Draft Final

Engineering Evaluation and Cost Analysis for Area of Concern 1 North—Scrap Metal Dump

Naval Weapons Station Yorktown Cheatham Annex
Williamsburg, Virginia

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Executive Summary

This report presents an Engineering Evaluation and Cost Analysis (EE/CA) for a Non-Time Critical Removal Action (NTCRA) at Area of Concern (AOC) 1 North, Naval Weapons Station (WPNSTA) Yorktown, Cheatham Annex (CAX), in Williamsburg, Virginia. AOC 1, Scrap Metal Dump, is composed of two debris disposal areas located between Chapman Road and overhead utility lines running parallel to Chapman Road in the northeastern portion of CAX. Because of the distance between the most significant debris areas, which are centered around the site drainage channels, AOC 1 was divided into two distinct areas (AOC 1 North and AOC 1 South). These areas are being evaluated separately. The EE/CA for AOC 1 North addresses only debris and soil. Debris is being addressed due to the surface and limited subsurface debris posing potential unacceptable risk to future human receptors from the leaching of contaminants from the debris, and soil is being addressed due to potential unacceptable risks to ecological receptors from exposure to zinc in surface soil. Groundwater requires no further action (NFA), as documented in the Expanded Site Inspection (ESI) Report, and agreed upon by the CAX Tier 1 Partnering Team (CH2M HILL, 2015).

The EE/CA identifies the objectives of the NTCRA, identifies removal action alternatives to achieve those objectives, and evaluates the effectiveness, implementability, and cost of those alternatives. The removal action objectives are to:

- Prevent exposure of ecological receptors to AOC 1 North surface soil that contains zinc concentrations that may pose unacceptable risks.
- Mitigate the potential for future transport or leaching of contaminants from debris and impacted soil areas to other portions of the site, offsite areas, and groundwater at concentrations that may pose unacceptable risk to future human receptors.

The following three removal action alternatives were identified and evaluated for AOC 1 North:

1. No Action: No action would be conducted; the site would remain “as is.”
2. Removal and Offsite Disposal: Excavation of surface and limited subsurface debris and impacted soil to 1 foot below ground surface, offsite disposal of the excavated material, post-excavation confirmation sampling, and backfilling the excavation areas with clean fill material.
3. Low-Permeability Soil Cover: Construction of a soil cover over the debris and impacted soil. Additional future actions would include periodic inspections and maintenance of the soil cover, implementation of land use controls (LUCs) to prevent unauthorized disturbance of the cover, and Five-Year Reviews to ensure that the remedy remains protective of human health and the environment.

Alternative 1 does not meet the objectives of the removal action; however, it is provided as a basis for comparison. Alternatives 2 and 3 are comparable in their ability to protect human health and the environment, ability to achieve the removal action objectives, ease of implementability, and compliance with applicable relevant and appropriate requirements (ARARs). Alternative 3 is more expensive than Alternative 2. In addition to being more expensive, Alternative 3 results in debris and impacted soil being left in place; therefore, post-removal site controls (PRSCs) (i.e., LUCs, operation and maintenance activities, and Five-Year Reviews) are required to ensure that the cover is not disturbed so the remedy remains protective over time. After evaluating the trade-offs associated with each alternative, Alternative 2, Removal and Offsite Disposal, is the recommended alternative, because it is a permanent solution that provides for unlimited use/unrestricted exposure and does not require PRSCs to ensure long-term protectiveness.

In accordance with the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), this EE/CA will be placed in the Administrative Record and the CAX local Administrative Record document repository, and a notice of its availability for public review, along with a brief summary of the EE/CA, will be published in the two local newspapers. The EE/CA subsequently will be available for review during a 30-day public comment period. A public information session may be held during or immediately following the public comment period, if requested.

Following the public comment period, if comments are received, a Responsiveness Summary documenting responses to significant comments will be prepared and included in an Action Memorandum, which also will be placed in the Administrative Record.

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Acronyms and Abbreviations

AOC	Area of Concern
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
CAX	Naval Weapons Station Yorktown Cheatham Annex
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	contaminant of concern
DPT	direct-push technology
E&S	erosion and sediment
EE/CA	Engineering Evaluation and Cost Analysis
ER	Environmental Restoration
ERA	Ecological Risk Assessment
ESI	Expanded Site Inspection
ESV	ecological screening value
ft^2	square feet/foot
HHRA	human health risk assessment
HQ	hazard quotient
LUC	land use control
mg/kg	milligram per kilogram
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NFA	no further action
NPL	National Priority List
NTCRA	Non-Time Critical Removal Action
O&M	operation and maintenance
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PRG	preliminary remediation goal
PRSC	post-removal site control
PSLP	Penniman Shell Loading Plant
RAO	removal action objective
RBC	risk-based concentration
SARA	Superfund Amendments and Reauthorization Act
SI	site inspection
SiteWise	SiteWise Version 3.0
SVOC	semivolatile organic compound
TAL	target analyte list
TCL	target compound list
TCLP	toxicity characteristic leaching procedure
TOC	total organic carbon
TPH	total petroleum hydrocarbon

USEPA	United States Environmental Protection Agency
UCL	upper confidence limit
UTL	upper tolerance level
VDEQ	Virginia Department of Environmental Quality
VOC	volatile organic compound
WPNSTA	Naval Weapons Station
WWI	World War I
yd^3	cubic yard

SECTION 1

Introduction

This report presents an Engineering Evaluation and Cost Analysis (EE/CA) for a Non-Time Critical Removal Action (NTCRA) to address potential unacceptable human health and ecological risks from exposure to contaminants in debris and soil at Area of Concern (AOC) 1 North, Scrap Metal Dump, Naval Weapons Station (WPNSTA) Yorktown, Cheatham Annex (CAX), Williamsburg, Virginia. AOC 1, Scrap Metal Dump, is composed of two debris disposal areas located between Chapman Road and overhead utility lines running parallel to Chapman Road in the northeastern portion of CAX. Because of the distance between the most significant debris areas, which are centered around the site drainage channels, AOC 1 was divided into two distinct areas (AOC 1 North and AOC 1 South), which have been evaluated separately. The EE/CA for AOC 1 North addresses only debris and soil. Site investigations have indicated that groundwater requires no further action (NFA), as documented in the Expanded Site Inspection (ESI) Report, and agreed upon by the CAX Tier 1 Partnering Team (CH2M HILL, 2015); therefore, groundwater is not addressed by this EE/CA. This EE/CA addresses soil and debris at AOC 1 North.

This EE/CA has been prepared for Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic under Contract N62470-11-D-8012, Comprehensive Long-term Environmental Action - Navy 1000, Contract Task Order WE25.

1.1 Regulatory Background

This document is issued by the United States Department of the Navy (Navy), the lead agency responsible for environmental remediation at CAX, and thus, AOC 1 North, in partnership with the United States Environmental Protection Agency (USEPA) Region III and the Virginia Department of Environmental Quality (VDEQ), under Section 104 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA) of 1986.

Section 104 of CERCLA and SARA allows an authorized agency to provide for remedial action and to remove, or arrange for removal of, hazardous substances, pollutants, or contaminants at any time, or to take any other response measures consistent with the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), as deemed necessary to protect public health or welfare and the environment. The NCP, Title 40 of the Code of Federal Regulations (CFR), Section 300, provides regulations for implementing CERCLA and SARA and regulations specific to removal actions. The NCP defines a removal action as:

> *[The] cleanup or removal of released hazardous substances from the environment, such actions as may be necessary to monitor, assess, and evaluate the threat of release of hazardous substances; the disposal of removed material; or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release.*

A removal action is being considered for AOC 1 North to mitigate potential unacceptable human health and ecological risks from exposure to surface soil, shallow subsurface soil, and debris. Under 40 CFR 300.415, the lead agency (Navy, in this case) is required to prepare an EE/CA when a removal action is planned for a site. The general purpose of an EE/CA is to identify the objectives of the removal action, identify removal action alternatives to achieve those objectives, and evaluate the effectiveness, implementability, and cost of those alternatives. An EE/CA documents the removal action alternatives and selection process. Where the extent of the contamination is well-defined and limited in extent, removal actions also allow for the expedited cleanup of sites in comparison to the remedial action process under CERCLA.

Community involvement requirements for removal actions include making the EE/CA available for public review in a comment period of 30 days. An announcement of the public review and comment period is required in a local newspaper. Written responses to significant comments are summarized in a Responsiveness Summary that is included in an Action Memorandum, which is placed in the Administrative Record file.

1.2 Purpose and Objectives

Submittal of this EE/CA is the first step in fulfilling the requirements for an NTCRA defined by CERCLA, SARA, and the NCP. This EE/CA has been prepared in accordance with *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (USEPA, 1993). The purposes of this EE/CA are to:

- Satisfy environmental review and public information requirements for removal actions
- Satisfy Administrative Record requirements for documenting the removal action selection
- Provide a framework for evaluating and selecting removal action alternative technologies

The goals of the EE/CA are to identify the objectives of the removal action, identify removal action alternatives to achieve those objectives, and evaluate the effectiveness, implementability, and cost of those alternatives.

The objective of a remedial action is to implement measures to mitigate potential unacceptable risks to human health and ecological receptors from exposure to contaminants in the surface soil and subsurface debris at AOC 1 North. Following completion of the removal action, no further action will be required for soil. There is an NFA decision for groundwater, as documented in the ESI Report, and agreed upon by the CAX Tier 1 Partnering Team (CH2M HILL, 2015).

This EE/CA compares the following three remedial action alternatives based on their technical feasibility, ability to protect human health and the environment, ability to prevent the potential continued or future release of hazardous constituents, and cost:

- **Alternative 1**—No Action
- **Alternative 2—**Removal and Offsite Disposal
- **Alternative 3—**Low-Permeability Soil Cover

SECTION 2

Site Characterization

This section provides background information on the facility and AOC 1 North, including environmental activities that have taken place at AOC 1 North.

2.1 Site Background

2.1.1 Cheatham Annex

CAX consists of 2,300 acres of land on the York-James Peninsula, northwest of WPNSTA Yorktown (**Figure 2-1**). CAX was the location of the former Penniman Shell Loading Plant (PSLP), a large powder and shell loading facility operated by DuPont during World War I (WWI). The facility closed in 1918, and the property was subsequently used for farming or remained idle until CAX was commissioned in 1943 as a satellite unit of the Naval Supply Depot to provide bulk storage facilities and serve as an assembly and overseas shipping point throughout World War II. In 1987, CAX was designated the Hampton Roads Navy Recreational Complex. Today, the mission of CAX includes supplying Atlantic Fleet ships and providing recreational opportunities to military and civilian personnel, with outdoor recreational facilities that include cabins, camp sites, an 18-hole golf course, swimming pool, ball fields, freshwater fishing areas, boating, wildlife watching, and hunting.

CAX is bordered by Queens Creek to the north, the Colonial National Historical Park to the south, the York River to the east, King Creek to the southeast, and the Queens Lake subdivision to the west. The city of Williamsburg is southwest of CAX. The majority of CAX is undeveloped and heavily wooded. Major surface water features at CAX consist of Youth Pond, Cheatham Pond, Jones Pond, and Penniman Lake. Potable water supply at CAX is provided by Newport News Waterworks (ASTDR, 2004).

In October 1998, control of CAX was transferred from the Fleet and Industrial Supply Center to WPNSTA Yorktown. Comprehensive Environmental Restoration (ER) activities at CAX began in 1984 under the Navy Assessment and Control of Installation Pollutants program and the ER Program. On January 2, 2001, CAX was added to the National Priorities List (NPL), which requires all subsequent ER activities to be conducted under CERCLA. The Navy, Commonwealth of Virginia (through VDEQ), and USEPA executed a Federal Facilities Agreement in March 2005, which identified 12 sites and 7 AOCs to be addressed under CERCLA (USEPA et al., 2005).

2.1.2 Area of Concern 1

AOC 1 is composed of two debris disposal areas located between Chapman Road and overhead utility lines running parallel to Chapman Road. This site was identified as an AOC in 1998 following site visits by the Navy, USEPA, and VDEQ. Because of the distance between the most significant debris areas, which are centered around the site drainage channels, AOC 1 was divided into two distinct areas (AOC 1 North and AOC 1 South), which have been evaluated separately. AOC 1 North is the focus of this EE/CA (**Figure 2-2**).

AOC 1 North is approximately 0.75 acre in size. The general topography of AOC 1 is characterized by the primary drainage channels located within the northern and southern subareas (AOC 1 North and AOC 1 South). These two drainages merge west of the site, where runoff from both AOC 1 North and AOC 1 South flows approximately 1,000 feet west toward Jones Pond (**Figure 2-2**). Surface water is generally not observed in the AOC 1 North drainage channel, which runs southeast-northwest through the center of the site.

Soil boring data from both the Site Inspection (SI) (CH2M HILL, 2012) and the ESI (CH2M HILL, 2015) indicate the shallow subsurface lithology at AOC 1 North consists (in descending order) primarily of dark-colored silty sand and topsoil followed by brownish-yellow sandy clay to medium-grained loose sand underlain by a shell hash layer that is then underlain by clayey sand with shells. The first encountered groundwater at AOC 1 North is within the Cornwallis Cave aquifer, at depths ranging from approximately 6 to 25 feet below ground surface (bgs); groundwater generally flows toward the west (CH2M HILL, 2015).

AOC 1 North is wooded and restricted to the general public by a locked, chain-link fence; however, it is unrestricted to Navy personnel and recreational users who use the Jones Pond area for recreation, including hiking and fishing. Future land use at AOC 1 North is not expected to change and will likely continue as wooded/green space with use of Jones Pond for recreation for the foreseeable future.

2.2 Summary of Previous Investigations

2.2.1 1999 Former Penniman Shell Loading Plant Site Inspection

In 1999, an SI was conducted to assess potential sources of contamination associated with the former PSLP to determine the need for additional investigation and, if appropriate, to support site evaluation for inclusion on the NPL. Of the 29 samples collected from potential source areas associated with the former PSLP, one sediment sample was collected within the vicinity of AOC 1 North (referred to as the Jones Pond Landfill in the Final SI Narrative Report [Weston, 1999]). The sediment sample was collected from the unnamed tributary leading to Jones Pond within the vicinity of AOC 1 North and analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), explosives, and metals.

The concentration of manganese in this sample (PEN1_SED-04) (168 milligrams per kilogram [mg/kg]) was above the detected concentration in the sediment sample collected to represent background conditions (20.8 mg/kg). Therefore, it was recommended that a more specific investigation be conducted (Weston, 1999).

2.2.2 2001 AOC 1 Site Inspection

Fieldwork for a subsequent SI was conducted at AOC 1 in 1999, which included a geophysical survey and soil and surface water/sediment sampling (Baker, 2001). During the 1999 AOC 1 SI, debris, including scrap metal, wood, empty drums, cinder blocks, bricks, concrete, and concrete slabs, was observed in the two ravines located in the northern and southern areas of AOC 1; it appears as though the debris was dumped. The buried debris areas in AOC 1 North, as defined by the geophysical survey, are roughly coincident with the apparent extent of debris that is present at the surface. The eastern (buried) edge of debris was interpreted to be approximately 10 to 12 feet beyond the edge of the surface debris (that is, unexposed debris is buried within an approximately 10- to 12-foot-wide area). With the exception of this 10- to 12-foot-wide area, the results of the survey indicated there is not extensive buried debris at AOC 1 North (Baker, 2001). The date(s) of debris disposal at AOC 1 North are unknown; however, it is possible some of this debris dates back to the WWI era (Weston, 1999). The total volume of debris at AOC 1 North was estimated to be 970[1] cubic yards (yd^3) (Baker, 2001).

All of the 1999 AOC 1 SI samples were analyzed for VOCs, SVOCs, metals, cyanide, and explosives (nitroamines/nitroaromatics). Polycyclic aromatic hydrocarbon (PAH[2]) concentrations were fairly widespread in surface soil and exceeded the residential soil risk-based concentrations (RBCs), the screening criteria in place at the time; however, no PAHs were detected in subsurface soil, surface water, or sediment at AOC 1 North. Arsenic and iron in surface soil, and arsenic in subsurface soil, were detected at concentrations exceeding their respective RBC value. However, with the exception of one detection of arsenic in surface soil, the detections were below the WPNSTA Yorktown background concentrations[3]. One phthalate (bis[2-ethylhexyl]phthalate) exceeded the tap water RBC multiplied by 10 in one surface water sample; however, none of the detected SVOCs exceeded the residential soil RBCs in sediment. While no inorganic constituent concentrations exceeded screening criteria in the surface water samples, arsenic concentrations exceeded the residential soil RBC in sediment; however, the arsenic concentrations were below the WPNSTA Yorktown background concentration (Baker, 2001). Based on these results, further investigation was recommended to evaluate disposal parameters and an EE/CA was recommended to evaluate the most appropriate means of removing or covering the site debris.

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1 Assuming an average thickness of 3 feet, the in-place volume of debris at AOC 1 North is (0.2 acre x 43,560 ft^2/acre x 3 ft) x .03704 yd^3/ft^3) = 970 yd^3

2 PAHs are chemicals that are often found together in groups of two or more and are a subset of SVOCs.

3 Baker Environmental, Inc. 1995. Final Summary of Background Constituent Concentrations and Characterization of the Biotic Community from the York River Drainage Basin. July 1995.

2.2.3 2012 Site Inspection Activities

A third SI was initiated in 2008 and included surface soil, subsurface soil, and direct-push technology (DPT) groundwater sampling (CH2M HILL, 2012). The SI also included a review of available aerial photographs and, based on this review, "mounded material" was initially identified within AOC 1 North on the 1963 aerial photo (USEPA, 1998). The SI soil and DPT groundwater samples were analyzed for VOCs, SVOCs, pesticides, PCBs, explosives (including pentaerythritol tentranitrate, 3,5-dinitroaniline, nitroglycerin, and nitroguanadine), metals (both total and dissolved metals for groundwater), cyanide, total organic carbon (TOC) (soil only), and pH (soil only). Elevated PAHs and metals were detected in surface soil, and metals were detected in DPT groundwater samples. The groundwater samples were collected using DPT collection methods, which can result in elevated total metal constituent concentrations that are not representative of aquifer conditions due to the potential presence of excess sediment in the groundwater sample. Based on the presence of elevated PAH and metal concentrations detected at the site, an ESI was recommended.

2.2.4 2015 Expanded Site Inspection

Fieldwork for an ESI was conducted in 2014 and consisted of surface soil sampling, monitoring well installation, and groundwater sampling to characterize the nature and extent of potential contamination in soil and groundwater, assess the potential risks posed by this contamination to human health and the environment via a human health risk assessment (HHRA) and ecological risk assessment (ERA), and determine the need for further investigation or action (CH2M HILL, 2015). The results of the HHRA identified potential unacceptable risks for future residents from exposure to benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, arsenic, and cobalt in combined surface and shallow subsurface soil *if* any future residents use groundwater at the site as a potable water supply. However, because potable water is supplied by the Newport News Waterworks and land at AOC 1 North is unlikely to be developed for residential use in the future, the results of the HHRA are considered to be overly conservative. Therefore, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, arsenic, and cobalt are not considered human health risk drivers in soil for the current and foreseeable future use of the site. The results of the ERA identified potential unacceptable ecological risks for lower trophic level receptors (plants and invertebrates) from exposure to zinc in surface soil.

Based on these results, the ESI recommended completing a removal action at AOC 1 North to address debris and potentially unacceptable ecological risks for zinc in surface soil. Although human health soil contaminants of concern (COCs) are not considered risk drivers, these chemicals fall within the footprint of the zinc and debris contamination and will be removed from the site. The CAX Tier I Partnering Team agreed with the recommendation for NFA for groundwater, because concentrations of COCs were determined to be consistent with naturally occurring, background conditions and not the result of a site-related release (CH2M HILL, 2015).

2.3 Nature and Extent of Contamination

A graphical representation of the conceptual site model for AOC 1 North is shown on **Figure 2-3**. Soil sample locations from the previous investigations and the estimated extent of debris are depicted on **Figure 2-4**.

Soil

Based on the risks identified in the HHRA and ERA (see summaries in Section 2.4), action within the proposed removal area was only determined to be necessary for zinc, which was identified as an ecological-based site COC in surface soil (0 to 6 inches bgs). Zinc was detected in surface soil at concentrations above background levels and screening criteria and at locations that were spatially limited and in the vicinity of debris that likely represents its source. Zinc was detected in 7 of 16 surface soil samples (CAA01-SS04, CAA01-SS11, CAA01-SS21, CAA01-SS22, CAA01-SS23, CAA01-SS24, and CAA01-SS25) at concentrations ranging from 150 to 872 mg/kg, all of which exceed both the ecological screening criterion (120 mg/kg) and background level (26.5 mg/kg). As previously mentioned, human health COCs (PAHs, arsenic, and cobalt) are not considered risk drivers in soil based on the current and foreseeable future land use scenarios for the site, and are not directly addressed in the removal action; however, the spatial extents of these chemicals fall within the footprint of the zinc and debris contamination and will be addressed by the removal action.

Debris

The only identified potential source of contamination at AOC 1 North has been determined to be debris (surface and limited subsurface), consisting of concrete, wood, metal, and empty drums. The wood (old railroad ties), metal, and empty drum debris will be addressed during the removal action. The concrete debris will not be addressed during the removal action because it is a relatively benign material that does not inherently pose any human health or ecological risks, has a low probability for leaching of site contaminants into soil or groundwater, and is not considered to represent a CERCLA-regulated release.

2.4 Risk Summary

Summaries of the baseline HHRA and the ERA presented in the ESI (CH2M HILL, 2015) are provided below.

2.4.1 Human Health Risk Summary

A baseline HHRA was conducted to evaluate exposure to debris and chemical constituents in soil for the following human receptors and exposure pathways:

- **Current maintenance worker**: Incidental ingestion of and dermal contact with surface soil and inhalation of particulate emissions from surface soil
- **Current recreational user/visitor (adult and child)**: Incidental ingestion of and dermal contact with surface soil and inhalation of particulate emissions from surface soil
- **Future maintenance worker**: Incidental ingestion of and dermal contact with surface and subsurface soil and inhalation of particulate emissions from surface and subsurface soil
- **Future recreational user/visitor (adult and child)**: Incidental ingestion of and dermal contact with surface and subsurface soil and inhalation of particulate emissions from surface and subsurface soil
- **Future industrial worker**: Incidental ingestion of and dermal contact with surface and subsurface soil and inhalation of particulate emissions from surface and subsurface soil, as well as, ingestion of shallow groundwater
- **Future construction worker**: Incidental ingestion of and dermal contact with surface and subsurface soil and inhalation of particulate emissions from surface and subsurface soil, as well as, dermal contact with shallow groundwater in an open excavation
- **Future resident (adult and child)**: Incidental ingestion of and dermal contact with surface and subsurface soil, as well as, ingestion of shallow groundwater and dermal contact with shallow groundwater while bathing/showering

The results of the risk evaluations for each receptor are summarized as follows:

- **Current maintenance worker**: No potential unacceptable noncarcinogenic hazards or carcinogenic risks associated with exposure to surface soil
- **Current recreational user/visitor (adult and child)**: No potential unacceptable noncarcinogenic hazards or carcinogenic risks associated with exposure to surface soil
- **Future maintenance worker**: No potential unacceptable noncarcinogenic hazards or carcinogenic risks associated with exposure to combined surface and subsurface soil
- **Future recreational user/visitor (adult and child)**: No potential unacceptable noncarcinogenic hazards or carcinogenic risks associated with exposure to combined surface and subsurface soil
- **Future industrial worker**: No potential unacceptable noncarcinogenic hazards or carcinogenic risks associated with combined surface and subsurface soil
- **Future construction worker**: No potential unacceptable noncarcinogenic hazards or carcinogenic risks associated with exposure to surface and subsurface soil

- **Future resident (adult and child)**: Potential unacceptable noncarcinogenic hazards or carcinogenic risks associated with exposure to combined surface and subsurface soil only if resident also uses site groundwater as a potable water supply:
  - Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, arsenic, and cobalt would pose unacceptable risks if future resident is exposed to soil and uses groundwater as a potable water supply.
  - If resident does not use groundwater as a potable water supply, no unacceptable noncarcinogenic hazards or carcinogenic risks associated with exposure to soil.
  - Once the soil contamination is addressed, there is no unacceptable human health risk from exposure to groundwater by a future residential receptor.

There are no unacceptable carcinogenic risks or noncarcinogenic hazards for exposure to soil alone for human receptors. Although not specifically evaluated, it is assumed that there is potential unacceptable risk to all human health receptors from the leaching of contaminants from the debris to soil and/or groundwater.

2.4.2 Ecological Risk Summary

An ERA was conducted to evaluate exposure chemical constituents in surface soil and shallow subsurface soil for lower trophic level terrestrial receptors (terrestrial plants and soil invertebrates), and to evaluate upper trophic level receptors (birds and mammals) for food web exposures. Because of the small size of AOC 1 North, exposures to upper trophic level receptors (birds and mammals) are not considered significant, and there were no unacceptable risks identified in the ERA for these receptors. The lower trophic level receptors may be exposed to site-related contaminants through root uptake from the soil (plants) and/or through direct contact with, and ingestion of, soil.

The ERA concluded that for terrestrial habitats, potential unacceptable risks for lower trophic level receptors (plants and invertebrates) exist as a result of zinc concentrations exceeding ecological screening values (ESVs) and background upper tolerance limits (UTLs) in 7 of 16 surface soil samples and exceeding both the mean and the 95 percent upper confidence limit (UCL) hazard quotient (HQ) of 1. The most impacted samples within AOC 1 North were from a small area delineated by samples CAA01-SO04, CAA01-SO11, and CAA01-SO23 (**Figure 2-4**); this area also correlates to where the greatest amounts of surface debris is generally located. Thus, potential risks in surface soil are spatially limited. No unacceptable ecological risks are associated with exposures to shallow subsurface soil or with food web exposures.

2.5 Development of Cleanup Goals

To meet the removal action objectives (RAOs), a preliminary remediation goal (PRG) for zinc was established for surface soil within AOC 1 North. The PRG for zinc is based on the ESV (soil invertebrates), and is summarized in **Table 2-1**. Soil PRGs were not developed for the human health based COCs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, arsenic, and cobalt), as these constituents are only considered soil COCs under the unlikely scenario of future residential use of groundwater at the site as a potable water supply. Nevertheless, the detected concentrations of these constituents fall within the footprint of the zinc and debris contamination and will be indirectly addressed by this removal action.

2.6 Determination of Removal Action Area

This EE/CA addresses soil and debris at AOC 1 North. The soil removal action area is approximately 3,000 square feet (ft^2) (50 feet by 60 feet) in size and corresponds with the PRG exceedances of zinc in surface soil characterized by sample locations CAA01-SO04, CAA01-SO11, CAA01-SO21, CAA01-SO22, CAA01-SO23, CAA01-SO24, and CAA01-SO25 (red box on **Figure 2-4**). Because only surface soil is impacted, the depth of the ecological risk-based removal action area is 1 foot bgs to ensure removal of impacted soil; this equates to a total excavated soil volume of 111 yd^3. The surface and limited subsurface debris area is approximately 9,580 ft^2 (**Figure 2-4**) in size. As shown on **Figure 2-4**, there is some overlap with the ecological risk-based soil area and the debris area.

TABLE 2-1
Summary of Ecologically Based Preliminary Remediation Goals

Chemical	Ecological Soil Screening Value (mg/kg)	Basis	Background - Surface Soil		Selected PRG (mg/kg)
			95% UTL (mg/kg)	Maximum (mg/kg)	
Zinc	120	Eco-SSL (invertebrate)	26.5	30.0 (113)[a]	**120[b]**

Notes:

[a] Maximum value in background samples before "outliers" were removed from the data set used to calculate the final UTLs

[b] Applies only to removal of soil up to 2 feet below ground surface

R:\USNavFacEngCom405450\CheathamAnnex\MapFiles\405134_AOC1_North_EECA\Figure 2-1 - Base Location Map.mxd11/11/2015jclements

Legend

Study Area Boundary

Cheatham Annex Boundary

N
W E
S

0 2,000 4,000 Feet

Imagery Source: GRC, 2010

Figure 2-1
Base Location Map
AOC 1 North Engineering Evaluation/Cost Analysis
Cheatham Annex
Williamsburg, Virginia

CH2MHILL

R:\USNavFacEngCom405450\CheathamAnnex\MapFiles\405134_AOC1_North_EECA\Figure 2-2 - Site Map.mxd11/10/2015jclements

Legend

- Utility Pole
- Drainage Channel (arrow represents flow direction)
- Anticipated Surface Water Flow
- General Groundwater Flow Direction
- Overhead Utility Line
- Approximate Study Area Boundary

N
W E
S

0 300 600
Feet

Imagery Source: GRC, 2010

Figure 2-2
Site Map
AOC 1 North Engineering Evaluation/Cost Analysis
Cheatham Annex
Williamsburg, Virginia

CH2MHILL

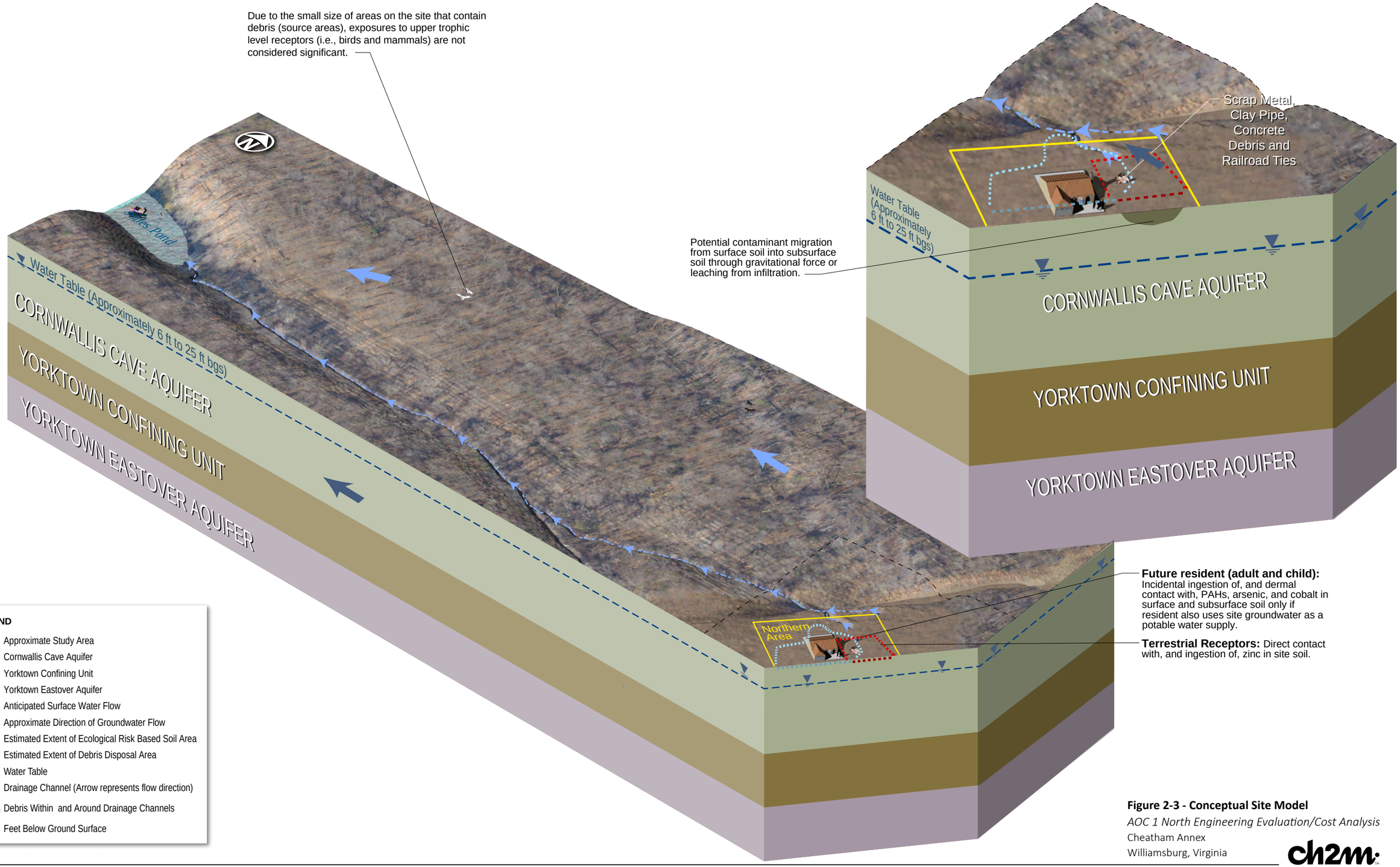


Figure 2-3 - Conceptual Site Model

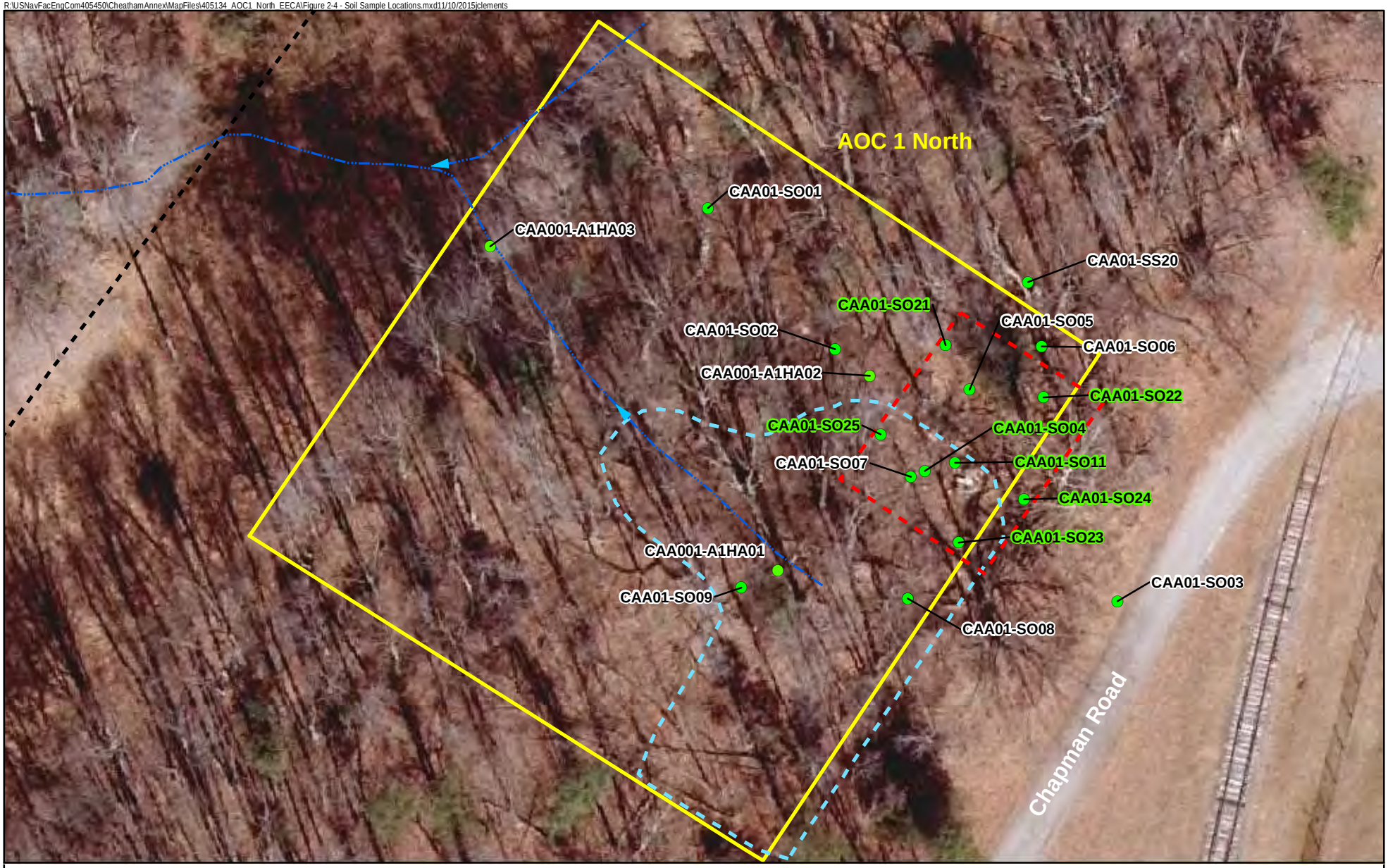
AOC 1 North Engineering Evaluation/Cost Analysis

Cheatham Annex

Williamsburg, Virginia

ES072012222417VBO CSMCAXAOC_Fig7-1_CMS_Site_AOC1_North_rev6.ai 08-25-15 LED/ct/dcd/bp

R:\USNavFacEngCom405450\CheathamAnnex\MapFiles\405134_AOC1_North_EECA\Figure 2-4 - Soil Sample Locations.mxd11/10/2015jclements



Legend

- Surface/Subsurface Soil Sample Location
- Utility Pole
- Drainage Channel (arrow represents flow direction)
- Overhead Utility Line
- Approximate Study Area Boundary
- Estimated Extent of Ecological Risk Based Soil Area
- Estimated Extent of Debris Disposal Area
- SO23 Soil Sample Location exceeding the Ecological PRG for Zinc

Imagery Source: GRC, 2010

N W E S

0 40 80 Feet

Figure 2-4
Soil Sample Locations and Estimated Extent of Debris
AOC 1 North Engineering Evaluation/Cost Analysis
Cheatham Annex
Williamsburg, Virginia

CH2MHILL

SECTION 3

Identification of Removal Action Objectives

3.1 Statutory Limits on Removal Action

The NCP, 40 CFR Part 300.415, dictates statutory limits of $2 million and a 12-month duration for USEPA fund-financed removal actions, with statutory exemptions for emergencies and actions consistent with the remedial action to be taken. However, this removal action will not be USEPA fund-financed. The *Department of the Navy Environmental Restoration Program Manual* (Navy, 2006) does not limit the cost or duration of removal actions; cost-effectiveness is a recommended criterion for the evaluation of removal action alternatives and is discussed in Sections 4 and 5.

3.2 Removal Action Objectives and Scope

The RAOs are as follows:

- Prevent exposure of ecological receptors to AOC 1 North surface soil that contains zinc concentrations that may pose unacceptable risks.
- Mitigate the potential for future transport or leaching of contaminants from debris and impacted soil areas to other portions of the site, offsite areas, and groundwater at concentrations that may pose unacceptable risk to future human receptors.

The removal action will be considered complete when these objectives have been met.

3.3 Determination of Removal Action Schedule

This EE/CA will be made available for a 30-day public comment period. Notice of its availability for public review, along with a brief summary of the EE/CA, will be published in two local newspapers – *Daily Press* and *The Virginia Gazette*. The public comment period is scheduled to be from March 21, 2016 to April 19, 2016. A public information session will be held during or immediately following the public comment period, if requested. If public comments are received during the public comment period, a Responsiveness Summary documenting responses to significant comments will be prepared and included in the Action Memorandum, which will be placed in the Administrative Record for CAX. The Administrative Record file can be found on the CAX Public Environmental Restoration Program web site at http://go.usa.gov/DynP. The Administrative Record is also available for public review by appointment through the NAVFAC Mid-Atlantic Public Affairs Office[4].

Because this removal action has been designated as non-time-critical, the start date of the removal action will be determined by factors other than the urgency of the threat. Possible factors include weather, the availability of resources, and site constraints. The total project period is anticipated to last 12 months from the beginning of the public comment period to completion of the associated construction completion documentation. Critical milestone periods for the removal action are as follows:

- EE/CA public comment period—30 days
- Subcontracting, work plan, and mobilization—6 months
- Removal action—3 weeks (for Alternative 2) or 2 weeks (for Alternative 3)
- CERCLA documentation—4 months

[4] Naval Weapons Station (WPNSTA) Yorktown
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160 Main Road
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wpnsta.pao@navy.mil

3.4 Applicable or Relevant and Appropriate Requirements

The removal action will, to the extent practicable, comply with applicable or relevant and appropriate requirements (ARARs) under federal and state environmental laws, as described in 40 CFR 300.415. As outlined by 40 CFR 300.415(j), the lead agency may consider the urgency of the situation and the scope of the removal action to be conducted in determining whether compliance with ARARs is practicable.

Applicable requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limits promulgated under federal or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance. Relevant and appropriate requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limits promulgated under federal or state law that, although not applicable to a hazardous substance, a pollutant, a contaminant, a remedial action, or other circumstances at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site so that their use is well suited to the particular site. Other federal and state advisories, criteria, and/or guidance, such as risk assessment calculations, will be considered as needed in formulating the removal action; however, these are neither promulgated nor enforceable and, therefore, are not ARARs. The Navy, as the lead agent, has reviewed federal and state requirements and determined that those listed in **Appendix A** are relevant to the proposed removal action at AOC 1 North.

Three classifications of ARARs are defined by USEPA: chemical-specific, location-specific, and action-specific.

Chemical-specific ARARs are promulgated and enforceable standards for specific chemicals that establish concentrations of contaminants for a given medium. These standards are established as ARARs when they have a direct effect on the implementation of a remedial action. Promulgated and enforceable standards were reviewed, and no federal or Virginia chemical-specific ARARs have been identified for the remedial alternatives proposed for AOC 1 North (**Appendix A,** Tables A-1 and A-2).

Location-specific ARARs are promulgated and enforceable standards that restrict remedial activities and media concentrations based on the characteristics of the surrounding environment. Location-specific ARARs may include restrictions on remedial actions within wetlands or coastal areas, near locations of known endangered species, or within protected waterways. Federal and Virginia location-specific ARARs have been identified for AOC 1 North (**Appendix A,** Tables A-3 and A-4).

Action-specific ARARs are promulgated and enforceable standards that govern activities that will be performed during the response actions, such as waste management, dust control, and erosion control. Federal and Virginia action-specific ARARs have been identified for AOC 1 North (**Appendix A,** Tables A-5 and A-6).

3.5 General Disposal Requirements

Waste disposal procedures implemented for the removal action will be in accordance with the state and federal laws and regulations that govern offsite disposal. For the purposes of this EE/CA, the cost estimates were based on the assumption that excavated soil and miscellaneous debris will be characterized as non-hazardous. Waste characterization testing will be conducted in accordance with the requirements of state and federal regulations. All materials will be disposed in a state-permitted disposal facility that is approved by the Navy and is permitted to accept CERCLA waste.

SECTION 4

Description and Evaluation of Removal Action Alternatives

The alternatives for this removal action were evaluated using professional judgment based on information and experience from previous environmental remediation activities. Alternatives were evaluated based on effectiveness, implementability, and cost. The no-action alternative was evaluated for comparative purposes.

4.1 Description of Removal Action Alternatives

4.1.1 Alternative 1: No Action

With this alternative, no action would be conducted and no administrative controls would be implemented. The area would be left as it currently exists, leaving the debris posing potential future human health risks and impacted soil posing potential ecological risks in place.

4.1.2 Alternative 2: Removal and Offsite Disposal

This alternative consists of excavation and offsite removal of debris (not including concrete debris which will remain in place) and impacted soil within the ecological risk-based soil removal area and the excavation and offsite removal of surface and limited subsurface debris within the debris disposal area (**Figure 4-1**). Excavated areas would be backfilled. No land use controls (LUCs), operation and maintenance (O&M) activities, or Five-Year Reviews are required for this alternative, because no waste will remain in place. Green and sustainable remediation best management practices that can be implemented with this alternative include truck and equipment idling control, use of backfill material that is sourced nearby to minimize emissions from truck transportation, vegetating the restored excavation area with locally available and low-maintenance grasses and plants, using a nearby disposal facility to minimize truck emissions, and recovering metal debris that can be recycled to avoid disposal.

Site Preparation

Site preparation activities would include a pre-excavation topographic survey, setup of a staging area and facilities, installation of erosion and sediment (E&S) controls, vegetation clearance, and installation of a construction entrance. Before construction begins, typical temporary E&S controls would be installed, such as silt fencing and hay bales installed around areas to be disturbed at topographic lows and around soil stockpile areas. Permanent E&S controls after construction would include appropriate grading and site vegetation. Specific details would be provided in an E&S control plan to be included with the removal action work plan.

Pre-Excavation Waste Characterization Sampling

Before excavation and offsite disposal of debris and impacted soil from the removal areas occur, pre-excavation waste characterization samples would be collected to determine if the waste is classified as hazardous or nonhazardous for disposal purposes. For cost-estimating purposes, it was assumed that pre-excavation waste characterization sampling would be conducted at a frequency of one sample per 1,000 yd^3 of soil and the samples analyzed for full toxicity characteristic leaching procedure (TCLP) (VOCs, SVOCs, metals, herbicides, and pesticides), PCBs, reactivity (cyanide and sulfide), ignitability, corrosivity, total petroleum hydrocarbons (TPH)-diesel range organics, and TPH-gasoline range organics with a 7-day turnaround time. Additional waste characterization samples may be necessary if post-excavation confirmation samples collected from the removal areas indicate additional excavation is required (see the Post-Excavation Confirmation Sampling subsection below). If needed, the additional samples would be collected at the same frequency and be analyzed for the same analytical parameters as the pre-excavation waste characterization samples.

Excavation and Offsite Disposal

The vast majority of the debris is on the surface, and there is limited subsurface debris. The surface and limited subsurface debris will be removed from an approximately 9,580 ft^2 area and impacted soil will be excavated to 1

foot bgs, over an approximately 3,000 ft^2 area. For the subsurface debris removal, the excavation is not expected to extend beyond 1 foot bgs; however, if it does, the excavated soil and debris will also be removed from the site. Any concrete that prohibits the removal of impacted soil will be lifted out of the way, but will remain onsite. An estimated total of 40 yd^3 of debris will be removed from the debris disposal area out of an estimated total of 111 yd^3 of material that will be excavated from the soil removal area. The water table at the site is approximately 6 to 25 feet bgs and should not be encountered during excavation activities; therefore, no dewatering is anticipated. The debris and impacted soil, which were assumed to be nonhazardous for cost-estimating purposes, will be transported to a USEPA offsite rule-approved disposal facility. The debris removal, soil excavation, offsite disposal, and backfilling will be performed using mechanical earthwork equipment (such as excavators, bulldozers, front end loaders, and dump trucks). Exact details will be provided in the removal action work plan.

Post-Excavation Confirmation Sampling

Before backfilling of excavations occurs, post-excavation confirmation samples would be collected, and the results compared against the soil PRG (**Table 2-1**), to confirm the horizontal and vertical extents of the soil removal area excavation is sufficient. For cost-estimating purposes, it was assumed the confirmation sampling would be conducted at a frequency of one excavation floor sample per every 625 ft^2 (25- by 25-foot grid) and one excavation wall sample per every 50 linear feet, resulting in an estimated total of 10 (5 floor and 5 wall) confirmation samples. The disposal area confirmation samples would be analyzed for the site COC (zinc) with a 24-hour turnaround time.

If zinc concentrations in confirmation soil samples are greater than the PRG, then the EE/CA assumes that further excavation would be conducted to meet the RAOs. This scenario is considered unlikely since existing shallow subsurface soil samples (6-24 inches bgs) in the removal area were less than background UTLs. In the event the removal extends to a depth of 2 feet bgs and PRGs are exceeded in confirmation samples at a depth of 2 feet bgs, the magnitude and extent of any such PRG exceedances will be evaluated to determine the level of potential risk. Should the risk associated with these samples be considered unacceptable, the Navy, in consultation with the Tier 1 Partnering Team, will determine the path forward for the site. Possibilities include additional excavation beyond 2 feet to meet PRGs or backfilling the existing excavation and instituting LUCs that prohibit disturbing the soil in the removal area below a depth of 2 feet bgs.

Backfill

Following completion of the excavation activities within the soil removal area, a topographic survey of the site would be completed to capture the spatial coordinates of the lateral and vertical extents of the excavation area.

An estimated total of 140 loose yd^3 of fill material (70 yd^3 of imported topsoil and 70 yd^3 of imported general fill) would be used to backfill the soil removal area excavation to match the surrounding grade. General fill would be used to bring the grade to within 6 inches of the final grade, followed by the placement of a 6-inch topsoil layer to support vegetation growth.

General fill and topsoil would be delivered to the site from an offsite source meeting the requirements agreed upon in the CAX Tier I Partnering Team's Consensus Statement for Certifying Clean Fill (**Appendix B**). For cost-estimating purposes, it was assumed that no excavated soil will be reused as topsoil or general fill.

Following completion of backfilling activities, another topographic survey of the site would be conducted to confirm that the post-backfill elevations are consistent with the pre-existing grade.

Site Restoration

Areas disturbed during the removal action would be stabilized by seeding with native species of grasses. Once site restoration is complete and vegetation has re-established, there would be no further changes to or maintenance of the ground surface under Alternative 2. All equipment, materials, and temporary E&S controls would be removed from the site. Site restoration details would be provided in the removal action work plan.

4.1.3 Alternative 3: Low-Permeability Soil Cover

This alternative consists of construction of a low-permeability soil cover over the ecological risk-based soil area and debris area (**Figure 4-1**). As a result of debris and impacted soil remaining onsite, LUCs, O&M, and Five-Year Reviews would be required and would be implemented indefinitely. Green and sustainable remediation best management practices that can be implemented with this alternative include collection and analysis of soil samples before cover placement to reduce the area requiring soil cover materials, truck and equipment idling control, use of cover material that is sourced nearby to minimize emissions resulting from truck transportation, and vegetating the cover with locally available, low-maintenance grasses and plants.

Pre-Soil Cover Delineation Sampling

Before placing the soil cover, samples would be collected to delineate the horizontal extent of the impacted soil within the ecological risk-based area. For cost-estimating purposes, it was assumed that discrete surface soil samples would be collected along the perimeter of the ecological risk-based area at a frequency of one sample per every 50 linear feet and be analyzed for the site surface soil COC (zinc). The sample results would be compared to the PRG in **Table 2-1**. If the perimeter results exceed the cleanup goal, additional sampling would be conducted until the perimeter results are below the cleanup goal and the required extent of the soil cover area has been defined. The sampling details would be established in a sampling and analysis plan.

Site Preparation

Site preparation activities would include a pre-soil cover topographic survey, setup of a staging area and facilities, installation of E&S controls, vegetation clearance, and installation of a construction entrance. Before construction begins, typical temporary E&S controls would be installed, such as silt fencing and hay bales installed around areas to be disturbed at topographic lows. Permanent E&S controls after construction would include appropriate grading and site vegetation. Additional details would be provided in an E&S control plan to be included with the work plan.

Soil Cover

A soil cover would be installed over the surface of an approximately 12,580 ft^2 area, which includes the entirety of both the ecological risk-based area and the debris area (**Figure 4-1**). For cost-estimating purposes, a 2-foot-thick soil cover consisting of 18 inches of general fill, topped by 6 inches of topsoil, would be placed over the surface area and seeded. The final desired as-built slope of the soil cover would be constructed to promote positive drainage off the soil cover and to provide a smooth transition to the surrounding native ground surface elevation. Hauling and backfilling would be performed using mechanical earthwork equipment (such as bulldozers and dump trucks). Specific details would be provided in the work plan.

Following completion of soil cover placement activities, a topographic survey of the site would be conducted to confirm that the soil cover elevations are consistent with the soil cover design provided in the work plan.

Site Restoration

Areas disturbed during the soil cover installation would be stabilized by seeding with native species of grasses. Alternative 3 would permanently alter the topography of the site. All equipment, materials, and temporary E&S controls would be removed from the site. Site restoration details would be provided in the work plan.

Land Use Controls, Operation and Maintenance, and Five-Year Reviews

As a result of debris and impacted soil remaining onsite, LUCs, O&M, and Five-Year Reviews would be required to ensure the following:

- Soil cover remains in place and continues to be protective of human health and the environment
- Land use remains the same and the cover is not disturbed without appropriate notification/authorization

The established LUC boundary would be included in the CAX master plan and geographic information system. For cost-estimating purposes, the LUCs would include the installation of signs at designated locations along the site boundary prohibiting unauthorized disturbances of the soil cover, and the O&M would include quarterly inspections of the cover for the first 2 years, followed by annual inspections, and soil cover and vegetative maintenance as required (assumed to be every 10 years). Although NFA is required for groundwater, monitoring

may be warranted as part of the Five-Year Review since debris will be left in place. If this is the case, then it is assumed that groundwater monitoring would be conducted concurrent with the Five-Year Reviews; the EE/CA assumes that monitoring wells installed during the ESI could be retrofitted during the soil cover design. The LUCs, O&M, and Five-Year Reviews would be implemented indefinitely; however, a period of 30 years was used for cost-estimating purposes.

4.2 Evaluation of Alternatives

4.2.1 Evaluation Criteria

The criteria used to evaluate the removal action alternatives are based on *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA*, PB93-963402 (USEPA, 1993).

4.2.2 Effectiveness

The *effectiveness* criterion addresses the expected results of the removal action alternatives. It includes two major subcategories: protectiveness and ability to achieve the removal objectives.

- Protectiveness
  - Protective of public health and community
  - Protective of workers during implementation
  - Protective of the environment
  - Complies with ARARs
- Ability to Achieve Removal Objectives
  - Ability to meet the expected level of treatment or containment
  - Has no residual effect concerns
  - Maintains long-term control

In addition to the protectiveness and ability to achieve the RAOs subcategories, sustainability should be considered. Therefore, a sustainability assessment was conducted using SiteWise Version 3.0 (SiteWise), a stand-alone tool that assesses the environmental footprint of a remedial alternative to compare the overall life-cycle environmental impacts of each remedy (Battelle, 2013). The sustainability assessment provides an additional comparison criterion that may allow options with smaller environmental impacts to be selected when all other criteria are met. The sustainability assessment is included in **Appendix C**. In addition, the environmental footprint of the selected alternative may be further evaluated in the design phase of the project to explore opportunities to optimize the environmental footprint of the project and integrate sustainable remediation best practices in the design, construction, and operation of the removal action.

4.2.3 Implementability

The *implementability* criterion encompasses the technical and administrative feasibility of the removal action. It includes three subcategories: technical feasibility, availability of resources, and administrative feasibility.

- Technical feasibility
  - Construction and operational consideration
  - Demonstrated performance and useful life
  - Adaptability to environmental conditions
  - Contribution to performance of long-term removal actions
  - Implementation within the allotted time
- Availability of resources
  - Availability of equipment
  - Availability of personnel and services
  - Laboratory testing capacity

  - Offsite treatment and disposal capacity
  - Post-removal action site control
- Administrative feasibility
  - Required permits and/or easement or rights-of-way
  - Impacts on adjoining property
  - Ability to impose institutional controls
  - Likelihood of obtaining exemptions from statutory limits (if needed)

4.2.4 Cost

The *cost* criterion encompasses the life-cycle costs of a project, including the projected implementation costs and the long-term O&M costs of an action. For the detailed cost analysis, the expenditures required to complete each alternative were estimated in terms of capital costs, including direct and indirect costs, to complete initial construction activities. Direct costs include the cost of construction, equipment, land and site development, treatment, transportation, and disposal. Indirect costs include engineering expenses and contingency allowances.

Future post-construction costs (that is, periodic inspections, maintenance, and monitoring) would be required to ensure the continued effectiveness of Alternative 3 (Low-Permeability Soil Cover). The future costs were calculated using an assumed annual inflation rate of 3.4 percent for a 30-year timeframe. After inflating the future costs, they were analyzed using present worth, which discounts all future costs to a common base year (2015). Present-worth analysis allows the cost of the removal action to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the life of the removal action. The present-worth calculations included an assumed discount rate of 3.4 percent (White House OMB, 2014).

The estimated costs are provided to an expected accuracy of +50 percent and -30 percent. The cost estimates are in 2015 dollars and the unit pricing is based on costs from similar projects, vendor quotes, or engineering estimates. The enclosed Engineer's Estimate (**Appendix D**) is only an estimate of possible construction costs for budgeting purposes.

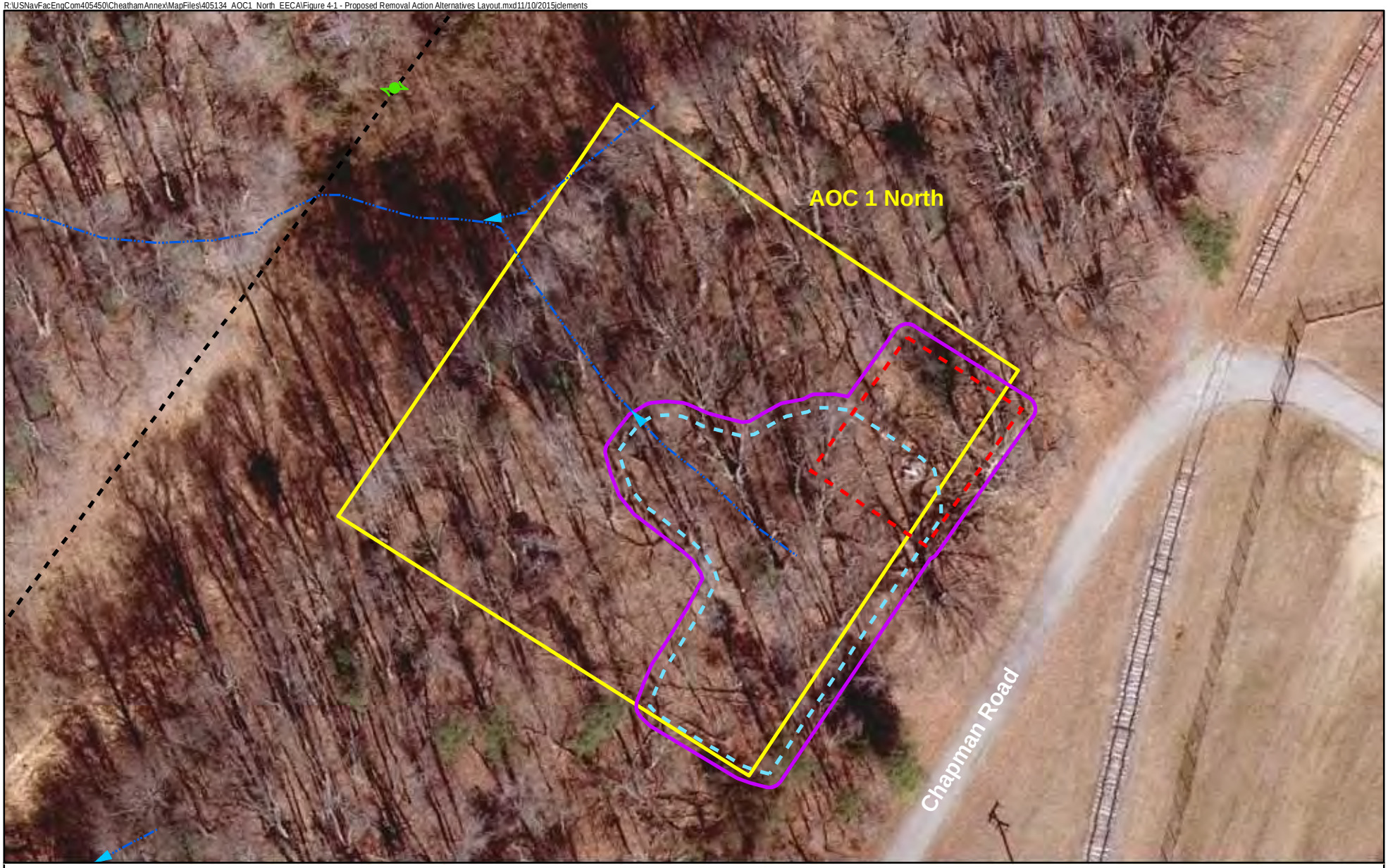
4.2.5 Evaluation of Alternatives

Table 4-1 summarizes the results of the alternative evaluation with respect to effectiveness, ease of implementation, and cost.

TABLE 4-1
Evaluation of Removal Action Alternatives

Alternative	Description	Effectiveness	Implementability	Cost
Alternative 1 - No Action	No removal action work performed; site left "as is."	Alternative 1 leaves soil posing unacceptable risk in place; therefore, it will not meet removal action objectives, reduce volume or mobility of contamination, provide any short- or long-term protectiveness, or pose any short-term environmental impacts.	No action to implement.	**$0**
Alternative 2 - Removal and Offsite Disposal	The surface and limited subsurface debris would be removed from an approximately 9,580 ft^2 area and impacted soil from the ecological risk-based removal action area would be excavated to approximately 1 foot bgs. Debris and impacted soil would be transported offsite for disposal. Post-excavation confirmation sampling would be completed followed by backfilling the excavated area.	Protective of human health, the community, and the environment because removal of debris and impacted soil eliminates direct exposure and risk. Potential short-term risks to site workers exposed to contaminated material during implementation would be managed through training and use of personal protective equipment. Potential short-term risks to the community as a result of the debris and impacted soil being transported offsite would be managed by ensuring that trucks are not overloaded and are covered prior to leaving the site. There would also be added traffic and noise impacts to the community. Complies with the ARARs. Although there are no chemical-specific ARARs, the contaminant concentrations pose potential unacceptable risk, which Alternative 2 would remove. Achieves the removal objective. No residual effect concerns, because no debris or impacted soil posing potential risk would remain onsite. Provides a permanent, long-term solution. Environmental impacts are primarily associated with the transportation and disposal of the excavated debris and impacted soil. The SiteWise evaluation indicates greenhouse gas and priority pollutant emissions are comparatively low while accident risks are moderate. There will also be the loss of landfill space and use of materials for backfill.	Is technically feasible - components are well established, available, and can be completed with conventional equipment in a relatively short timeframe (less than a year). Level of difficulty to implement is similar to Alternative 3. However, it requires no post-removal site controls (PRSCs) since debris and impacted soil would be removed.	Capital Cost: $243,000 Future Cost: $0 Total Cost: **$243,000**
Alternative 3 - Low-Permeability Soil Cover	Construct a soil cover over the ecological risk-based soil area and debris area. Future actions include LUCs, O&M, and Five-Year Reviews to ensure the soil cover remains in place and continues to be protective of human health and the environment, land use remains the same, and the cover is not disturbed without appropriate notification or authorization.	Protective of human health and the environment because it prevents direct exposure to debris and impacted soil posing potential risks. Potential short-term risks to site workers exposed to contaminated materials during construction would be managed through training and use of personal protective equipment. Potential short-term risks to the community as a result of transporting fill material onsite would be managed by ensuring trucks are not overloaded and are covered as they transport fill material to the site. There would also be added traffic and noise impacts to the community. Complies with the ARARs. Although there are no chemical-specific ARARs, the contaminant concentrations pose potential unacceptable risk, which Alternative 3 would cover and isolate to prevent exposure; however, the contaminants would remain in place. Achieves the removal objective. Long-term protectiveness is achieved, provided the soil cover is maintained and LUCs are in place. However, because it does not remove debris and impacted soil, there are residual effect concerns. Environmental impacts are primarily associated with the transportation and operation of the mechanical earthwork equipment. The SiteWise evaluation indicates greenhouse gas and priority pollutant emissions are comparatively higher while accident risks are moderate compared to Alternative 2. Overall, Alternative 3 has a higher environmental footprint than Alternative 2 as a result of importing materials for the soil cover.	Is technically feasible - components are well established, available, and can be completed with conventional equipment in a relatively short timeframe (less than a year). Level of difficulty to implement is similar to Alternative 2, but cover technology is not as effective at reducing risk as Alternative 2, because debris and impacted soil remains onsite. PRSCs (i.e., LUCs, O&M, and Five-Year Reviews) will be required.	Capital Cost: $264,000 Present Value of LUCs, O&M, and Five-Year Reviews: $352,000 Total Present Value of Alternative: **$616,000**

R:\USNavFacEngCom405450\CheathamAnnex\MapFiles\405134_AOC1_North_EECA\Figure 4-1 - Proposed Removal Action Alternatives Layout.mxd11/10/2015jclements



Legend

- Utility Pole
- Drainage Channel (arrow represents flow direction)
- Overhead Utility Line
- Estimated Extent of Soil Cover (Alternative 3)
- Approximate Study Area Boundary
- Estimated Extent of Debris and Impacted Soil Excavation to 1 ft bgs (Alternative 2)
- Estimated Extent of Surface and Limited Subsurface Debris Removal (Alternative 2)

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0 50 100 Feet

Imagery Source: GRC, 2010

Figure 4-1
Proposed Removal Action Alternatives Layout
AOC 1 North Engineering Evaluation/Cost Analysis
Cheatham Annex
Williamsburg, Virginia

CH2MHILL

SECTION 5

Comparative Analysis of Removal Action Alternatives

Section 5 expands on the evaluation of the alternatives by providing a comparative analysis to assist the decision-making process by which a removal action will be selected. In Section 4, these alternatives were described according to their effectiveness, ease of implementation, and cost. In this section, the alternatives are compared to one another for each of the three criteria.

Table 5-1 summarizes the results of the alternatives comparison. Comparative terms used in **Table 5-1** are defined relative to the other alternatives.

TABLE 5-1
Removal Action Alternative Comparison

Alternative	Effectiveness	Implementation	Cost
Alternative 1 – No Action	Least Effective	Easiest	Least Expensive
Alternative 2 – Removal and Offsite Disposal	Most Effective	Moderately Easy	Moderately Expensive
Alternative 3 – Low-Permeability Soil Cover	Effective	Moderately Easy	Moderately Expensive and Most Expensive of the Three Alternatives

5.1 Effectiveness

Alternative 1 would not be effective, because it would not be protective of human health and the environment and would not achieve the RAOs of this EE/CA. Alternatives 2 and 3 would be effective because they would both be protective of human health and the environment, comply with ARARs, and be able to achieve the removal objectives.

Alternative 2 is the most effective alternative in reducing toxicity, mobility, and volume, because it results in the removal and offsite disposal of debris and impacted soil. It eliminates the residual effect concern and the potential for contaminants to migrate to the surrounding media; thus, there is no risk of control failure that could result in exposure. Alternative 2 provides a permanent, long-term solution.

Alternative 3 is considered to be less effective than Alternative 2. As a result of the debris and impacted soil remaining onsite, PRSCs would need to be implemented to maintain effectiveness; that is, to prevent the potential for contaminants from debris and impacted soil to migrate to the surrounding media over time and to prevent exposure.

Alternative 2 also had a lower overall footprint for the sustainability metrics compared with Alternative 3 (**Appendix C**) because it involves less transportation of imported soil and no long-term field visits. Both alternatives require the use of fill material for either backfill or soil cover, resulting in the loss of some natural resources. Although Alternative 2 would result in the small loss of landfill space, the removal action would result in the gain of beneficial reuse of the site since unlimited use/unrestricted exposure would be met.

5.2 Implementability

Alternative 1 requires no implementation and, therefore, is the easiest to implement. Alternatives 2 and 3 would both be moderately easy to implement because both alternatives are technically and administratively feasible and the resources needed to implement the alternatives are readily available. Both Alternatives 2 and 3 would be completed using common construction practices and in a short timeframe (less than a year). Alternative 2 would

not require PRSCs following completion of the removal action due to the removal of debris and impacted soil, whereas Alternative 3 would require PRSCs (LUCs, O&M, and Five-Year Reviews) to maintain protectiveness.

5.3 Cost

Alternative 1 is the least expensive alternative and Alternative 3 is the most expensive alternative. The detailed cost estimates for the alternatives are provided in **Appendix D** and summarized in **Table 4-1**.

SECTION 6

Recommended Removal Action Alternative

Alternatives 2 and 3 are comparable in their ability to protect human health and the environment, ability to achieve the removal objectives, ease of implementability, and compliance with ARARs. However, Alternative 3 is more expensive than Alternative 2. In addition to being more expensive, Alternative 3 results in debris and impacted soil remaining in place; therefore, PRSCs (LUCs, O&M, and Five-Year Reviews) would be required to ensure the removal action remains protective over time and the cover is not disturbed.

Based on the evaluation of the trade-offs between the alternatives, the recommended removal action alternative is Alternative 2, Removal and Offsite Disposal. Alternative 2 consists of removing surface and limited subsurface debris, excavating the AOC 1 North ecological risk-based soil area to a depth of 1 feet bgs, offsite disposal of the debris and excavated material, post-excavation confirmation sampling within the ecological risk-based soil area, and backfilling and restoring the excavation area. The end result of Alternative 2 is a permanent solution that provides for unlimited use/unrestricted exposure at AOC 1 North and does not require PRSCs (inspection and maintenance activities) to ensure long-term protectiveness.

Navy, USEPA, and VDEQ representatives were involved with developing the recommended removal action alternative through the Tier I Partnering Team process and will have the opportunity to comment on the recommendation during the regulatory review period for this EE/CA. Following the regulatory review period, a 30-day public comment period will be held to assess public acceptance of the recommended alternative. If comments are received, a Responsive Summary addressing significant comments will be prepared as part of the Action Memorandum and included in the Administrative Record, along with the final EE/CA.

SECTION 7

References

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Appendix A
Applicable or Relevant and Appropriate Requirements Tables

Acronyms and Abbreviations

ARAR	Applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFC	Chlorofluorocarbon
CFR	Code of Federal Regulations
DCR	Virginia Department of Conservation and Recreation
DNH	Division of Natural Heritage
NAAQS	National Ambient Air Quality Standards
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NSDWRs	National Secondary Drinking Water Regulations
NSPS	New Source Performance Standards
NSDWRs	National Secondary Drinking Water Regulations
NSPS	New Source Performance Standards
RCRA	Resource Conservation and Recovery Act
SDWA	Safe Drinking Water Act
SMCL	Secondary Maximum Contaminant Level
TBC	To Be considered
TCLP	Toxicity Characteristic Leaching Procedure
TSCA	Toxic Substance Control Act
USACE	US Army Corps of Engineers
USC	United States Code
USEPA	United States Environmental Protection Agency
VA	Virginia
VAC	Virginia Administrative Code
VMRC	Virginia Marine Resource Commission
VPA	Virginia Pollutant Abatement
VPDES	Virginia Pollutant Discharge Elimination System

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TABLE A-1

Federal Chemical-Specific ARARs

AOC 1 North

Cheatham Annex, Williamsburg, Virginia

Media	Requirement	Prerequisite	Citation	Alternative	ARAR/TBC Determination	Comment
No Federal Chemical-Specific ARARs apply.						

TABLE A-2

Virginia Chemical-Specific ARARs

AOC 1 North

Cheatham Annex, Williamsburg, Virginia

Media	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
No Virginia Chemical-Specific ARARs apply.						

TABLE A-3

Federal Location-Specific ARARs

AOC 1 North

Cheatham Annex, Williamsburg, Virginia

Location	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Migratory Bird Treaty Act						
Migratory bird area	Protects almost all species of native birds in the United States from unregulated taking.	Presence of migratory birds.	16 USC 703	2, 3	Applicable	The site is located in the Atlantic Migratory Flyway. If migratory birds, or their nests or eggs, are identified at the site, operations will not destroy the birds, nests, or eggs.
Presence of any threatened or endangered species of plant or insect						
Presence of any threatened or endangered species of plant or insect	Prohibits taking, transporting, processing, selling, or offering for sale within the Commonwealth of Virginia any threatened or endangered species of plant or insect except as authorized by law.	Habitat of endangered species of plant or insect.	50 C.F.R. §402.14(a)	2, 3	Applicable	AOC 1 North is located within the range of the Northern Long-eared Bat. These bats can be found roosting in the bark of trees with a diameter of 3 inches or greater during the summer (April 15th to September 15th). Potential roosting trees will not be disturbed or removed during roosting season.

TABLE A-4

Virginia Location-Specific ARARs

AOC 1 North

Cheatham Annex, Williamsburg, Virginia

Location	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
No Virginia Location-Specific ARARs apply.						

TABLE A-5
Federal Action-Specific ARARs
AOC 1 North
Cheatham Annex, Williamsburg, Virginia

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Closure of an Unpermitted Disposal Area						
Installing soil cover at a facility that did not receive waste after 1991	Design requriements are provided for the closure of solid waste sites	Closure of a municipal solid waste site	40 CFR 258.60(a)	3	Relevant and Appropriate	Requirements are relevant and appropriate because there are no provisions for facilities that did not receive waste after 1991 in the Commonwealth of Virginia.
Storage of fuels and oils (petroleum and non-petroleum) onsite						
Storage of fuels and oils (petroleum and non-petroleum) onsite	If storage capacity limits are exceeded, a Spill, Prevention, Control, and Countermeasures Plan must be prepared and implemented with procedures, methods, equipment, and other requirements to prevent discharge into or upon the navigable waters of the United States.	Activities that could result in the discharge of pollutants into surface waters, or otherwise altering the physical, chemical or biological properties of surface waters.	40 CFR 112.1(b) through (d), 112.3 [excluding paragraph f], 112.5 through 8, and 12	2, 3	Applicable	It is anticipated that fuels or other oils will be stored onsite. If the storage capacity in containers that are 55 gallons or greater is equal to or exceeds 1,320 gallons, a Spill Prevention, Control, and Countermeasure (SPCC) Plan must be prepared and implemented. Containers include oil and fuel reservoirs in equipment.

TABLE A-6

Virginia Action-Specific ARARs

AOC 1 North

Cheatham Annex, Williamsburg, Virginia

Action	Requirement	Prerequisite	Citation	Alternative	ARAR Determination	Comment
Erosion and Sediment Control						
Erosion and deposits of soil/sediment caused by land disturbing activities	Regulations for the effective control of soil erosion, sediment deposition and nonagricultural runoff which must be met in any control program to prevent the unreasonable degradation of properties, stream channels, waters and other natural resources.	Construction activities that will disturb more than 10,000 square feet of land.	9 VAC 25-840-40(1); (2); (3); (4); (17); (18); (19)(h), (i)	2, 3	Relevant and Appropriate	Appropriate erosion control measures will be implemented for the construction activities in order to prevent the migration of contaminated soil during the removal action.
	Establishes required plans and best management practices to prevent storm water pollution from discharges related to construction activity. Properties and receiving waterways downstream of any land-disturbing activity shall be protected from erosion and damage due to changes in runoff rate of flow and hydrologic characteristics, including but not limited to, changes in volume, velocity, frequency, duration, and peak flow rate of stormwater runoff.	Construction activities that will disturb more than one acre of land or that have a the potential to significantly contribute to a violation of a water quality standard or for significant contribution of pollutants to surface waters.	9 VAC 25-870-54(A, B, and D), 55 (B)(1-8)	2, 3	Relevant and Appropriate	Site activities have the potential to impact to the downgradient unnamed tributary and pond. Therefore, storm water pollution prevention best management practices will be implemented during construction. Activites performed on-site and in compliance with CERCLA are not subject to adminsitrative review; however the substantive requirements of the regulations and permit will be followed.
Fugitive Dust Control						
Generation of fugitive dust	Regulations regarding reasonable precautions to prevent particulate matter from becoming airborne.	Conducting any activity which may cause particulate matter to become airborne.	9 VAC 5-50-90	2 , 3	Applicable	Dust control measures will be implemented during activities at the site.
Waste Management						
Management of non-hazardous solid waste in containers	Establishes standards and procedures pertaining to the management of non-hazardous solid wastes in containers. Nonputrescible wastes must be stored in appropriate containers and not staged for more than 90 days.	Generation of non-hazardous solid waste that is managed onsite in containers.	9 VAC 20-81-95(D)(10)(b)	2, 3	Applicable	It is anticipated that some wastes (such as decontamination fluids) may be generated and managed onsite in containers. Based on the analytical results from previous investigations, it is expected that these wastes will be non-hazardous solid waste. Wastes will be characterized prior to offsite disposal.
Management of non-hazardous solid waste in waste piles	Establishes standards and procedures pertaining to the construction,management, and closure of waste piles being used to manage non-hazardous solid wastes.	Generation of non-hazardous solid waste that is managed onsite in piles.	9 VAC 20-81-330(F), 340(F), 360(1)(a)	2	Applicable	It is anticipated that soil will be excavated and managed in a waste pile prior to disposal offsite. Based on the analytical results from previous investigations, it is anticipated that excavated soil will be characterized as non-hazardous solid waste.
Accumulation of hazardous waste in containers onsite for less than 90 days	Hazardous waste may be accumulated onsite in containers for up to 90 days, so long as the containers are in good condition, compatible with the waste being stored, and labeled with the words “Hazardous Waste” and the date that accumulation began. The containers must also be kept closed, unless adding or removing waste, and inspected weekly.	Accumulation of hazardous waste in containers onsite.	9 VAC 20-60-262 only as it incorporates 40 CFR 262.34 (a) (1)(i), (2), (3)	2,3	Applicable	This requirement is only applicable if hazardous waste is generated and managed onsite in containers. Containers will be managed in accordance with these requirements.
Accumulation and/or treatment of hazardous waste in staging piles onsite	A staging pile must be designed, constructed, and maintained to prevent the migration of hazardous constituents to other media. The design must consider location, hydrogeology, and any other factors that may reasonably influence the migration of hazardous constituents. Closure requirements are also included.	Accumulation or treatment of hazardous wastes in staging piles onsite	9 VAC 20-60-264 only as it incorporates 40 CFR 264.554(d)(1)(ii), (d)(2), (j)(1), (j)(2)	2, 3	Applicable	This requirement is only applicable if hazardous waste is generated and managed onsite in staging piles. Piles will be designed and managed in accordance with these requirements.

Appendix B
Cheatham Annex Consensus Statement
#01-08-15-49

CHEATHAM ANNEX CONSENSUS STATEMENT

CONSENSUS STATEMENT # 01-08-15-49 **Site Name:** All CAX ER Sites

Date: January 8, 2015

Site Description:

This consensus statement applies to all current and future Cheatham Annex (CAX) Environmental Restoration (ER) sites, but is not retroactive to CAX ER sites that have had previous remedial/removal actions and/or are closed.

Consensus Topic:

This consensus statement has been prepared to ensure that fill material used as backfill at CAX ER sites is properly sampled to document that it is "clean" and appropriate for onsite placement at CAX. This consensus statement is applicable only to terrestrial areas. Aquatic and wetland backfill requirements will be handled on a site-specific basis.

Consensus Statement:

Fill material suitable for use as backfill at CAX ER sites undergoing remedial action is limited to topsoil and backfill material (collectively referred to in this document as fill material) in compliance with ASTM D2487 *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)* (ASTM International, 2011). Specifically, suitable fill material from soil classification groups GW, GP, GM, SW, SP, SM, SC, and ML[i], or any combination of these groups, that is free of the following: rock or gravel larger than 75 mm (3 inches) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. To ensure that potentially suitable fill material obtained from off-base sources and/or from sources within the base that are outside of the boundaries of the proposed site (on-base sources) for placement is "clean," all fill material will be analyzed at an environmental laboratory for the specific parameters listed below in Table 1, prior to consideration for transport to, and use at, any CAX ER site.

Table 1
Fill Material Sampling Parameters

Constituent	Analytical Method
TCL VOCs	EPA SW-846 Method 8260B
TCL SVOCs	EPA SW-846 Method 8270C
TCL Pesticides	EPA SW-846 Method 8081
PCBs	EPA SW-846 Method 8082
Explosives	EPA SW-846 Method 8330B
Herbicides	EPA SW-846 Method 8151
Total Petroleum Hydrocarbons	EPA 600/4-79/020 Method 418.1
Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX)	EPA SW-846.3-3 Method 5030/8020
TAL Metals (including mercury and cyanide)	SW-846 3050B/6010C/6020A/7471A

Prior to bringing any backfill material to a CAX ER site, the CAX Tier 1 Partnering Team must agree the fill material is "clean" based on the sampling results and is suitable for use at the CAX ER site. The remedial/removal action contractor will collect samples of the fill material (at the source, whether it be from an on-base or off-base source) for laboratory analyses (Table 1 parameters), prior to consideration for transport to the CAX ER site. One sample per fill material type per source will be collected. Each collected sample will be a five-point composite sample that is representative of the fill material to be consideredfor transportation to, and use at, the CAX ER site. Alternatively, if fill material is from an off-base source, the fill material provider may provide the remedial/removal action contractor with fill material analytical results; however, they must provide results for a five-point composite sample that is representative of the fill material to be transported to CAX, and was analyzed within one year of the date of transport to CAX, for the parameters listed in Table 1.

Upon receipt of the analytical data, a chemist (Navy and/or contractor) will review the data to ensure their usability. The remedial/removal action contractor will prepare a table comparing the fill material analytical results to the screening values listed in Tables 2 and 3 (attached). The comparison table will then be forwarded to the CAX Navy RPM, who will forward the results to the CAX Tier 1 Partnering Team for review. Within two workdays of receipt of the analytical results, the CAX Tier 1 Partnering Team will collaborate (via email and/or conference call) and decide if the proposed fill material is "clean" and can be used as backfill at the CAX ER site. The CAX Tier 1 Partnering Team will use the decision analysis outlined in Figure 1 (attached) to determine if the fill material can be used at the CAX ER site; however, ultimately, it will be at the discretion of the CAX Tier 1 Partnering Team to accept or reject usability of "clean" fill at the CAX ER site.

Upon CAX Tier 1 Partnering Team agreement on the use of fill material, the Team will document their agreement in an email and forward it to the remedial/removal action contractor for notification that they may proceed with transporting and using the fill material at the CAX ER site. The remedial/removal action contractor's Construction Closeout Report will include the fill material analytical results, a comparison of these results to the screening values listed in Tables 2 and 3, text that reflects that the analytical results were evaluated, and the CAX Tier 1 Partnering Team's agreement the material is "clean" and suitable for use.

CAX Tier 1 Partnering Team:

NAME	ORGANIZATION	SIGNATURE & DATE
Scott Park	NAVFAC Mid-Atlantic	Scott R. Park 1-9-15
Gerald Hoover	USEPA Region III	Gerald F. Hoover 1/12/15
Wade Smith	VDEQ	01/14/2015
Marlene Ivester	CH2M HILL	
Stephanie Sawyer	CH2M HILL	

ASTM International. 2011. *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)*. Designation: D-2487-11 (current version). Available at: www.astm.org (or earlier versions available for free on the Internet).

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Soil Classification[1]	
Group Symbol	**Group Name**
GW	Well-graded gravel
GP	Poorly graded gravel
GM	Silty gravel
SW	Well-graded sand
SP	Poorly graded sand
SM	Silty sand
SC	Clayey sand
ML	Silt

[1]From Table 1 (Soil Classification Chart) of ASTM D2487; the table provides a more detailed description of each type.

Table 2
Backfill Screening Criteria - Organic Compounds
Cheatham Annex
Williamsburg, Virginia

Chemical Name	BTAG (EPA Region 3 Eco Protective Backfill Value)	Residential Soil RSL	Backfill Screening Criterion
Volatile Organic Compounds (UG/KG)			
1,1,1-Trichloroethane	--	640,000	640,000
1,1,2,2-Tetrachloroethane	--	600	600
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	--	910,000	910,000
1,1,2-Trichloroethane	--	150	150
1,1-Dichloroethane	--	3,600	3,600
1,1-Dichloroethene	--	23,000	23,000
1,2,3-Trichlorobenzene	--	4,900	4,900
1,2,4-Trichlorobenzene	20,000	5,800	5,800
1,2-Dibromo-3-chloropropane	--	5.3	5.3
1,2-Dibromoethane	--	36	36
1,2-Dichlorobenzene	--	180,000	180,000
1,2-Dichloroethane	--	460	460
1,2-Dichloropropane	--	1,000	1,000
1,4-Dichlorobenzene	20,000	2,600	2,600
2-Butanone	--	2,700,000	2,700,000
2-Hexanone	--	20,000	20,000
4-Methyl-2-pentanone	--	530,000	530,000
Acetone	--	6,100,000	6,100,000
Benzene	--	1,200	1,200
Bromochloromethane	--	15,000	15,000
Bromodichloromethane	--	290	290
Bromoform	--	67,000	67,000
Bromomethane	--	680	680
Carbon disulfide	--	77,000	77,000
Carbon tetrachloride	--	650	650
Chlorobenzene	50	28,000	50
Chloroethane	--	1,400,000	1,400,000
Chloroform	--	320	320
Chloromethane	--	11,000	11,000
cis-1,2-Dichloroethene	--	16,000	16,000
cis-1,3-Dichloropropene	--	1,800	1,800
Cyclohexane	--	120,000	120,000
Dibromochloromethane	--	730	730
Dichlorodifluoromethane (Freon-12)	--	8,700	8,700
ETHYL BENZENE	50	--	50
Isopropylbenzene	--	190,000	190,000
m- and p-Xylene	--	55,000	55,000
Methyl acetate	--	7,800,000	7,800,000
Methylene chloride	--	35,000	35,000
Methyl-tert-butyl ether (MTBE)	--	47,000	47,000
o-Xylene	--	65,000	65,000
Styrene	100	600,000	100
Tetrachloroethene	--	8,100	8,100
Toluene	50	490,000	50
trans-1,2-Dichloroethene	--	160,000	160,000
trans-1,3-Dichloropropene	--	1,800	1,800
Trichloroethene	--	410	410
Trichlorofluoromethane (Freon-11)	--	73,000	73,000
Vinyl chloride	--	59	59
Xylene, total	50	58,000	50

Table 2
Backfill Screening Criteria - Organic Compounds
Cheatham Annex
Williamsburg, Virginia

Chemical Name	BTAG (EPA Region 3 Eco Protective Backfill Value)	Residential Soil RSL	Backfill Screening Criterion
Semivolatile Organic Compounds (UG/KG)			
1,1-Biphenyl	60,000	4,700	4,700
1,2,4,5-Tetrachlorobenzene	--	1,800	1,800
1,4-Dioxane	--	5,300	5,300
2,2'-Oxybis(1-chloropropane)	--	4,900	4,900
2,3,4,6-Tetrachlorophenol	20,000	180,000	20,000
2,4,5-Trichlorophenol	4,000	620,000	4,000
2,4,6-Trichlorophenol	9,000	6,200	6,200
2,4-Dichlorophenol	20,000	18,000	18,000
2,4-Dimethylphenol	--	120,000	120,000
2,4-Dinitrophenol	20,000	12,000	12,000
2,4-Dinitrotoluene	--	1,700	1,700
2,6-Dinitrotoluene	--	360	360
2-Chloronaphthalene	--	630,000	630,000
2-Chlorophenol	7,000	39,000	7,000
2-Methylnaphthalene	--	23,000	23,000
2-Methylphenol	--	310,000	310,000
2-Nitroaniline	--	61,000	61,000
2-NITROPHENOL	7,000	--	7,000
3- and 4-Methylphenol	--	310,000	310,000
3,3'-Dichlorobenzidine	--	1,200	1,200
4,6-Dinitro-2-methylphenol	--	490	490
4-Chloro-3-methylphenol	--	620,000	620,000
4-Chloroaniline	20,000	2,700	2,700
4-Nitroaniline	--	25,000	25,000
4-NITROPHENOL	7,000	--	7,000
Acenaphthene	20,000	350,000	20,000
Acenaphthylene	--	350,000	350,000
Acetophenone	--	780,000	780,000
Anthracene	100	1,700,000	100
Atrazine	--	2,300	2,300
Benzaldehyde	--	780,000	780,000
Benzo(a)anthracene	--	150	150
Benzo(a)pyrene	100	15	15
Benzo(b)fluoranthene	--	150	150
Benzo(k)fluoranthene	--	1,500	1,500
bis(2-Chloroethoxy)methane	--	18,000	18,000
bis(2-Chloroethyl)ether	--	230	230
bis(2-Ethylhexyl)phthalate	--	38,000	38,000
Butylbenzylphthalate	--	280,000	280,000
Caprolactam	--	3,100,000	3,100,000
Chrysene	--	15,000	15,000
Dibenz(a,h)anthracene	--	15	15
Dibenzofuran	--	7,200	7,200
Diethylphthalate	100,000	4,900,000	100,000
DIMETHYLPHTHALATE	200,000	--	200,000
Di-n-butylphthalate	200,000	620,000	200,000
Di-n-octylphthalate	--	62,000	62,000
Fluoranthene	100	230,000	100
Fluorene	30,000	230,000	30,000
Hexachlorobenzene	--	330	330
Hexachlorobutadiene	--	6,200	6,200
Hexachlorocyclopentadiene	10,000	37,000	10,000
Hexachloroethane	--	4,300	4,300
HMW PAHs	11,000	--	11,000
Indeno(1,2,3-cd)pyrene	--	150	150
Isophorone	--	560,000	560,000
LMW PAHs	29,000	--	29,000
Naphthalene	100	3,800	100
Nitrobenzene	40,000	5,100	5,100
n-Nitroso-di-n-propylamine	--	76	76
n-Nitrosodiphenylamine	20,000	110,000	20,000
Pentachlorophenol	5,000	990	990
Phenanthrene	100	--	100
Phenol	30,000	1,800,000	30,000
Pyrene	100	170,000	100

Table 2
Backfill Screening Criteria - Organic Compounds
Cheatham Annex
Williamsburg, Virginia

Chemical Name	BTAG (EPA Region 3 Eco Protective Backfill Value)	Residential Soil RSL	Backfill Screening Criterion
Pesticide/Polychlorinated Biphenyls (UG/KG)			
4,4'-DDD	210	2,200	210
4,4'-DDE	210	1,600	210
4,4'-DDT	210	1,900	210
Aldrin	--	31	31
alpha-BHC	--	85	85
alpha-Chlordane	--	1,800	1,800
Aroclor-1016	--	400	400
Aroclor-1221	--	150	150
Aroclor-1232	--	150	150
Aroclor-1242	--	240	240
Aroclor-1248	--	240	240
Aroclor-1254	--	110	110
Aroclor-1260	--	240	240
beta-BHC	--	300	300
delta-BHC	--	300	300
Dieldrin	49	33	33
Endosulfan I	--	37,000	37,000
Endosulfan II	--	37,000	37,000
Endosulfan sulfate	--	37,000	37,000
Endrin	--	1,800	1,800
Endrin aldehyde	--	1,800	1,800
Endrin ketone	--	1,800	1,800
gamma-BHC (Lindane)	--	560	560
gamma-Chlordane	--	1,800	1,800
Heptachlor	--	120	120
Heptachlor epoxide	--	59	59
Methoxychlor	--	31,000	31,000
Total PCBs	371	240	240
Toxaphene	--	480	480
Herbicides (UG/KG)			
2,4,5-T	--	62,000	62,000
2,4,5-TP (Silvex)	--	49,000	49,000
2,4-D	--	69,000	69,000
2,4-DB	--	49,000	49,000
Dalapon	--	180,000	180,000
Dicamba	--	180,000	180,000
Dinoseb	--	6,200	6,200
MCPA	--	3,100	3,100
MCPP	--	6,200	6,200
Explosives (UG/KG)			
1,3,5-Trinitrobenzene	--	220,000	220,000
1,3-Dinitrobenzene	--	620	620
2,4,6-Trinitrotoluene	--	3,600	3,600
2-Amino-4,6-dinitrotoluene	--	15,000	15,000
2-Nitrotoluene	--	3,200	3,200
3-Nitrotoluene	--	620	620
4-Amino-2,6-dinitrotoluene	--	15,000	15,000
4-Nitrotoluene	--	25,000	25,000
HMX	--	380,000	380,000
Nitroglycerin	--	620	620
PETN	--	12,000	12,000
RDX	--	6,000	6,000
Tetryl	--	12,000	12,000
9VAC20-80-700(D)(5) (MG/KG)	**SCREENING CONCENTRATION**		
BTEX (EPA SW-846.3-3 Method 5030/8020)	10		
TPH (EPA 600/4-79/020 Method 418.1)	50		

Notes:
MG/KG - Milligrams per kilogram
UG/KG - Micrograms per kilogram

Table 3
Backfill Screening Criteria - Metals
Cheatham Annex
Williamsburg, Virginia

Chemical Name	CLEAN CAX 95% UTL BKG SB	CLEAN CAX 95% UTL BKG SS	Residential Soil RSL	BTAG (EPA Region 3 Eco Protective Backfill Value)	Backfill Screening Criterion*	Backfill Screening Criterion, Including Background
Total Metals (MG/KG)						
Aluminum	13,000	12,200	7,700	pH < 5.5	7,700	13,000
Antimony	--	11.0	3.1	2.7	2.7	11.0
Arsenic	5.54	6.36	0.67	18	0.67	6.36
Barium	84.5	52.9	1,500	330	330	330
Beryllium	0.52	0.587	16	40	16	16
Cadmium	--	1.50	7	3.6	3.6	3.6
Calcium	2,380	2,290	--	--	--	2,380
Chromium	33.7	18.2	0.3	260	0.3	33.7
Cobalt	5.18	9.93	2.3	13	2.3	9.93
Copper	3.17	4.25	310	70	70	70.0
Cyanide	2.70	--	2.1	5	2.1	2.70
Iron	32,000	19,900	5,500	2,000	2,000	32,000
Lead	8.79	17.4	400	110	110	110
Magnesium	1,120	1,070	--	--	--	1,120
Manganese	176	324	180	220	180	324
Mercury	0.14	0.111	2.3	0.00051	0.00051	0.14
Nickel	17.6	9.52	150	38	38	38.0
Potassium	901	708	--	--	--	901
Selenium	0.64	0.51	39	0.5	0.5	0.64
Silver	1.10	2.10	39	42	39	39.0
Sodium	811	521	--	--	--	811
Thallium	--	--	0.078	1.00	0.078	0.078
Vanadium	48.3	27.9	39	78	39	48.3
Zinc	28	26.5	2,300	120	120	120

*Backfill Screening Criterion if the background UTL is exceeded

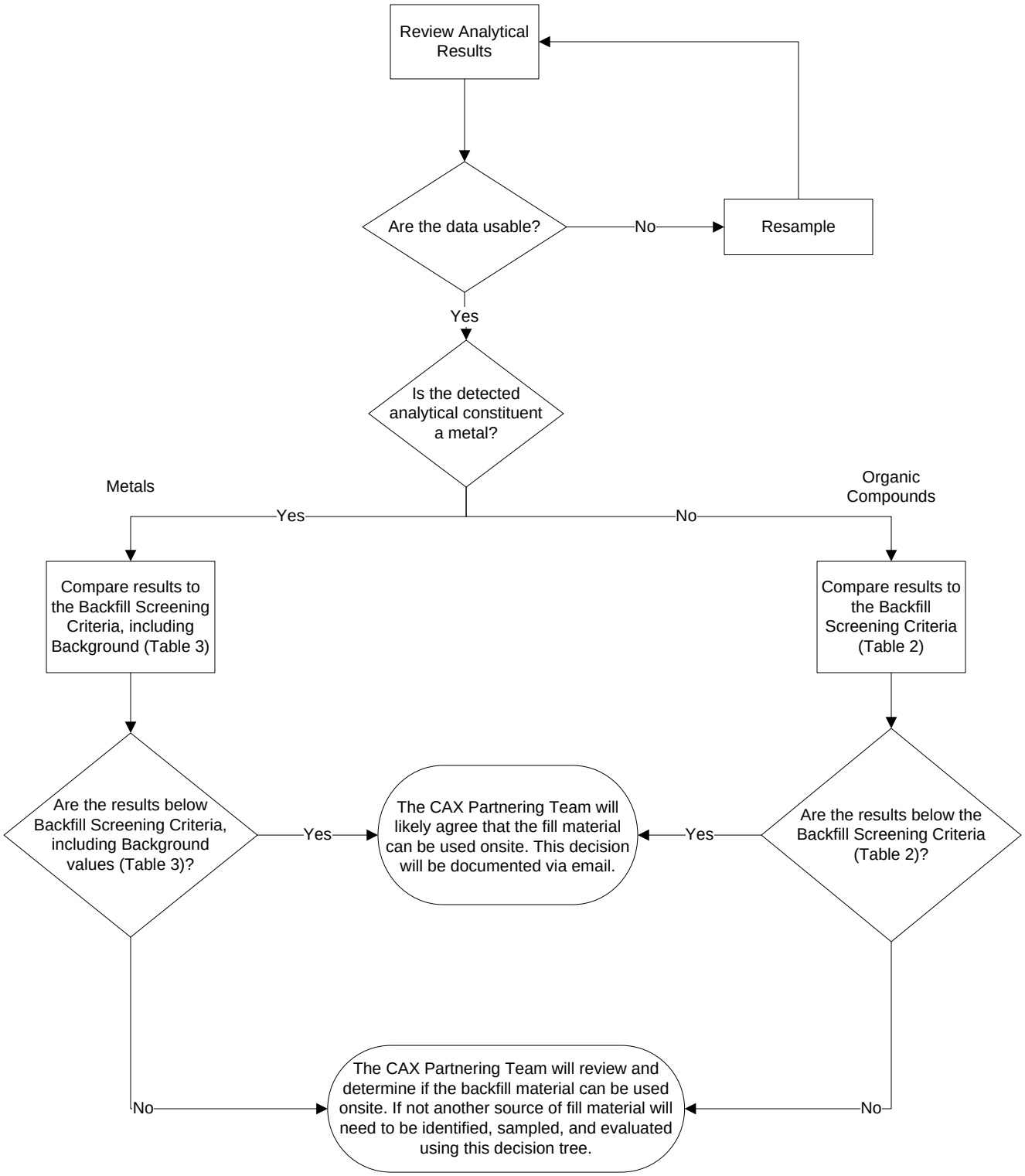

Figure 1
Clean Fill Decision Tree
Cheatham Annex
Williamsburg, Virginia

Appendix C
SiteWise Evaluation

APPENDIX C

Sustainability Analysis for AOC 1 North – Scrap Metal Dump

Introduction

This appendix presents the approach taken and results obtained from a sustainability analysis performed for Area of Concern (AOC) 1 North – Scrap Metal Dump, Cheatham Annex (CAX), Williamsburg, Virginia. A site description and history of AOC 1 North is provided within the Engineering Evaluation/Cost Analysis (EE/CA). The following alternatives were developed to address potential risks to human health and the environment from exposure to impacted surface soil and subsurface debris. A detailed summary of the alternatives is provided in the EE/CA.

- Alternative 1 – No Action
- Alternative 2 – Removal and Offsite Disposal
- Alternative 3 – Low Permeability Soil Cover

The purpose of this analysis is to provide a quantitative assessment of the potential environmental and social impact of each alternative. The sustainability analysis was performed using SiteWise Version 3.0 (Battelle, 2013) for Alternatives 2 and 3. Although the No Action alternative (Alternative 1) has no actions that would impact sustainability, it is not considered a viable alternative and will not be further discussed in this analysis.

Method and Assumptions

The SiteWise tool consists of a series of Excel-based spreadsheets used to conduct a baseline assessment of sustainability metrics. The assessment is carried out using a spreadsheet-based building block approach, where every remedial alternative can be broken down into components for discrete phases of work (such as construction, operation, long-term monitoring), or different systems for more complex remedial actions.

SiteWise uses various emission factors from governmental or non-governmental research sources to determine the environmental impact of each activity. The quantitative metrics calculated by the tool include:

1) Greenhouse gases (GHGs) reported as metric tons of carbon dioxide equivalents (CO_2e), consisting of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)
2) Energy usage (expressed as millions of British Thermal Units [MMBTU])
3) Water usage (gallons of water)
4) Air emissions of criteria pollutants consisting of metric tons of nitrogen (NO_x), sulfur oxides (SO_x), and particulate matter (PM_{10})
5) Accident risk (risk of injury and risk of fatality)

For the purpose of this discussion, the term “footprint” will be used to describe the quantified emissions or quantities for each metric. To estimate the sustainability footprint for each alternative, only those elements possessing important sustainability impacts were included in the assessment. A lower footprint indicates lower deleterious impacts to environmental and social metrics, which collectively make up the SiteWise sustainability metrics. Conversely, a higher footprint indicates higher deleterious impacts associated with the SiteWise metrics. The major conclusions of this sustainability analysis are incorporated into the effectiveness criteria evaluation of the EE/CA.

The following is a description of the major activities for each alternative:

- Alternative 2 –Removal and Offsite Disposal
  - Production of soil for backfilling (industry averages for heavy equipment operation to dig soil from the ground and/or borrow area)
  - Transportation of personnel and equipment for excavation and backfilling activities
  - Equipment use to excavate impacted soil and backfill excavated area
  - Transportation and disposal of residuals to hazardous and non-hazardous landfills
  - Onsite labor hours for estimate of accident risks during excavation and backfilling activities
- Alternative 3 – Low Permeability Soil Cover
  - Production of soil for cover (industry averages for heavy equipment operation to dig soil from the ground and/or borrow area)
  - Transportation of personnel and equipment for cover installation activities
  - Equipment use to install cover
  - Onsite labor hours for estimate of accident risks during cover installation
  - Long-term monitoring (LTM) – includes quarterly inspections for 2 years and annual inspections for 28 years, groundwater sampling every 5 years, minor cover repairs (assumed to happen every 10 years)

General Assumptions

The specific assumptions made for the individual remedies are presented in **Tables C-1** and **C-2**. The following general assumptions are used for the SiteWise tool evaluation:

- The complete environmental footprint for production of equipment used, or production of the vehicles used for transportation, is not considered in this analysis.
- Daily local transportation is assumed to consist of 25 miles of driving a light duty truck per day.
- Water use is 500 gallons per day of construction activities.
- The nonhazardous landfill is located 50 miles away from the site, and all waste is assumed to be non-hazardous.
- The environmental impacts associated with the life cycle of the landfill are not included, as reliable footprint factors are not available for this element of the project
- Negligible waste will be generated for long-term monitoring.
- The following weights and distance for delivery are used for equipment:
  - Bulldozer, Loader, Off-road dump truck – 20 tons, 50 miles round trip
  - Excavator – 30 tons, 50 miles round trip

Results and Conclusions

A comparative analysis for Alternatives 2 and 3 is summarized in **Figure C-1**. **Table C-3** presents a comparison of the quantitative environmental footprint metrics evaluated for each of the alternatives. Alternative 2 (removal and offsite disposal) had lower footprints for all of the sustainability metrics compared with Alternative 3, because it involves importing less soil and use of heavy equipment during the removal action.

A qualitative relative impact summary is also provided in **Table C-3**. The relative impact is a qualitative assessment of the relative footprint of each alternative. A rating of high, medium, or low is assigned to each alternative based on its performance against the other alternatives. The tool assigns a ranking of high to the highest footprint in each category and assigns the rankings of other alternatives based on the difference in the data between alternatives. The ranking is based on a 30 percent difference; for example, if the footprints of two alternatives are within 30 percent of each other, they will be assigned the same rating. This allows for some uncertainty inherent in the assumptions used in the model. Alternative 2 was assigned a rank of “low” for GHG, energy use, NO_X, SO_X and a “medium” rank for PM_{10}, and the accident risk footprints. Alternative 3 was assigned a rank of “high” for all footprints. Water use for both alternatives was considered “high” as both alternatives were similar in duration with Alternative 2 being slightly longer.

It should be noted that while this analysis compares the environmental footprints of each of the alternatives, the alternatives may differ with respect to other evaluation criteria. Therefore, a comparison of the results of the alternatives needs to be made in the context of the benefits (e.g., ARAR compliance, contaminant reduction, site reuse, cost effectiveness, and etc.) of each of the alternatives. In this case, Alternative 2 results in removal of the waste from the site, whereas Alternative 3 involves waste being managed onsite.

The following is a summary of the individual alternatives:

Alternative 2— Removal and Offsite Disposal

GHG and Energy Use – The majority of the GHG and energy use was associated with material production (backfill soil and topsoil) and waste disposal. Material production and residual handling contributed approximately 70 percent of the total potential GHG and energy use footprints. Personnel, material, and equipment transportation, and equipment use each contributed approximately 10 percent of the GHG and energy footprints.

Criteria Air Pollutants (NO_X, SO_X, PM_{10}) – Similar to GHG and energy use, the majority of the criteria air pollutant footprints were from material production and waste disposal activities. Material production accounted almost 50 percent of the NO_X, over 70 percent of the SO_X, and approximately 20 percent of the PM_{10} footprints. Waste handling accounted for approximately 30 percent of the NO_X, approximately 20 percent of the SO_X, and almost 80 percent of the PM_{10} footprints. Equipment use contributed to approximately 20 percent of the NO_X footprint.

Accident Risks – The majority of each accident risk footprint (risk of injury and risk of fatality) are from onsite labor hours, which contributes approximately 80 and 90 percent of the injury and fatality footprints, respectively. Transportation of personnel contributes approximately 10 and 5 percent of the injury and accident risk footprints. Transportation of equipment and waste contributed to the remaining portions of the accident risk footprints.

Results are provided in **Table C-4** and **Figure C-1**.

Alternative 3 – Low Permeability Soil Cover

GHG and Energy Use – Almost 95 percent of the GHG and energy footprints are from construction of the cover, with approximately 5 percent contribution from LTM. Approximately 75 to 80 percent of the potential GHG and energy use footprints are from material production (soil excavation and handling). Material and equipment transportation and equipment use each contributed approximately 15 percent of the remaining GHG and energy footprints. Approximately 2 percent of each footprint is from personnel transportation.

Criteria Air Pollutants (NO_X, SO_X, PM_{10}) – More than 95 percent of the criteria air pollutant footprints are from construction of the cover. Approximately 85 percent of the NO_X footprint and 95 percent of the SO_X and PM_{10} footprints are from material production. Equipment use contributes approximately 10 percent of the NO_X footprints and less than 3 percent of the SO_X and PM_{10} footprints. Personnel transportation and material and equipment transportation each contribute less than 1 percent of the criteria air pollutant footprints.

Accident Risks – Approximately 45 percent of the fatality risk is from construction of the cover and the remaining 55 percent is from LTM. The majority of the fatality footprint is from equipment use and onsite hours, with a lesser contribution from transportation. The distribution of the injury risk footprint is similar for construction of the cover but has a higher contribution from onsite labor hours for LTM.

Results are provided in **Table C-5** and **Figure C-1**.

Uncertainty

The SiteWise tool calculates environmental and risk footprints based on industry averages, published emissions factors, and generalized data sources. The footprint results are not representative of actual emissions and should be used for comparative purposes only.

Recommendations

The estimates from the SiteWise tool were used to estimate the environmental footprint of the alternatives. Once the alternative is selected, it is recommended that the footprint of the selected alternative be further

evaluated in the design phase of the projects to explore opportunities to optimize the environmental footprint of the project and integrate sustainable remediation best practices in the design, construction, and operation of the alternative.

If Alternative 2 is selected, potential best practices may include using equipment with emissions control devices, managing work such that engine idle time is minimized, regrading the excavation to minimize fill brought onsite or using soil from a “clean” area of the site rather than import soil from an offsite source (provided the CAX Tier 1 Partnering Team is in agreement on “clean”). A non-hazardous waste landfill was assumed for disposal; however, if scrap metal can be recycled, additional environmental benefits may be realized.

If Alternative 3 is selected, potential best practices may include using equipment with emissions control devices or managing work such that engine idle time is minimized.

References

Battelle. 2013. *SiteWise Version 3*. NAVFAC Engineering Service Center. August.

TABLE C-1

Alternative 2 - Removal and Offsite Disposal

Engineering Evaluation and Cost Analysis for AOC 1 North - Scrap Metal Dump

Naval Weapons Station Yorktown Cheatham Annex

Williamsburg, Virginia

Sitewise Tab	**Assumptions**
Removal Action Construction	**Debris and soil excavation, backfill (approximate values)**
Material Production - Fill/Backfill/Topsoil/Access Road	Access Road (gravel) - 94 sy, 6 inches deep. 16 cy x 1.4 ton/cy = 22 tons Fill material (soil) - 70 cy x 1.5 ton/cy = 105 tons = 210,000 lbs Topsoil - 70 cy x 1.5 ton/cy = 105 tons = 210,000 lbs
Personnel Transportation - Road	Daily local travel: 5 people, 25 miles round trip, 13 days, 1 person per vehicle (65 total trips), includes sampling, surveying, excavation, and site restoration oversight
Equipment/Material Transportation - Road	General assumption: 25 miles one way, ~20 ton loads, diesel powered Fill Material - 105 tons total, 5 trips, 25 miles = 125 miles full, same empty, 21 ton load Topsoil - 105 tons total, 5 trips, 25 miles = 125 miles full, same empty, 21 ton load Gravel - 22 tons, 1 trips, 22 tons each, 25 miles full, same empty Heavy Equipment to site - Excavator (30 tons), Dozer (20 tons), Front End Loader (20 tons) Roller (10 tons) each transported 25 miles to site, 25 miles from site at end of work
Equipment Use	Vegetation Clearance - 16 hrs operation, internal combustion diesel engine with 3 gallon per hour fuel consumption Excavator - remove 140 cy material Dozer - backfill 70 cy fill, 70 cy topsoil = 140 cy Front-end loader - assume moves all soil/gravel once - 140+16 = 156 cy material Grading (proxy roller) - 1,398 sy x 9 sf/sy = 12,600 sf
Water Use	6 days of construction activities x 500 gallons/day = 3.000 gallons
IDW transportation/disposal	227 tons of nonhazardous soil/debris to landfill located 50 miles away, 6 trips, 21 tons each
Labor Hours Onsite	800 hours (assumes 13 x 10 hr days to complete - 1 site superintendent, 2 heavy equipment operator, 2 laborers, 1 health and safety manager, 20 hrs precharacterization/confirmation sampling) - all construction laborers

Notes:

cy - cubic yard

sy - square yard

sf - square feet

hr - hour

TABLE C-2

Alternative 3 - Low Permeability Soil Cover

Engineering Evaluation and Cost Analysis for AOC 1 North - Scrap Metal Dump

Naval Weapons Station Yorktown Cheatham Annex

Williamsburg, Virginia

Sitewise Tab	**Assumptions**
Removal Action Construction	**Cover installation, LUCs**
Material Production - Cover/Access Road	Access Road (gravel) - 94 sy, 6 inches deep. 16 cy x 1.4 ton/cy = 22 tons Fill material for cover (soil) - 874 cy x 1.5 ton/cy = 1,311 tons = 2,622,000 lbs
	Topsoil - 292 cy x 1.5 ton/cy = 438 tons = 876,000 lbs
Personnel Transportation - Road	Daily local travel: 5 people, 25 miles round trip, 10 days, 1 person per vehicle (50 total trips)
Equipment/Material Transportation - Road	General assumption: 25 miles one way, ~20 ton loads, diesel powered
	Fill Material - 1,311 tons total, 22 trips, 25 miles x 66 trips = 1,650 miles full, same empty
	Topsoil - 438 tons, 22 trips, 25 miles = 550 miles full, 550 miles empty Gravel - 22 tons, 1 trips, 22 tons each, 25 miles full, same empty Heavy Equipment to site - Dozer (20 tons), Front End Loader (20 tons), Roller (10 tons) each transported 25 miles to site, 25 miles from site at end of work
Equipment Use	Vegetation Clearance - 16 hrs operation, internal combustion diesel engine with 3 gallon per hour fuel consumption
	Front-end loader and Dozer - assume each moves all soil/gravel once - 94+874+292 = 1,260 cy material
	Roller - 1,398 sy x 2 passes x 9 sf per sy = 25,164 sf
Water Use	5 days of construction activities x 500 gallons/day = 2,500 gallons
Labor Hours Onsite	500 hours (assumes 10 x 10 hr days to complete, including sampling, surveying, etc - 1 site superintendent, 1 heavy equipment operator, 2 laborers, 1 health and safety manager) - all construction laborers
O&M	2 years of quarterly inspections, annual groundwater LTM, 28 years of annual inspections
Personnel Transportation - Road	Personnel transport: 1 vehicle, 2 people, 36 trips, 50 miles round trip (assume inspections completed at the same time as groundwater sampling), 3 people x 3 trips x 50 miles round trip for repairs
Labor Hours Onsite	690 hours (assumes 1 x 10 hr day per inspection for quarterly and annual inspections, 2 x 10 hr days per sampling x 2 people x 6 events, 3 x 10 hr days x 3 people for repairs) - all construction laborers
Cover repairs	20 tons soil every 10 years x 30 years = 120,000 lbs soil brought onsite for repairs Backhoe for repair (20 ton transport, 25 miles x 3 events = 75 miles) Backhoe use = ~13 cy per event x 3 events = 39 cy

Notes:

cy - cubic yard

sy - square yard

sf - square feet

hr - hour

TABLE C-3

Relative Impact of Alternatives

Engineering Evaluation and Cost Analysis for AOC 1 North - Scrap Metal Dump

Naval Weapons Station Yorktown Cheatham Annex

Williamsburg, Virginia

Remedial Alternatives	GHG Emissions	Total energy Used	Water Used	NO_x emissions	SO_x Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
	metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Alternative 2 - Removal and Offsite Disposal	11	191	3,000	4.41E-02	3.30E-02	5.19E-02	9.39E-05	2.04E-02
Alternative 3 - Low Permeability Soil Cover	51	868	2,500	1.74E-01	1.94E-01	7.89E-02	1.76E-04	3.37E-02

Relative Impact

Remedial Alternatives	GHG Emissions	Total energy Used	Water Used	NO_x emissions	SO_x Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
Alternative 2 - Removal and Offsite Disposal	Low	Low	High	Low	Low	Medium	Medium	Medium
Alternative 3 - Low Permeability Soil Cover	High	High	High	High	High	High	High	High

The relative impact is a qualitative assessment of the relative footprint of each alternative, a rating of High for an alternative is assigned if it is at least 70 percent of the maximum footprint, a rating of Medium is assigned if it is between 30 and 70 percent of the maximum footprint, and a rating of Low is assigned if it is less than 30 percent of the maximum footprint.

Notes:

MMBTU - million British Thermal Unit

NOx - Nitrogen Oxides

SOx - Sulfur Oxides

LUCs - land use controls

PM10 - Particulate Matter

GHG - Greenhouse Gases

NA - Not applicable

TABLE C-4

Alternative 2 - Removal and Offsite Disposal Results

Engineering Evaluation and Cost Analysis for AOC 1 North - Scrap Metal Dump

Naval Weapons Station Yorktown Cheatham Annex

Williamsburg, Virginia

Phase	Activities	GHG Emissions	Total Energy Used	Water Used	NO_x Emissions	SO_x Emissions	PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Action Construction	Material Production	5	87	NA	1.9E-02	2.4E-02	9.4E-03	NA	NA
	Transportation-Personnel	1	11	NA	3.7E-04	1.2E-05	5.3E-05	1.3E-05	1.0E-03
	Transportation-Equipment	1	17	NA	4.2E-04	7.4E-06	3.7E-05	3.7E-06	3.0E-04
	Equipment Use and Misc	1	16	3.0E+03	9.9E-03	1.6E-03	1.2E-03	7.5E-05	1.9E-02
	Residual Handling	3	60	NA	1.5E-02	7.7E-03	4.1E-02	2.3E-06	1.9E-04
	Total	**11**	**191**	**3,000**	**4.4E-02**	**3.3E-02**	**5.2E-02**	**9.4E-05**	**2.0E-02**

Notes:

MMBTU - million British Thermal Unit

NOx - Nitrogen Oxides

SOx - Sulfur Oxides

PM10 - Particulate Matter

NA - Not Applicable

GHG - Greenhouse Gases

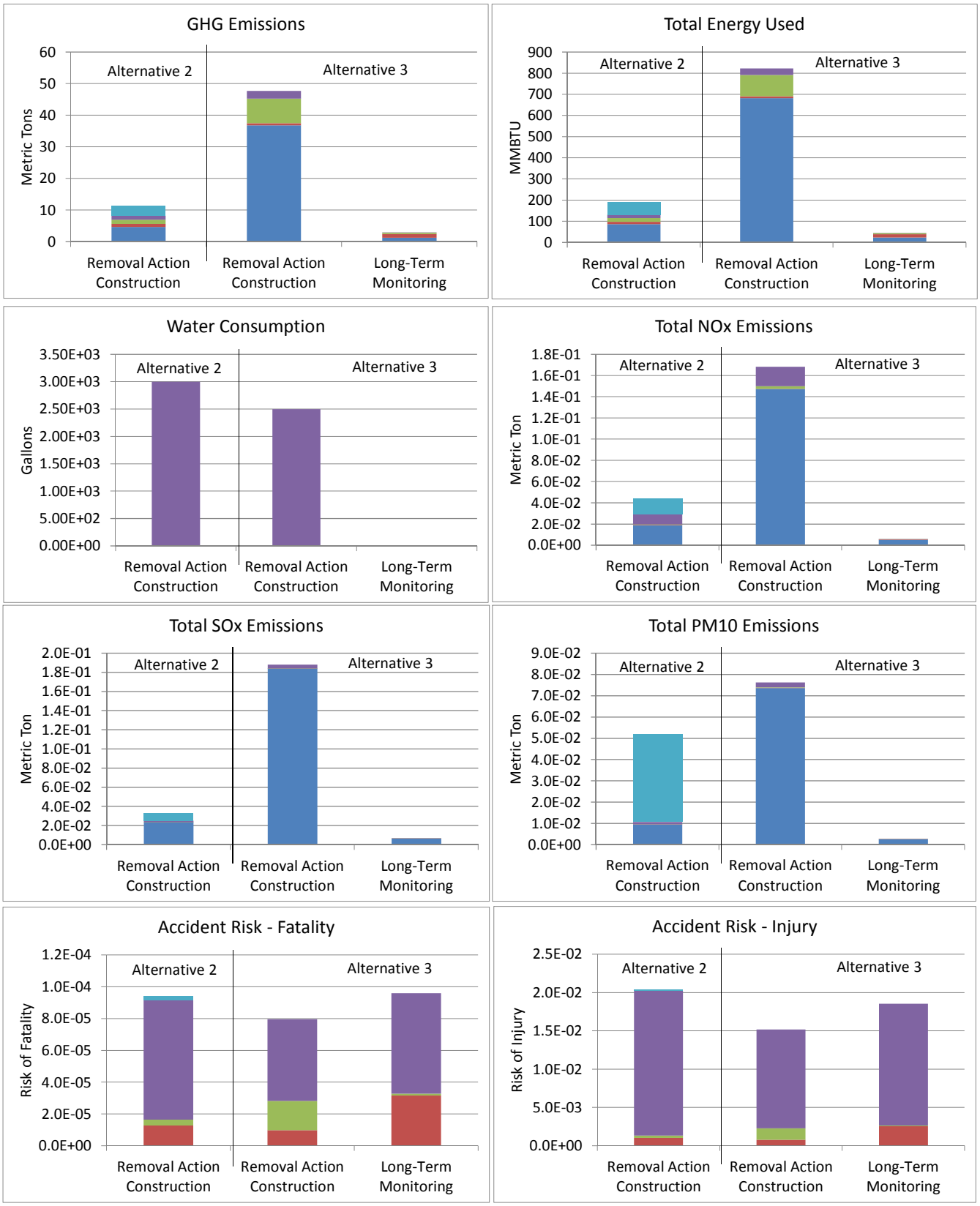

Figure C-1
Site Wise Results
Engineering Evaluation and Cost Analysis for AOC 1 North - Scrap Metal Dump
Naval Weapons Station Yorktown Cheatham Annex
Williamsburg, Virginia

Appendix D
Cost Estimates

TABLE D-1

Engineer's Cost Estimate for Alternative 2: Removal and Offsite Disposal

Engineering Evaluation and Cost Analysis for AOC 1 North - Scrap Metal Dump

Naval Weapons Station Yorktown Cheatham Annex

Williamsburg, Virginia

Description: Alternative 2 consists of excavation and offsite disposal of debris and impacted soil and backfilling with imported clean fill material. A total of 111 yd ^{3} of material will be excavated and the removal of surfaced and limited subsurface debris would be completed over an approximately 9,580 ft ^{2} area. The removal area consists of a 3,000 ft ^{2} ecological-based removal area at a depth of 1 ft bgs and a 9,580 ft ^{2} surface and limited subsurface debris removal area.

Description of Service/Items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
Construction Work Plan	Lump Sum	1	$20,000.00	$20,000.00	Includes draft and final submission and Erosion and Sediment Control Plan
UFP-SAP	Lump Sum	1	$30,000.00	$30,000.00	Includes scoping plus pre-draft, draft, and final submission of UFP-SAP.
EM385 Health and Safety Plan	Lump Sum	1	$12,000.00	$12,000.00	Includes draft and final submission and AHAs
Construction Completion Report	Lump Sum	1	$20,000.00	$20,000.00	Includes draft and final submission
Work Planning Documents Total				***$82,000***	
Mobilization/Demobilization and Site Setup					
Mobilization/Demobilization	Each	2	$6,394.32	$12,788.64	Includes mobilization and demobilization of all equipment and materials necessary to perform the work. [RSMeans Crew #B-1, #B-10L, #B-10T, and #B-12A] (2014 + 1.3% Escl)
Construction Entrance Temporary Road	square yard	94	$14.54	$1,366.76	One 70'x12' and 6" thick with #1 VDOT stone. [RSMeans #01-55-23.50 (0100)] (2014 + 1.3% Escl)
Material Handling Area	Lump Sum	1	$3,000.00	$3,000.00	Assumes 50' x 50' area. Includes impermeable liner, straw bale berm, sandbags, and 3" layer of sand over the impermeable liner to protect the liner; setup and removal included. Based on recent similar project.
Material Staging Area for Fill Material	Lump Sum	1	$1,200.00	$1,200.00	Assumes 50' x 50' area. Includes silt fence; removal included.
Vegetation Clearance	Day	2	$3,500.00	$7,000.00	Includes all labor, equipment, and materials for clearing within boundary of AOC 1 North to access removal areas. Assumes all cleared vegetation remains onsite. Based on recent similar project.
Silt Fence	Linear Feet	200	$4.50	$900.00	Includes all labor, equipment, and materials. Assumes installation along west boundary of AOC 1 North. Based on quote from recent similar project.
Portable Toilet and Handwash Station	Week	3	$100.00	$300.00	Based on quote from recent similar project.
Trimble GPS	Week	1	$525.00	$525.00	For identifying soil and debris removal areas. Based on quote from recent similar project.
Pre-Excavation Topographic Survey	Day	1	$3,240.00	$3,240.00	Assumes 1 10-hour day to complete the survey. Includes mobilization/demobilization, survey data evaluation/reporting, and all labor, equipment, and materials. Assumes 2-man surveying crew. BOA rates used.
Pre-Excavation Waste Characterization Sampling	Each	1	$1,257.69	$1,257.69	Assumes 1 sample per 1,000 cy of soil for full TCLP (VOCs, SVOCs, metals, herbicides, and pesticides), reactivity (cyanide and sulfide), ignitability, corrosivity, TPH-DRO, and TPH-GRO with 7 day TAT. BOA rates.
Mobilization/Demobilization and Site Setup Total				***$31,578***	
Site Support					
Sample Technician/Site Labor	Hour	120	$67.50	$8,100.00	12 10-hr work days
Project Vehicle (Pickup Truck)	Week	3	$652.50	$1,957.50	Includes fuel and rental vehicle. Assumes 1 truck for Site Management [Hertz Equipment Rental = 1 each @ $530/week plus 1 each @ $122.50/week (35 gallons @ $3.50/gallon for fuel). Onsite for duration of field work.
Site Support Total				***$10,058***	
Post-Excavation Confirmation Sampling					
Floor Confirmation Sampling	each	5	$66.24	$331.22	Assumes 24-hour TAT; 1 floor sample per every 625 ft^2 (25' x 25' grid). Samples analyzed for zinc. BOA rates used.
Wall Confirmation Sampling	each	5	$66.24	$331.22	Assumes 24-hour TAT; 1 sample per 50 linear feet of excavation wall. Samples analyzed for zinc. BOA rates used.
Post-Excavation Confirmation Sampling Total				***$662***	
Excavation and Surface/Limited Subsurface Debris Removal					
Excavate and Load Material	Ton	167	$7.50	$1,248.75	Engineer's Estimate. Assumes 1.5 tons/cy for soil and production rate of 400 tons per day. Includes labor and equipment.
Surface/Limited Subsurface Debris Removal	Day	3	$2,500.00	$7,500.00	Engineer's Estimate based on recent similar projects. Assumes production rate of 3,200 ft^2 per day. Includes labor, equipment, and materials.
Transportation and Disposal					
T&D of Non-Hazardous Soil and Debris	Ton	227	$60.00	$13,590.00	Assumes 1.5 tons/cy and total of 111 cy of soil and 40 cy of debris. Includes labor and equipment. Based on recent similar project.
Excavation, Transportation, and Disposal Total				***$22,339***	
Material Delivery and Placement					
Fill Material Source Sampling	Each	2	$796.34	$1,592.69	Assumes 7 day TAT and 1 sample per offsite borrow source. Samples analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. BOA rates
Topsoil material and delivery	cubic yard	70	$35.00	$2,450.00	Includes 6" of topsoil over a 3,000 ft^2 area; assume 1.25 cy loose/in-place and production rate of 400 cy per day. Based on recent similar projects.
General fill material and delivery	cubic yard	70	$23.00	$1,610.00	Includes 6" of general fill over a 3,000 ft^2 area; assume 1.25 cy loose/in-place and production rate of 400 cy per day. Based on recent similar projects.

TABLE D-1

Engineer's Cost Estimate for Alternative 2: Removal and Offsite Disposal

Engineering Evaluation and Cost Analysis for AOC 1 North - Scrap Metal Dump

Naval Weapons Station Yorktown Cheatham Annex

Williamsburg, Virginia

Description: Alternative 2 consists of excavation and offsite disposal of debris and impacted soil and backfilling with imported clean fill material. A total of 111 yd ^{3} of material will be excavated and the removal of surfaced and limited subsurface debris would be completed over an approximately 9,580 ft ^{2} area. The removal area consists of a 3,000 ft ^{2} ecological-based removal area at a depth of 1 ft bgs and a 9,580 ft ^{2} surface and limited subsurface debris removal area.

Description of Service/Items	Unit	Quantity	Unit Price	Total	Assumptions
Topsoil and General Fill Placement	cubic yard	140	$3.50	$490.00	Engineer's Estimate. Includes labor and equipment. Assumes 1.25 cy loose/in-place and production rate of 400 cy per day.
Material Delivery and Placement Total				***$6,143***	
Surveying					
Post-Excavation Topographic Survey	Day	1	$3,240.00	$3,240.00	Assumes 1 10-hour day to complete the survey. Includes mobilization/demobilization, survey data evaluation/reporting, and all labor, equipment, and materials. Assumes 2-man surveying crew. BOA rates used.
As-Built Topographic Survey	Day	1	$3,240.00	$3,240.00	Assumes 1 10-hour day to complete the survey. Includes mobilization/demobilization, survey data evaluation/reporting, and all labor, equipment, and materials. Assumes 2-man surveying crew. BOA rates used.
Surveying Total				***$6,480***	
Site Restoration					
Grading	square yard	1398	$2.96	$4,138.08	Includes grading the backfilled area and surface debris removal area. [RSMeans #31-22-16.10 (1050)] (2014 + 1.3% Escl)
Seeding	Lump Sum	1	$3,353.60	$3,353.60	Includes 1 application of seed and straw for all disturbed areas. Assumes the area to be restored is less than 1 acre. [RSMeans #32-92-19.14 (0800)] (2014 + 1.3% Escl)
Site Restoration Total				***$7,492***	
Subtotal				$166,751	
Contingency (25%)			*25.0%*	$41,688	
Construction Management (10%)			*10.0%*	$16,675	
Project Management (8%)			*8.0%*	$13,340	
Subtotal				$238,454	
Performance Bond (2%)			2.0%	$4,769	Industry Average
TOTAL CAPITAL COST				**$243,000**	
			+50%	**$365,000**	
			-30%	**$170,000**	

References and Source Notes

- Base costs used are 2015 dollars.
- RS Means: Facilities Construction Cost Data, 2014 + 1.3% average 2015 escalation (Golbal Insight, 2nd Quarter, 2015)
- Recent similar projects include construction projects in Weapons Naval Station Yorktown and Cheatham Annex in Williamsburg, VA.

Assumptions and Exclusions

1. Mobilization includes utility clearance.

2. The enclosed Engineer's Estimate is only an estimate of possible construction costs for budgeting purposes. This estimate is limited to the conditions existing at its issuance and is not a guarantee of actual price or cost. Uncertain market conditions such as, but not limited to: local labor or contractor availability, wages, other work, material market fluctuations, price escalations, force majeure events, and developing bidding conditions etc may affect the accuracy of this estimate. CH2M Hill is not responsible for any variance from this estimate or actual prices and conditions obtained. This is an order-of-magnitude cost estimate that is expected to be within +50 to -30 percent of the anticipated costs in the EE/CA.

TABLE D-2

Engineer's Cost Estimate for Alternative 3: Low Permeability Soil Cover

Engineering Evaluation and Cost Analysis for AOC 1 North - Scrap Metal Dump

Naval Weapons Station Yorktown Cheatham Annex

Williamsburg, Virginia

Description: Alternative 3 consists of installing a 2 ft soil cover, consisting of 18 inches of general fill followed by 6 inches of topsoil and permanent seeding, over a 12,580 ft^2 area which includes the entirety of both the ecological risk-based area and the surface debris area. LUCs, O&M, and five-year reviews would be implemented for the soil cover area.

Description of Service/Items	Unit	Quantity	Unit Price	Total	Assumptions
Work Planning Documents					
Construction Work Plan	Lump Sum	1	$20,000.00	$20,000.00	Includes draft and final submission and Erosion and Sediment Control Plan.
UFP-SAP	Lump Sum	1	$30,000.00	$30,000.00	Includes scoping plus pre-draft, draft, and final submission of UFP-SAP.
EM385 Health and Safety Plan	Lump Sum	1	$12,000.00	$12,000.00	Includes draft and final submission and AHAs.
Construction Completion Report	Lump Sum	1	$20,000.00	$20,000.00	Includes draft and final submission.
Work Planning Documents Total				***$82,000***	
Mobilization/Demobilization and Site Setup					
Mobilization/Demobilization	Each	2	$6,312.26	$12,624.52	Includes mobilization and demobilization of all equipment and materials necessary to perform the work. [RSMeans Crew #B-1, #B-10L, #B-10T, and #B-12A] (2014 + 1.3% Escl)
Construction Entrance Temporary Road	square yard	94	$14.54	$1,366.76	One 70'x12' and 6" thick with #1 VDOT stone. [RSMeans #01-55-23.50 (0100)] (2014 + 1.3% Escl)
Material Staging Area for Fill Material	Lump Sum	1	$1,200.00	$1,200.00	Assumes 50' x 50' area. Includes 3 rolls of poly sheeting and silt fence; removal included.
Vegetation Clearance	Day	2	$3,500.00	$7,000.00	Includes all labor, equipment, and materials for clearing within boundary of AOC 1 North to access removal areas. Assumes all cleared vegetation remains onsite. Based on recent similar project.
Silt Fence	Linear Feet	200	$4.50	$900.00	Includes all labor, equipment, and materials. Assumes installation along west boundary of AOC 1 North. Based on quote from recent similar project.
Portable Toilet and Handwash Station	Week	2	$100.00	$200.00	Based on quote from recent similar project.
Pre-Soil Cover Topographic Survey	Day	1	$3,240.00	$3,240.00	Assumes 1 10-hour day to complete the survey. Includes mobilization/demobilization, survey data evaluation/reporting, and all labor, equipment, and materials. Assumes 2-man surveying crew. BOA rates used.
Pre-Soil Cover Delineation Sampling	each	5	$66.24	$331.22	Assumes 24-hour TAT; 1 sample per 50 linear feet of soil cover limits within ecological risk-based area. Samples analyzed for zinc. BOA rates used.
Mobilization/Demobilization and Site Setup Total				***$26,863***	
Site Support					
Sample Technician/Site Labor	Hour	100	$67.50	$6,750.00	10 10-hr work days
Project Vehicle (Pickup Truck)	Week	2	$652.50	$1,305.00	Includes fuel and rental vehicle. Assumes 1 truck for Site Management [Hertz Equipment Rental = 1 each @ $530/week plus 1 each @ $122.50/week (35 gallons @ $3.50/gallon for fuel). Onsite for duration of field work.
Site Support Total				***$8,055***	
Material Delivery and Placement					
Topographic Survey Support	Day	10	$3,240.00	$32,400.00	Assumes full-time survey support to place grade stakes/maintain control during cover installation.
Fill Material Source Sampling	Each	2	$796.34	$1,592.69	Assumes 7 day TAT and 1 sample per offsite borrow source. Samples analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. BOA rates
Topsoil material and delivery	cubic yard	292	$35.00	$10,220.00	Includes 6" of topsoil over a 12,580 ft^2 area; assume 1.25 cy loose/in-place and production rate of 400 cy per day. Based on recent similar projects.
General fill material and delivery	cubic yard	874	$23.00	$20,102.00	Includes 1.5' of general fill over a 12,580 ft^2 area; assume 1.25 cy loose/in-place and production rate of 400 cy per day. Based on recent similar projects.
Topsoil and General Fill Placement	cubic yard	1,166	$3.50	$4,081.00	Engineer's Estimate. Includes labor and equipment. Assumes 1.25 cy loose/in-place and production rate of 400 cy per day.
Material Delivery and Placement Total				***$68,396***	
Surveying					
As-Built Topographic Survey	Day	1	$3,240.00	$3,240.00	Assumes 1 10-hour day to complete the survey. Includes mobilization/demobilization, survey data evaluation/reporting, and all labor, equipment, and materials. Assumes 2-man surveying crew. BOA rates used.
Surveying Total				***$3,240***	
Site Restoration					
Grading	square yard	1398	$2.96	$4,138.08	Includes grading the backfilled area and surface debris removal area. [RSMeans #31-22-16.10 (1050)] (2014 + 1.3% Escl)
Seeding	Lump Sum	1	$3,353.60	$3,353.60	Includes 1 application of seed and straw for all disturbed areas. Assumes the area to be restored is less than 1 acre. [RSMeans #32-92-19.14 (0800)] (2014 + 1.3% Escl)
Site Restoration Total				***$7,492***	

TABLE D-2

Engineer's Cost Estimate for Alternative 3: Low Permeability Soil Cover

Engineering Evaluation and Cost Analysis for AOC 1 North - Scrap Metal Dump

Naval Weapons Station Yorktown Cheatham Annex

Williamsburg, Virginia

Description: Alternative 3 consists of installing a 2 ft soil cover, consisting of 18 inches of general fill followed by 6 inches of topsoil and permanent seeding, over a 12,580 ft^2 area which includes the entirety of both the ecological risk-based area and the surface debris area. LUCs, O&M, and five-year reviews would be implemented for the soil cover area.

Description of Service/Items	Unit	Quantity	Unit Price	Total	Assumptions
LUCs					
Sign (small)	Each	2	$95.00	$190.00	Assumes 24" x 24" white sign with black lettering.
Survey Plat	Each	1	$6,000.00	$6,000.00	Includes field surveying, data evaluation, reporting, filing fees, and labor.
LUCs Total				***$6,190***	
Subtotal				$202,235	
Contingency (10%)			*10.0%*	$20,223	
Construction Management (10%)			*10.0%*	$20,223	
Project Management (8%)			*8.0%*	$16,179	
Subtotal				$258,861	
Performance Bond (2%)			2.0%	$5,177	Industry Average
TOTAL CAPITAL COST				**$264,000**	
Operations and Maintenance (O&M) for Soil Cover (1 to 30 Years)					
LUC and Cover Quarterly Inspections	Each	8	$3,500.00	$28,000.00	Assumes 2 years of quarterly inspections. Includes reporting. Engineer's estimate based on recent similar projects.
Annual LUC and Cover Inspections	Each	28	$3,500.00	$98,000.00	Engineer's estimate based on recent similar projects.
5-Year Review and Report	Each	6	$50,000.00	$300,000.00	Engineer's estimate based on recent similar projects. Includes groundwater LTM for metals and PAHs as well as soil cover and vegetative maintenance consisting of repairs of any monitoring well and soil cover defects noted during the Five-Year Review site inspections.
Subtotal				$426,000	
Contingency (25%)			*25.0%*	$106,500	
Project Management (8%)			*8.0%*	$34,080	
TOTAL O&M COST				**$567,000**	
Total O&M Cost Per Year				$18,900	
Total Years of O&M				30	
Discount Rate				3.40%	
Discount Factor				18.62	
Total Present Value of O&M Cost				**$352,000**	
TOTAL PRESENT VALUE of ALTERNATIVE				**$616,000**	
			+50%	**$924,000**	
			-30%	**$431,000**	

References and Source Notes

- Base costs used are 2015 dollars.
- RS Means: Facilities Construction Cost Data, 2014 + 1.3% average 2015 escalation factor (Global Insight, 2nd Quarter, 2015).
- Recent similar projects include construction projects in Weapons Naval Station Yorktown and Cheatham Annex in Williamsburg, VA.
- Discount factor established per "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis", OSWER Directive No. 9355.3-20,December 2014.

Assumptions and Exclusions

1. Mobilization includes utility clearance.

2. The enclosed Engineer's Estimate is only an estimate of possible construction costs for budgeting purposes. This estimate is limited to the conditions existing at its issuance and is not a guarantee of actual price or cost. Uncertain market conditions such as, but not limited to: local labor or contractor availability, wages, other work, material market fluctuations, price escalations, force majeure events, and developing bidding conditions etc may affect the accuracy of this estimate. CH2M Hill is not responsible for any variance from this estimate or actual prices and conditions obtained. This is an order-of-magnitude cost estimate that is expected to be within +50 to -30 percent of the anticipated costs in the EE/CA.