05
5.00E-05
4.00E-05
3.00E-05
2.00E-05
1.00E-05
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Injury
Risk of Injury
8.00E-03
7.00E-03
6.00E-03
5.00E-03
4.00E-03
3.00E-03
2.00E-03
1.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Topsoil Consumption
cubic yards
6.0E+01
5.0E+01
4.0E+01
3.0E+01
2.0E+01
1.0E+01
0.0E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring


Hazardous Waste Landfill Space
Tons
9.0E+01
8.0E+01
7.0E+01
6.0E+01
5.0E+01
4.0E+01
3.0E+01
2.0E+01
1.0E+01
0.0E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring

	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions CO_2e	CO_2	N_20	CH_4	Criteria Pollutant Emission NO_x	SO_x	PM_{10}	Energy Consumption	Water Consumption
Stage	**Materials**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Common fill	Soil	Assume top soil, 49 cy, 1.5 ton/cy, 2000 lb/ton	147,000	lbs	1.53	1.53	0.00	0.00	0.00	0.00	0.00	40.52	0.00
RAC	Top Soil	Soil	Assume top soil, 3 cy, 1.5 ton/cy, 2000 lb/ton	9,000	lbs	0.09	0.09	0.00	0.00	0.00	0.00	0.00	2.48	0.00
RAC	Seeding, mulch	Mulch	200 sy, assume mulch assume, 50 lb per msf	90.00	lbs	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.32	0.00
RAC	Seeding, fertilizer	Fertilizer	200 sy, assume fertilizer, assume 20 lb per msf	36.00	lbs	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.81	0.02
	Subtotal					**3.27**	**2.51**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**53.31**	**0.27**
Stage	**Construction Equipment**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Excavator, 2.5 cy, 2 units	Excavator, Hydraulic, 2 CY (diesel)	5 days, 8 hours per day, 80% utilization	64	hrs	6.20	6.20	0.00	0.00	0.04	0.01	0.00	28.16	
RAC	Tractor, 220 hp	Tractor, 250 hp, diesel	1 day, 8 hours per day, 80% utilization	6.40	hrs	0.48	0.48	0.00	0.00	0.00	0.00	0.00	1.72	
RAC	Excavator 2.5 CY	Excavator, Hydraulic, 2 CY (diesel)	2 days. 8 hours per day, 80% utilization	12.80	hrs	1.24	1.24	0.00	0.00	0.01	0.00	0.00	5.63	
RAC	Compactor 75 hp	Compactor 85 hp (diesel)	2 days. 8 hours per day, 80% utilization	12.80	hrs	0.38	0.38	0.00	0.00	0.00	0.00	0.00	1.33	
	Subtotal					**8.30**	**8.30**	**0.00**	**0.00**	**0.05**	**0.01**	**0.01**	**36.84**	**0**
				Total		**12**	**11**	**0.00**	**0.01**	**0.05**	**0.02**	**0.01**	**90**	**0**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions CO_2e	CO_2	N_20 (CO_2e)	CH_4 (CO_2e)	Criteria Pollutant Emission NO_x	SO_x	PM_{10}	Energy Consumption	Water Consumption
				Tonnes				**MMBTU**	**gal**
RI	-	-	-	-	-	-	-	-	-
RAC	11.57	10.81	0.63	0.13	0.05	0.02	0.01	307.59	271.08
RAO	-	-	-	-	-	-	-	-	-
LTM	-	-	-	-	-	-	-	-	-

Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

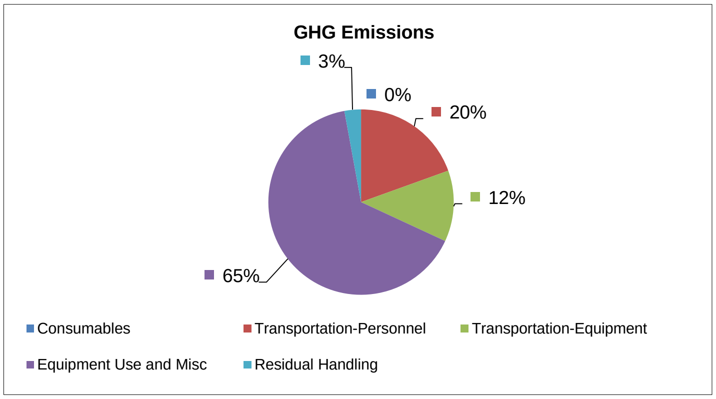
Sustainable Remediation - Environmental Footprint Summary
Alternative 4

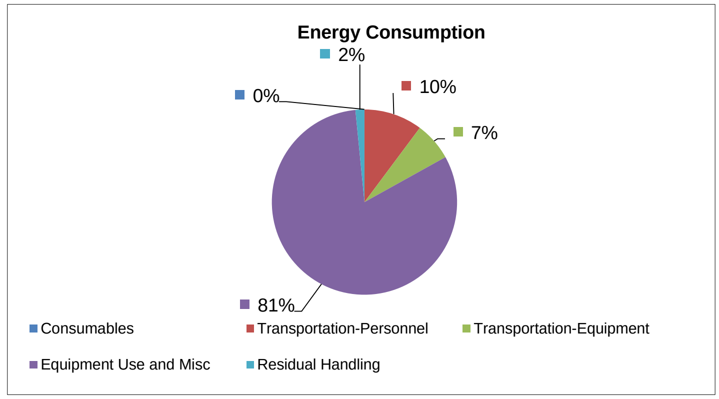
Phase	Activities	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	1.01	1.3E+01	NA	3.7E-04	1.3E-05	7.6E-05	2.1E-05	1.7E-03
	Transportation-Equipment	0.64	8.4E+00	NA	2.0E-04	3.6E-06	1.8E-05	1.7E-06	1.4E-04
	Equipment Use and Misc	3.38	1.0E+02	1.4E+03	1.0E-02	4.7E-03	1.9E-03	4.8E-06	1.2E-03
	Residual Handling	0.15	1.9E+00	NA	4.7E-05	8.3E-07	4.2E-06	7.8E-07	6.3E-05
	Sub-Total	5.18	1.25E+02	1.40E+03	1.11E-02	4.72E-03	1.98E-03	2.79E-05	3.06E-03
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.23	2.9E+00	NA	8.5E-05	3.0E-06	1.7E-05	4.7E-06	3.8E-04
	Transportation-Equipment	0.14	1.8E+00	NA	4.4E-05	7.9E-07	4.0E-06	7.8E-07	6.3E-05
	Equipment Use and Misc	3.65	8.2E+01	0.0E+00	2.2E-02	5.4E-03	2.4E-03	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	4.02	8.69E+01	0.00E+00	2.18E-02	5.39E-03	2.47E-03	5.46E-06	4.39E-04
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.69	8.6E+00	NA	2.5E-04	8.9E-06	5.1E-05	1.4E-05	1.1E-03
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.69	8.63E+00	0.00E+00	2.54E-04	8.94E-06	5.15E-05	1.40E-05	1.13E-03
Total		**9.9E+00**	**2.2E+02**	**1.4E+03**	**3.3E-02**	**1.0E-02**	**4.5E-03**	**4.7E-05**	**4.6E-03**

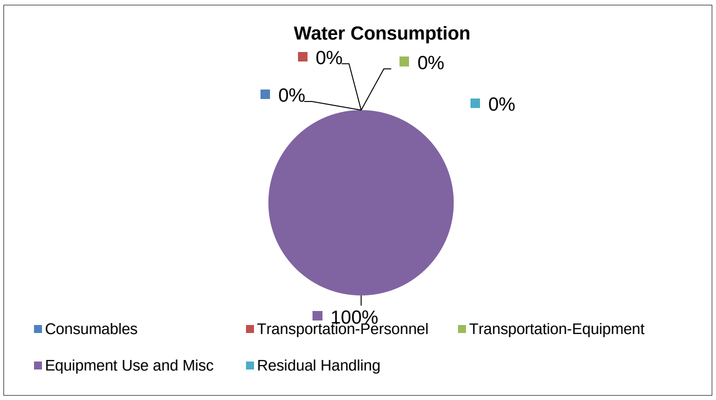
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space	Hazardous Waste Landfill Space	Topsoil Consumption	Costing	Lost Hours - Injury
	tons	tons	cubic yards	$	
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	1.6E+01	0	2.4E-02
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	3.5E-03
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	9.0E-03
Total	**0.0E+00**	**0.0E+00**	**1.6E+01**	**$0**	**3.7E-02**

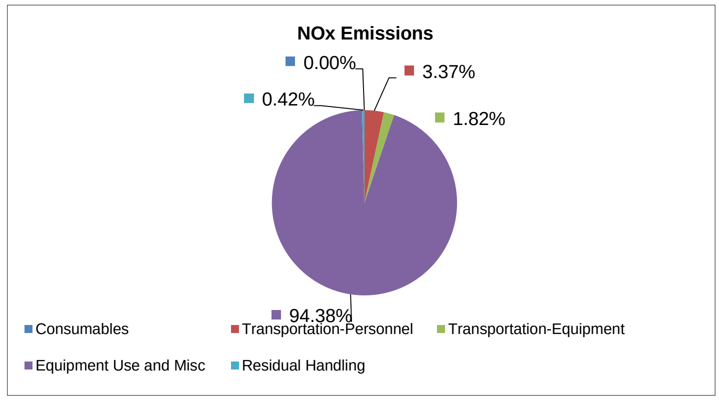
Total Cost with Footprint Reduction
$0

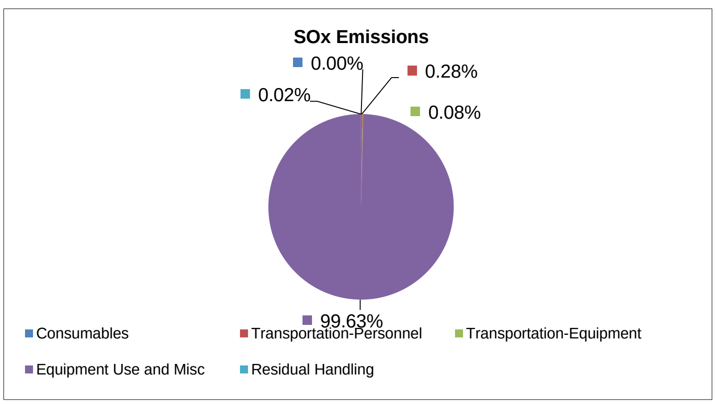
SiteWise™ Results Alternative 4
Remedial Action Construction Stage
OU9, Portsmouth Naval Shipyard
Kittery, Maine

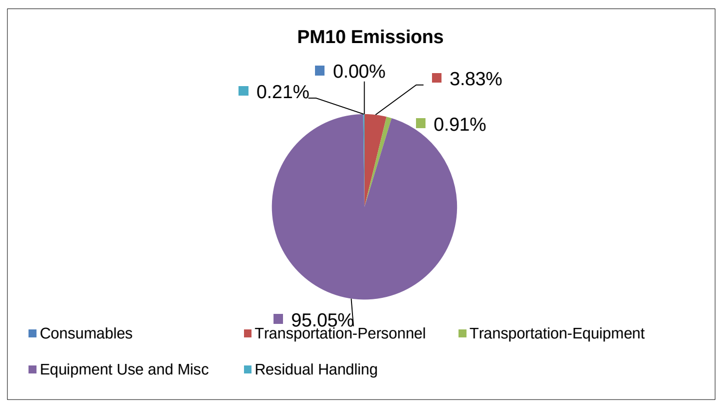


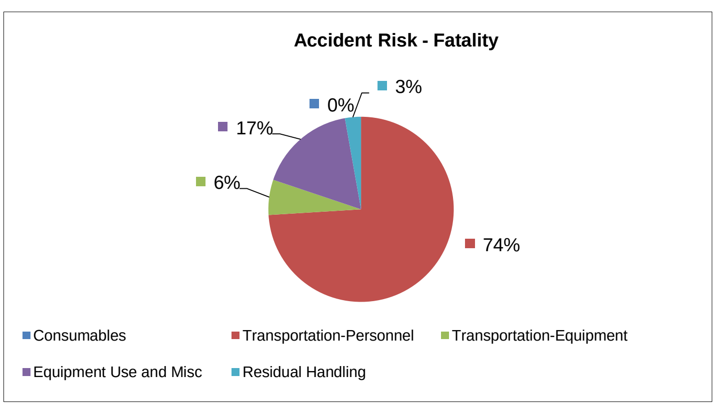


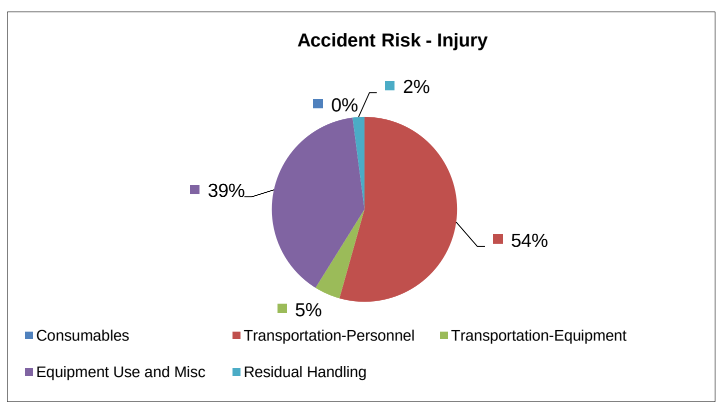


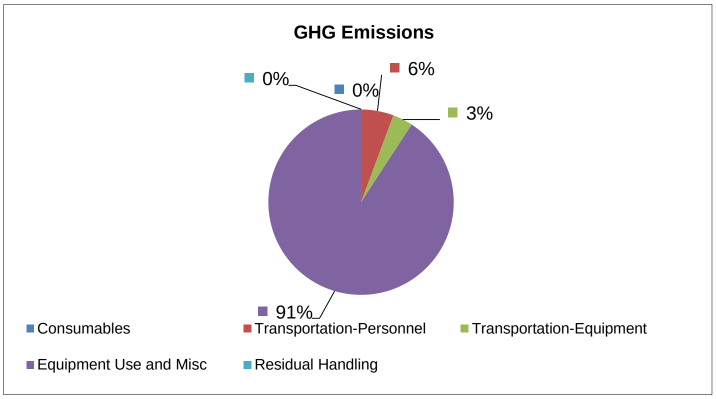


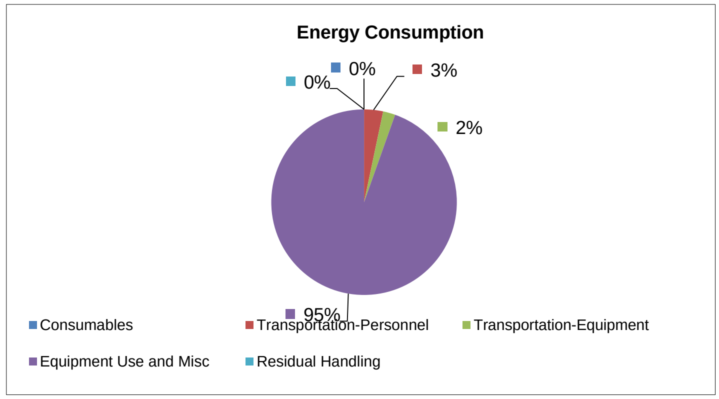


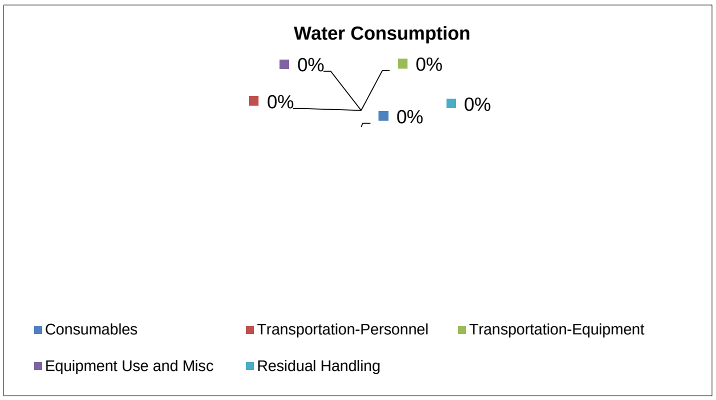


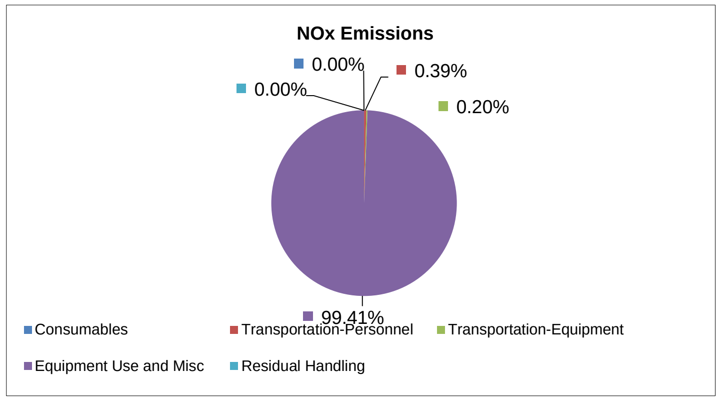


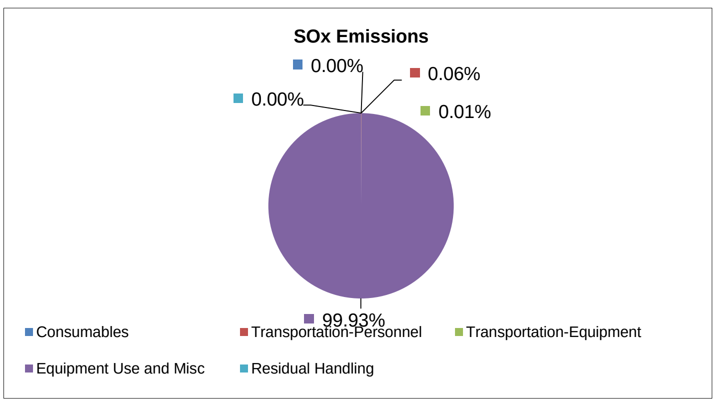


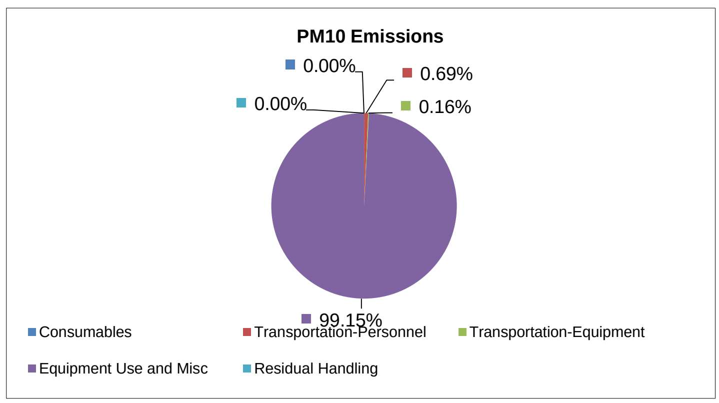

GHG Emissions
0%
6%
0%
3%
91%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

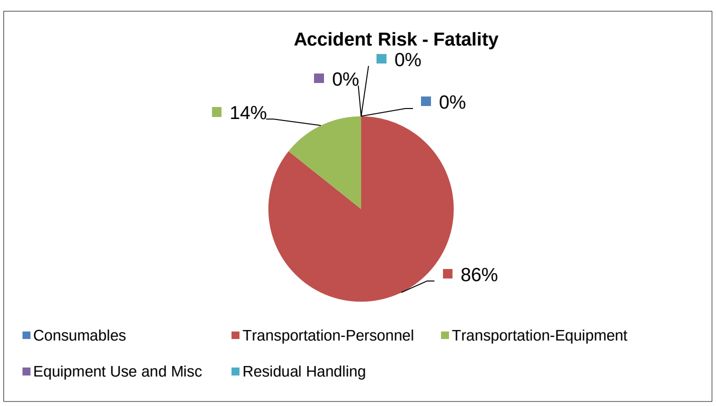

Energy Consumption
0%
0%
3%
2%
95%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

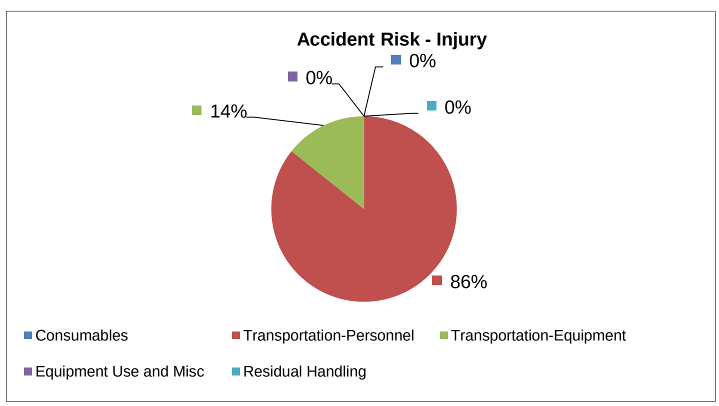

Water Consumption
0%
0%
0%
0%
0%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling


NOx Emissions
0.00%
0.39%
0.00%
0.20%
99.41%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

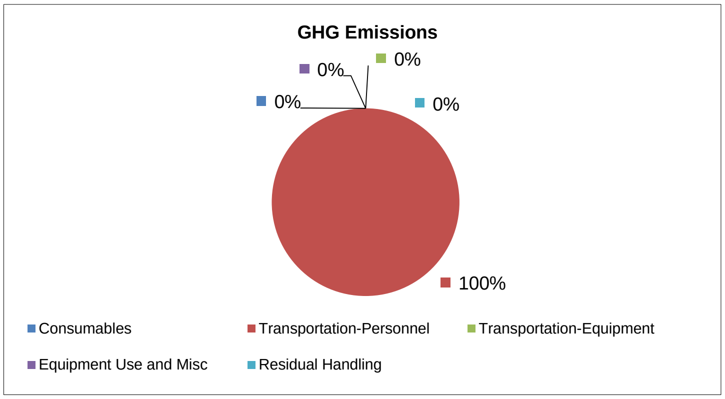

SOx Emissions
0.00%
0.06%
0.00%
0.01%
99.93%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

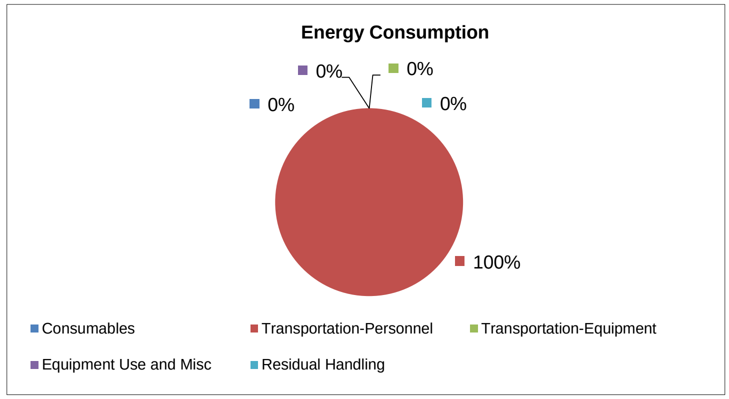

PM10 Emissions
0.00%
0.69%
0.00%
0.16%
99.15%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

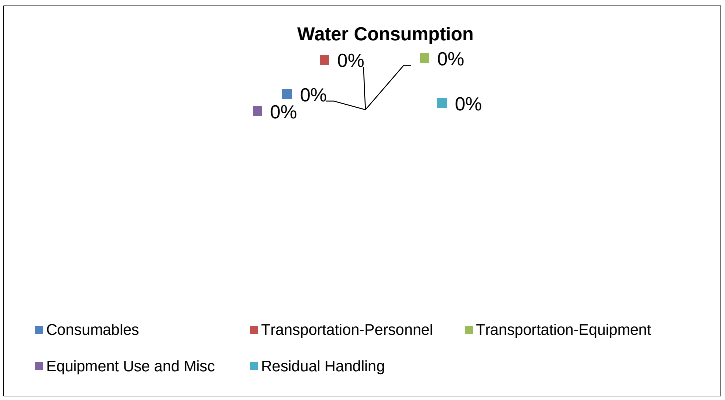

Accident Risk - Fatality
0%
0%
0%
14%
86%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

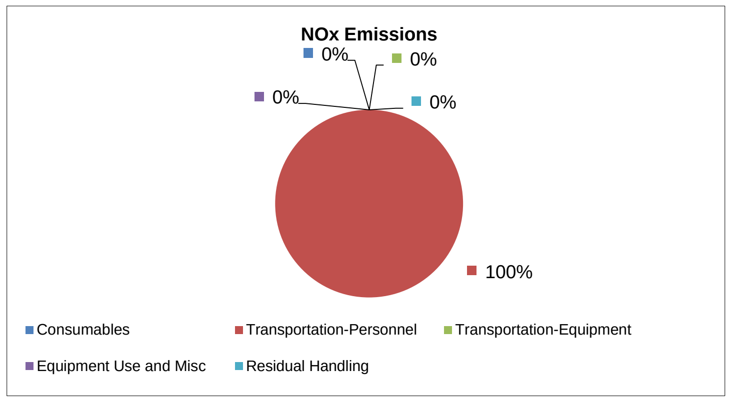

Accident Risk - Injury
0%
0%
0%
14%
86%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

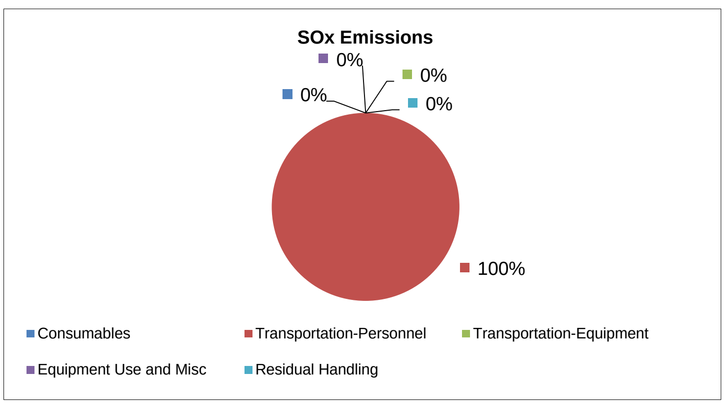
SiteWise™ Results Alternative 4
Remedial Action Construction Stage
OU9, Portsmouth Naval Shipyard
Kittery, Maine

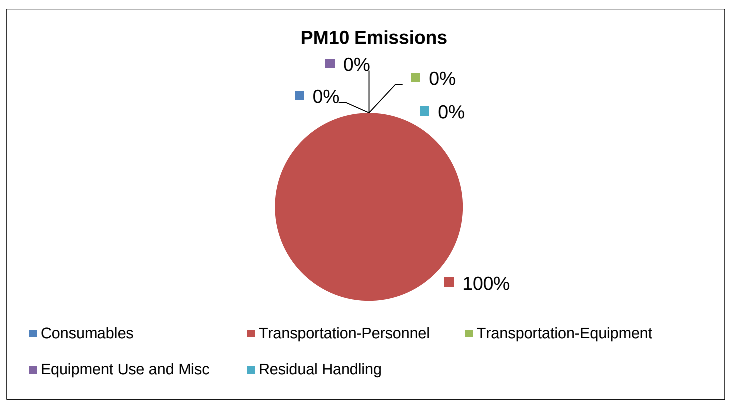


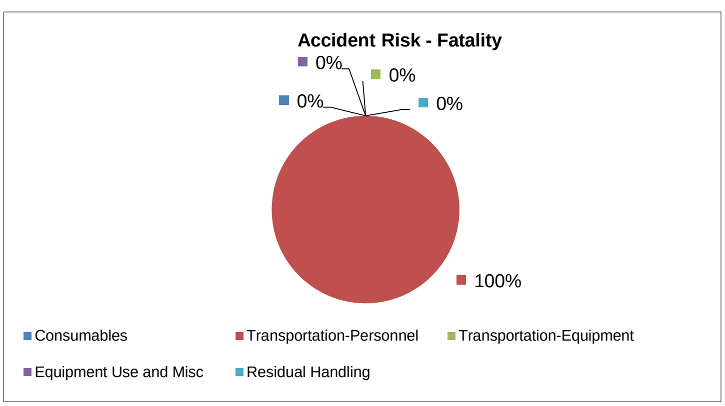


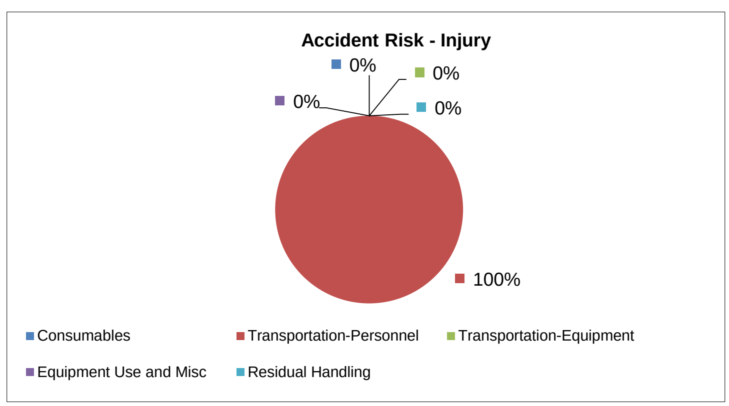


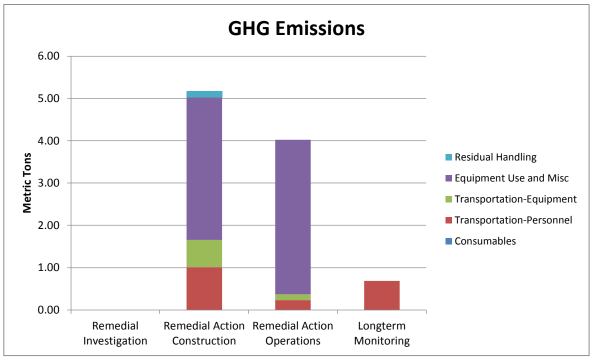


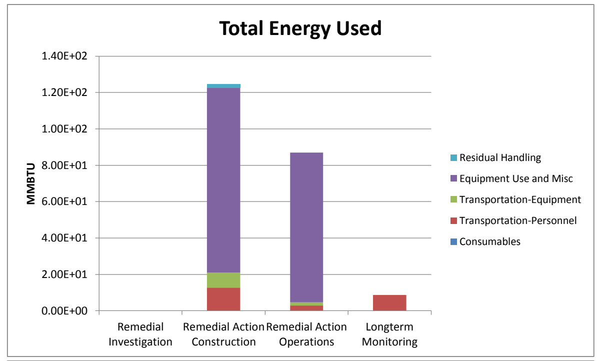


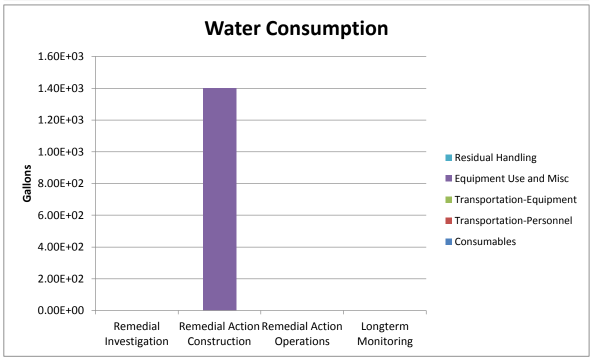


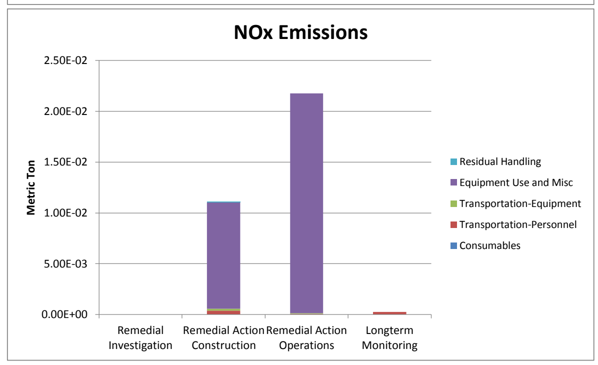


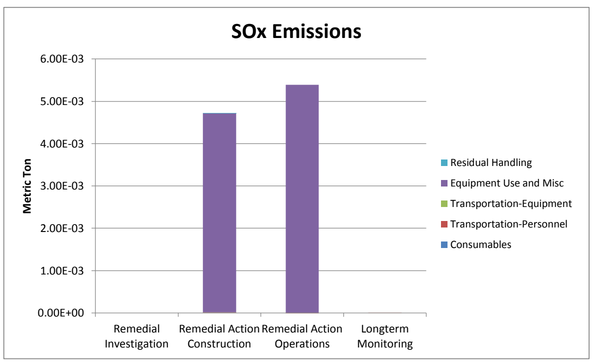


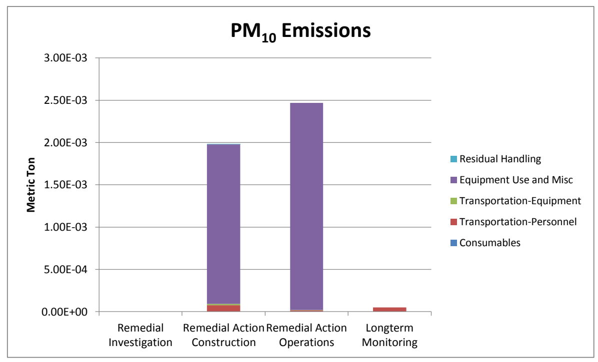

GHG Emissions
Metric Tons
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

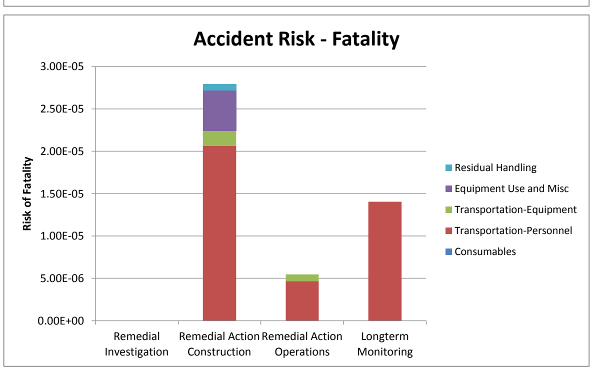

Total Energy Used
MMBTU
1.40E+02
1.20E+02
1.00E+02
8.00E+01
6.00E+01
4.00E+01
2.00E+01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

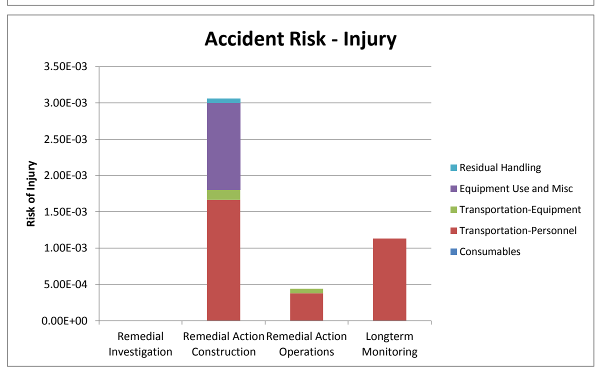

Water Consumption
Gallons
1.60E+03
1.40E+03
1.20E+03
1.00E+03
8.00E+02
6.00E+02
4.00E+02
2.00E+02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

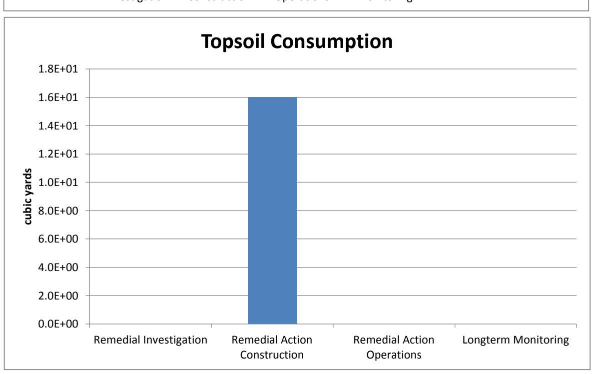

NOx Emissions
Metric Ton
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
6.00E-03
5.00E-03
4.00E-03
3.00E-03
2.00E-03
1.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM10 Emissions
Metric Ton
3.00E-03
2.50E-03
2.00E-03
1.50E-03
1.00E-03
5.00E-04
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
3.00E-05
2.50E-05
2.00E-05
1.50E-05
1.00E-05
5.00E-06
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Injury
Risk of Injury
3.50E-03
3.00E-03
2.50E-03
2.00E-03
1.50E-03
1.00E-03
5.00E-04
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Topsoil Consumption
cubic yards
1.8E+01
1.6E+01
1.4E+01
1.2E+01
1.0E+01
8.0E+00
6.0E+00
4.0E+00
2.0E+00
0.0E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring

GSRx Results Alternative 4
OU9, Portsmouth Naval Shipyard
Kittery, Maine

Stage	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions: $CO_{2\ equiv}$	Greenhouse Gas Emissions: CO_2	Greenhouse Gas Emissions: N_20	Greenhouse Gas Emissions: CH_4	Criteria Pollutant Emission: NO_x	Criteria Pollutant Emission: SO_x	Criteria Pollutant Emission: PM_{10}	Energy Consumption	Water Consumption
Stage	**Materials**					Tonnes							MWhr	gal x 1000
RAC	Borings	PVC	10 borings, 80 lf, 1 in diameter, Assume PVC, 0.333 lb/ft	80.00	lft	0.06	0.03	7.25E-05	3.50E-04	0.00E+00	1.17E-04	1.69E-05	1.10	0.14
RAC	Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	1.97E-03	6.04E-03	0.00E+00	3.49E-03	5.08E-04	9.17	0.25
RAC	Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Topsoil	Soil	16 CY, 1.5 ton/cy, 2000 lb/ton, Assume top soil	48,000.00	lbs	0.50	0.50	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	13.23	0.00
RAC	Seeding, mulch	Mulch	100 sy, assume mulch assume, 50 lb per msf	45.00	lbs	0.01	0.00	2.88E-05	1.53E-05	8.47E-09	4.86E-05	3.67E-06	0.16	0.00
RAC	Seeding, fertilizer	Fertilizer	100 sy, assume fertilizer, assume 20 lb per smf	18.00	lbs	0.02	0.02	2.96E-11	0.00E+00	0.00E+00	8.16E-06	1.64E-08	0.41	0.01
RAC	Abandon of wells	Sand	Assume sand, 80 lf, 2 in diameter, 1922 kg/m3 (gravel with sand)	209.42	lbs	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.01	0.00
RAC	Abandon of wells	Gravel	Assume gravel, 80 lf, 2 in diameter, 1922 kg/m3 (gravel with sand)	209.42	lbs	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.04	0.00
	Subtotal					**2.17**	**1.39**	**2.07E-03**	**6.40E-03**	**8.47E-09**	**3.67E-03**	**5.29E-04**	**24.12**	**0.40**
	Construction Equipment					Tonnes							MWhr	gal x 1000
RAC	Drill Rig, DPT	Drill Rig, DPT (diesel)	5 wells per day, 10 wells total, 8 hours per day, 80% utilization	12.80	hrs	0.21	0.20	0.00	2.34E-04	2.15E-03	4.31E-05	2.15E-04	1.56	
RAC	Truck tractor, 220 hp	Tractor, 250 hp, diesel	1 day, 8 hours per day, 80% utilization	6.40	hrs	0.48	0.48	0.00E+00	0.00E+00	4.00E-03	0.00E+00	3.02E-04	1.72	
RAC	Bakchoe Loader, 80hp	Loader, 80 HP, 1.5 CY (diesel)	5 days, 8 hours per day, 80% utilization	32.00	hrs	0.53	0.53	0.00	0.00	4.31E-03	9.96E-04	8.37E-04	2.35	
	Subtotal					**1.21**	**1.21**	**0.00E+00**	**2.34E-04**	**1.05E-02**	**1.04E-03**	**1.35E-03**	**5.63**	**0**
				Total		**3**	**3**	**2.07E-03**	**0.01**	**0.01**	**4.71E-03**	**1.88E-03**	**30**	**0**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions: $CO_{2\ equiv}$	Greenhouse Gas Emissions: CO_2	Greenhouse Gas Emissions: N_20 (CO2e)	Greenhouse Gas Emissions: CH_4 (CO2e)	Criteria Pollutant Emission: NO_x	Criteria Pollutant Emission: SO_x	Criteria Pollutant Emission: PM_{10}	Energy Consumption	Water Consumption
	Tonnes							MMBTU	gal
RI	-	-	-	-	-	-	-	-	-
RAC	3.38	2.60	0.64	0.14	0.01	4.71E-03	1.88E-03	101.53	400.51
RAO	-	-	-	-	-	-	-	-	-
LTM	-	-	-	-	-	-	-	-	-

Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

APPENDIX F

RESPONSES TO COMMENTS

RESPONSES TO MEDEP COMMENTS DATED JANUARY 14, 2013
DRAFT FEASIBILITY STUDY REPORT FOR OPERABLE UNIT 9
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

1. **Comment:** Add PEF to the acronym list.

   Response: PEF (particulate emission factor) will be added to the acronym list.

2. **Comment:** 1.6.2. p. 1-10, last full sentence. "…contamination at OU9 is due to PAHs…" Contamination at OU9 is due to past activities at the site. Risk at OU9 is due to PAHs. Please revise this statement.

   Response: The text will be revised to read "In summary, PAH-contaminated soil from past OU9 activities was found in subsurface soil associated with small isolated pockets of burnt material/ash."

3. **Comment:** 1.6.2. p. 1-10. Indicate the source of the risk-based screening levels and include a table showing the screening levels used in the report.

   Response: This section is a summary of the Remedial Investigation (RI) Report for OU9. For the nature and extent of contamination discussion in the RI, concentrations were compared to United States Environmental Protection Agency (USEPA) Regional Screening Levels (November 2010), which are provided in Tables 4-1 and 4-2 of the RI Report. The text will be revised to indicate that the risk-based screening levels are the USEPA Regional screening levels. A reference to Tables 4-1 and 4-2 in the RI Report will be included at the end of the first paragraph of Section 1.6.2 to indicate that risk-based screening levels and facility background concentrations were used to provide a general understanding of the nature and extent of contamination.

4. **Comment:** 1.6.3. p. 1-11, 2nd paragraph. "…because most of the site contamination was removed, offsite migration of remaining contamination in the subsurface is not expected." Removal of most of the contamination has no bearing on the migration of remaining contamination. Migration of the subsurface soil could occur if it were brought to the surface or if shoreline controls failed. It would be more accurate to say something like, "…because most of the site contamination was removed, any risk resulting from offsite migration of remaining contamination in the subsurface is expected to be insignificant."

   Response: The text will be reworded as suggested.

5. **Comment:** 3.3.3, p. 3-9. Please indicate the depth of the water line.

   Response: The approximate depth to the water line (approximately 3 feet below ground surface) will be included in the text.

6. **Comment:** Table A.1, Footnote 2. This is the only time in the document the term "Regional Screening Level" is used. Please state the source of the regional screening levels and include it in the references if appropriate.

   Response: The footnote will be corrected to indicate that the pre-remediation concentrations that exceeded the preliminary remediation goal (PRG) are presented at the concentration of the

PRG to represent post-remediation concentrations. Regional Screening Levels (USEPA, May 2012) were not used for the post-remediation calculation.

7. **Comment:** 4.2.2. Alternative 2. p. 4-7. The description of this alternative states that LUCs would prevent residential land use of the PAH-contaminated area north of Building 62. Applying a LUC to this very small area in the midst of land where residential use would be allowed would be confusing at best. It would be much simpler to apply LUCs preventing residential use to the entire property.

   In addition, this would satisfy MEDEP's preference to limit residential exposure to surface and subsurface soil contaminants posing a risk with an Incremental Lifetime Cancer Risk (ILCR) level to less than 1×10^{-5}. As stated previously, MEDEP's ILCR benchmark is not promulgated and therefore we cannot require the Navy to meet it. However, we have a strong preference for remedial alternatives that meet this benchmark.

   Response: Residential use of the site is unlikely; however, the Navy will place LUCs on the portion of the site that poses unacceptable residential risk. Difficulty in applying the residential LUC is not expected, because LUCs are tracked within NIRIS and internal Navy maps. For the portion of the site which does not pose unacceptable risk, it is more beneficial to the base if the land is unencumbered. In regards to future land use if the facility were to close, at such a time, land use and associated controls would be re-evaluated as part of base closure activities. In addition, the LUC RD would specify the requirements for notifying the USEPA and MEDEP if transfer or sale of the property is anticipated.

   In regards to risk, risk management decisions for this site were made based on the 95%/5% scenario and exceedances of cancer risks of $1\text{x}10^{-4}$ (there were no unacceptable non-cancer risks). Only exposure to subsurface soil for a hypothetical child and lifetime resident had potential ILCR levels of greater than $1\text{x}10^{-4}$ ($4 \text{ x}10^{-4}$ and $5 \text{ x}10^{-4}$) under the reasonable maximum exposure (RME) scenario. There were no exceedances of $1\text{x}10^{-4}$ for subsurface soil under the central tendency exposure (CTE) and there were no exceedances of $1\text{x}10^{-4}$ for surface soil under RME or CTE. Therefore, the Navy believes that the risk management decision is sufficiently conservative to address potential risks. Review of the surface soil risk estimates in comparison to Maine's ILCR guideline shows that, only the hypothetical resident (child and lifetime) had ILCRs greater than $1\text{x}10^{-5}$ under the RME scenario ($6 \text{ x}10^{-5}$ and $7 \text{ x}10^{-5}$) but was less than the guideline under the CTE scenario ($7\text{x}10^{-6}$ and $8\text{x}10^{-6}$).

8. **Comment:** App. C, Cost Estimates. Alternative 4 should include a line for "Site Health & Safety and QA/QC" as is shown for Alternative 3, line 3.6.

   Response: The cost estimate for Alternative 4 will be updated as suggested.

1. **Comment:** *Pg. ES 1.* The document states that OU9 consists of Site 34 – Former Oil Gasification Plant, Building 62. The site also includes the surrounding land area, running down to the Piscataqua River. The full extent of the Site boundaries should be described.

   Response: The referenced sentence is discussing which sites are within OU9. There is only one site within OU9, which is Site 34. Site 34, as identified in the Federal Facility Agreement (FFA) for PNS and updated by the Site Management Plan (see the Final FY12 Amended SMP, Tetra Tech, February 2012 or the Draft Final FY13 SMP, Resolution Consultants, September 2012), is the Former Oil Gasification Plant, Building 62. OU9/Site 34 includes the area surrounding Building 62, but does not include the area down to the Piscataqua River. Section 1.4.2 provides the description of OU9 and Figure 1-2 shows the general layout and boundary of OU9.

2. **Comment:** *Pg. 1-3.* The text states: The Federal Facility Agreement (FFA) for PNS was signed by USEPA and the Navy in September 1999, became effective February 2000, and supersedes the HSWA Permit. Please explain why the FFA supersedes the HSWA permit?

   Response: The FFA for PNS that became effective February 2000 supersedes the final RCRA Hazardous and Sold Waste Amendment (HSWA) Corrective Action Permit to the Navy for PNS that became effective in April 1989. The Corrective Action Permit is the HSWA Permit that is indicated in the referenced text on page 1-3 of the draft FS for OU9. Information on the history of the permit is provided in Section VI (Findings of Fact) of the FFA and the statement that the FFA supersedes the Corrective Action Permit is provided in Section V (Scope of Agreement) (see item 5.3 on page 12 of the FFA) as well as in Section VIII (Statutory Compliance/RCRA-CERCLA integration).

3. **Comment:** *Figure 1-2* should depict the precise boundaries of OU 9 including the extent of the 2007 excavation.

   Response: Disagree. There was some over excavation as part of the 2007 removal action; however, that did not enlarge the site boundary. The portion excavated off-site that goes along the shoreline/down to the river was excavated as part of the shoreline stabilization. Other areas where the excavation line extends beyond the site boundary, over-excavation occurred to ascertain that no additional ash was present. The site boundary as shown on Figure 1-2 is appropriate for the FS.

4. **Comment:** *Table 1-1.* Please explain further why facility background levels are relevant to whether site related pesticide storage releases occurred. Couldn't background levels be elevated due to regular application of pesticides in other areas.

   Response: Table 1-1 is a summary of past investigations. The potential that pesticides storage and rinsing activities in Building 62 could have resulted in a release to soil was evaluated as part of the Site Screening Investigation (SSI). Facility background and risk screening levels were used in the evaluation for the SSI to determine whether there was a potential unacceptable risk. Facility background was also used to determine whether concentrations were likely indicative of the general historical spraying of pesticides at the

Shipyard and not a result of storage or disposal activities at Building 62. A detailed evaluation was provided in the SSI Report (Tetra Tech, August 2004, see Appendix D).

The text in Table 1-1 will be reworded as follows: "The SSI Report indicated that source contamination had not migrated from ash to underlying soil. ~~and that pesticide concentrations on site were low in relation to risk screening and facility background levels. Therefore,~~ ***Pesticide concentrations at the site did not indicate that that*** ~~site-related~~ pesticide storage and rinsing activities ~~not~~ resulted in a CERCLA release to soil at the site ***and were not detected at concentrations that would cause an unacceptable risk***. "

5. **<u>Comment:</u>** *Page 1-9* states that any work to be performed near or within these buildings that would affect the structures must comply with Section 106 of the National Historic Preservation Act." Pease affirm that the SHPPO consulted?

   <u>Response</u>: The Shipyard contacts the State Historic Preservation Officer (SHPO) as needed when work may affect a historic building. Site contamination is not under or near the building and therefore, remediation work for OU9 is not anticipated to affect the structure of Building 62.

6. **<u>Comment:</u>** *Pg. 1-10, §1.6.2.* This section is written in a confusing manner and could be read to contradict itself. Please rewrite to clarify extent of contamination.

   <u>Response</u>: To clarify the extent of contamination, the paragraph will be rewritten to read as follows:

   "The discussion of the nature and extent of contamination at OU9 focuses on the distribution of chemical concentrations across OU9 with consideration of site uses, geological conditions, and whether it was in the excavated or unexcavated portion of the site. Surface and subsurface soil at OU9 were investigated. As provided in the RI Report, for a general understanding of the nature and extent of contamination, concentrations were compared to USEPA residential and industrial Regional Screening Levels and to the maximum facility background detected concentration (see Tables 4-1 and 4-2 in the OU9 RI Report).

   PAHs, antimony, lead, and mercury were detected in surface and subsurface soil at OU9. Concentrations were generally greater in subsurface soil than in surface soil. Carcinogenic PAHs [i.e., benzo(a)pyrene (BAP) and related compounds] and lead had maximum concentrations exceeding industrial and residential risk-based screening levels and facility background in surface and subsurface soil. Maximum mercury concentrations in subsurface soil exceeded the residential risk-based screening level and facility background. Mercury concentrations in surface soil and antimony concentrations in surface and subsurface soil were less than the risk-based screening levels and facility background.

   In surface soil, most of the lead concentrations, all antimony and mercury concentrations were less than residential screening levels and facility background. Many PAH concentrations were greater than residential screening levels but generally similar to industrial screening levels. Surface soil concentrations of antimony, lead, mercury, and PAHs indicated that contamination was sufficiently removed during the 2007 removal action in the excavated area and that the unexcavated area was not adversely impacted by past contaminant releases at OU9.

   In subsurface soil, most of the lead and mercury concentrations and all of the antimony concentrations were less than residential screening levels and facility background. Antimony, lead, and mercury concentrations in subsurface soil for both the excavated and unexcavated areas indicate that subsurface soil was not adversely affected from past OU9 releases. PAH contamination is present and is associated with ash/burnt material, which represents a small portion of site soil (approximately 5 percent) based on the evaluation of subsurface conditions. Most of the burnt material was found in the subsurface soil in the excavated area (north of Building 62); very minor amounts of ash/burnt material were found in the unexcavated area. In summary, PAH contamination in subsurface soil at OU9 is associated with small isolated pockets of burnt material/ash, which were found north of Building 62. Ash from past Building 62 activities may be present beneath the Building 62 Annex floor, built after Building 62 industrial activities ended. Ash from past Building 62 activities has elevated carcinogenic PAH concentrations. "

7. **<u>Comment:</u>** *Table 2-2.* The ARARs analysis should also address: the Essential Fish Habitat Assessment requirements of 16 U.C.C. §1851 et seq; the Fish and Wildlife Coordination Act, 16 U.S.C §§ 661-677(e); and the Rivers and Harbors Act of 1899, 33 U.S.C§493 et seq, 33 CFR Parts 320-323, Section 10.

   <u>Response</u>: The Essential Fish Habitat Assessment requirements and the Fish and Wildlife Coordination Act was not included because site contamination is located onshore and is not located such that it would impact the coastal floodplain or river. In addition, the remedial action alternatives evaluated would also not impact the coastal floodplain or river. Therefore, these acts will not be included as a potential ARAR for OU9.

   The Rivers and Harbors Act control unauthorized obstruction or alternative of navigable waters. Site contamination and any remedial activities for site contamination would not be conducted close enough to the Piscataqua River to obstruct or alter the river. Therefore, this act will not be included as a potential ARAR for OU9.

8. **<u>Comment:</u>** *Page 2-9,* ¶ 3. This paragraph is poorly written. EPA has often demolished buildings to conduct remedies. A more appropriate statement would be that because the Shipyard has no current plans to demolish this building, the existing building, along with institutional controls on any future use of the land, will need to be imposed to make the remedy protective.

   <u>Response</u>: The sentence will be reworded to clarify that the Navy does not intend to remove the building and that land use controls would be used to prevent exposure to contamination under the building. The text will be reworded as follows: "~~However,~~ ***B***ecause the Shipyard has no plans to remove Building 62 Annex, ~~excavation or treatment~~ ***active remediation or removal*** of ash, ***presumed to be*** present under the floor of the Annex, ~~would not be possible~~ ***was not considered as part of remedial alternatives for OU9. The building and land use controls would prevent unacceptable exposure to contamination under the Annex***."

9. **<u>Comment:</u>** *Page 3-1.* The description of the initial screening criterion of effectiveness is not consistent with the NCP. See 40 CFR §400.430.

   <u>Response</u>: Page 3-1 discusses the evaluation criteria for screening technologies and process options and not initial screening of alternatives, which is described in 40 CFR 300.430(e)(7). The NCP does not provide a description of criteria for technology and process option screening, and the description is sufficiently consistent with USEPA guidance that the Navy recommends no change to the text.

   USEPA guidance (1988) provides a description of the criteria and indicates for the screening of technologies and process options that the evaluation should focus on effectiveness in handling the estimated areas or volumes of media and meeting the remediation goals identified in the remedial action objectives, potential impacts to human health and the environment during the construction and implementation phase, and how proven and reliable the process is with respect to the contaminants and conditions at the site. For the most part the description on Page 3-1 is consistent with USEPA guidance; however, it also includes treatment and permanence of the solution. This component of effectiveness is consistent with the goal to include treatment to the extent practicable.

While the NCP provides the three criteria for screening of remedial of remedial alternative, it does not specifically call out criteria for screening of technologies and process options. The effectiveness criteria for screening of alternatives focuses on the degree to which an alternative reduces toxicity, mobility or volume through treatment, minimizes residual risks and provides long-term protection, complies with ARARs, minimizes short-term impacts, and how quickly it achieves protection. Alternatives providing significantly less effectiveness than other more promising alternatives may be eliminated; however, ones that do not provide adequate protection must be eliminated.

10. **Comment:** *Page 3-8.* The text states: “Currently, there is no reason to anticipate the transfer of OU9 land to the public (i.e., OU9 will be owned by the Navy in the near and extended future). Therefore, deed restrictions are not needed for OU9.” Please note the ROD will require the Navy to affirm the requirement for permanent LUCs in the event of property transfer.

    Response: Comment noted. If LUCs is part of the selected remedy, text regarding LUCs requirements would be provided consistent with the text that has been developed regarding LUCs in the OU1 and OU2 RODs.

11. **Comment:** *Page 4-1.* Overall Protection of Human Health and the Environment is not consistent with language in the NCP. Is should be made consistent.

    Response: The second sentence will be revised by changing “diminish the unacceptable risks posed” to “protect from unacceptable risks posed”. The following sentence will be added after the second sentence “Overall protection of human health and the environment draws on the assessment of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.”

12. **Comment:** *Page 4-10.* Table B-3 makes no mention of RCRA closure requirements. If the waste that remains on site is RCRA waste, then the closure requirements are relevant and appropriate and perhaps applicable. The table does state that “wastes generated as part of remedial activities would be analyzed to determine whether they are RCRA characteristic hazardous wastes. If determined to be hazardous waste, then the waste would be managed in accordance with regulatory requirements. Those requirements would be ARARs and should be identified in the table.

    Response: There is no known RCRA hazardous waste disposed of at the site and therefore RCRA closure requirements are not pertinent. Table B-3 provides the appropriate ARAR if a waste is determined to be hazardous.

13. **Comment:** *Appendix E.* EPA did not complete a detailed technical evaluation of the analysis presented in Appendix E. In general, EPA supports Navy’s efforts to evaluate the sustainability of planned remediation efforts and identify opportunities to mitigate environmental impacts of the remediation. EPA agrees that these considerations can be evaluated under the short-term effectiveness criteria. Further, EPA suggests that a valuable use of the results presented here will be in the design of the selected remedy to ensure that the drivers of any significant impacts are considered and that those environmental impacts are mitigated to the extent practicable.

The Navy's efforts should be consistent with EPA Region 1's recently updated Clean and Green Policy (http://www.clu-in.org/greenremediation/docs/R1GRPolicy_Feb2012.pdf). In addition, EPA has developed a number of Green Remediation Fact Sheets that provide best management practices (BMPs) for a number of common remediation processes. Navy should consider these as they move forward with the remediation of the NUSC site: excavation and surface restoration (http://www.cluin. org/greenremediation/docs/GR_Quick_Ref_FS_exc_rest.pdf), bio-remediation (http://www.clu-in.org/greenremediation/docs/GR_factsheet_biorem_32410.pdf), and clean fuel and emission technology (http://www.cluin. org/greenremediation/docs/Clean_FuelEmis_GR_fact_sheet_8-31-10.pdf). Review of these BMP fact sheets may provide additional recommendations for reducing the environmental footprint of the remedies that could be added to the Recommendations Section of this analysis.

Response: The evaluation in Appendix E was performed taking into account the activities that are most likely to occur in the field. The conclusions and recommendations suggest further considerations for minimizing the environmental footprint of remedies, which are in agreement with the BMPs presented by the USEPA such as lowering idling time of equipment and utilizing different modes of transportation for wastes. The Navy agrees that the evaluation will be useful for the design and development of work plan for a remedy and that the evaluation could be refined at that time. For example, consideration of alternative sources for generation of electricity in Alternative 4 could be evaluated further if that alternative is proposed in the Proposed Remedial Action Plan. The Navy believes the current scope of the environmental footprint evaluation in the FS is appropriate for this stage of the CERCLA process and no additional recommendations for reducing the environmental footprint of the remedies in the FS will be added.

RESPONSES TO MEDEP COMMENTS DATED APRIL 17, 2013
DRAFT FINAL FEASIBILITY STUDY REPORT FOR OPERABLE UNIT 9
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

1. **Comment:** Please provide some discussion regarding the ash remaining under the water line. During the 2007 removal action all parties agreed to leave the ash under the line so as to not damage it. However, it is an existing source of contamination and its presence should be indicated in some way, perhaps as a notice in the LUC RD. Presumably the Shipyard's existing excavation policy provides the level of protection needed to prevent unacceptable risk to construction workers that may come into contact with this ash. Please determine in this is the case.

   Response: The Navy is aware that there are small pockets of ash/burnt material remaining in the subsurface at Operable Unit (OU9) such as potential ash/burnt material under the water line and elsewhere at the site. The presence of minor amounts of ash/burnt material at the site outside of Building 62 Annex was considered in the evaluation of risks in the Remedial Investigation (RI) Report and in the evaluation of remedial options in the Feasibility Study (FS) Report. The RI indicated that risks for industrial worker (construction worker and occupational worker) exposed to soil was acceptable. There were potentially unacceptable risks for hypothetical future residential exposure to subsurface soil. These risks are being driven by polycyclic aromatic hydrocarbon (PAH) concentrations. As discussed in the FS Report, the pocket of ash/burnt material found north of Building 62 by the water line is driving the potentially unacceptable risks for hypothetical residential exposure. Not all of the locations where ash/burnt material was observed, such as OU9-04, had unacceptable levels of PAHs.

   In the OU9 RI Report an evaluation of the subsurface was conducted that conservatively determined 95% of the subsurface is fill and native material and 5% is ash/burnt (potentially contaminated) material. Exposure point concentrations (EPCs) were weighted to account for 5% of the subsurface potentially being ash/burnt material. Based on evaluations of ash/burnt material subsurface locations as discussed in the OU9 RI and FS reports, the pocket of ash/burnt material near the water line north of Building 62 with elevated concentrations of PAH that are driving unacceptable risks to hypothetical future residents. This pocket of ash/burnt material is within the proposed LUCs residential boundary.