ENGINEERING EVALUATION/ COST ANALYSIS

FOR THE EASTERN MOUNDS IN THE NEW O-FIELD PUSHOUT AREA

Aberdeen Proving Ground, Maryland
April 2001

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The purpose of this Engineering Evaluation/Cost Analysis (EE/CA) is to evaluate potential alternatives for the non-time critical removal of source material from the Eastern Mounds in the New O-Field Pushout Area. The sixteen identified mounds in this area range from 10 ft to 42 ft in diameter and 3 ft to 5 ft in height. The following waste materials were found during test digs in, and around, the mounds: 55 gallon drums, tanks, laboratory tubs, ordnance and explosive scrap, machinery, concrete, rebar, conduit, pipe, and red brick. The source material in the mounds is believed to be the primary source of sediment contamination in this portion of the Pushout Area. This waste also presents a risk for further contaminant migration to groundwater and to Watson Creek, located downgradient of the site, where arsenic, copper, mercury, silver, zinc, and 4,4-dichlorodiphenyldichloroethylene (4,4-DDE) have been identified as chemicals of concern in the sediment. This area may also contain unexploded ordnance (UXO), which poses a potential risk to human health.

Four alternatives are presented: No Action, Institutional Controls, Protective Cover, and Excavation and Off-Site Disposal. Each alternative is evaluated using the criteria outlined in the *Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA*. The report concludes with a recommendation for Excavation and Off-Site Disposal of approximately 338 cubic yards (cy) of waste and 507 cy of soil, at an estimated cost of $558,200.

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Aberdeen Proving Ground (APG), New O-Field Pushout Area, Center Road & Adjacent Mounds, Unexploded Ordnance (UXO), Ordnance and Explosive (OE) Scrap, Chemical Warfare Materiel (CWM)

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LIST OF ACRONYMS AND ABBREVIATIONS

µg/kg ..... microgram per kilogram
4,4-DDD..... 4,4-dichlorodiphenyldichloroethane
4,4-DDE..... 4,4-dichlorodiphenyldichloroethylene
4,4-DDT 4,4-dichlorodiphenyltrichloroethane
AA ..... Aberdeen Area
APG ..... Aberdeen Proving Ground
ARAR ..... Applicable or Relevant and Appropriate Requirement
CAIRA..... Chemical Accident or Incident Response and Assistance
CERCLA ..... Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR ..... Code of Federal Regulations
COC..... Chemical of Concern
COMAR ..... Code of Maryland Regulations
CWM..... Chemical Warfare Materiel
cy ..... cubic yard
DCP ..... Disaster Control Plan
DOT ..... Department of Transportation
DSHE..... Directorate of Safety, Health and Environment
EA ..... Edgewood Area
EE/CA ..... Engineering Evaluation and Cost Analysis
EPA..... Environmental Protection Agency
FEMA..... Federal Emergency Management Agency
ft..... feet
GIS..... Geographical Information System
GP..... General Physics
GWTF..... Groundwater Treatment Facility
H&S ..... Health and Safety
HDPE..... High Density Polyethylene
ICF KE ..... ICF Kaiser Engineers
IMPA ..... Isopropyl Methylphosphonic Acid
LCU..... Lower Confining Unit
LDR..... Land Disposal Restriction
LF..... Linear Foot
LUC..... Land-Use Control
MDE ..... Maryland Department of the Environment
MMR ..... Military Munitions Rule
MPA ..... Methyl Phosphonic Acid
N/A..... Not Applicable
NCP ..... National Oil and Hazardous Substances Pollution Contingency Plan
NEPA ..... National Environmental Policy Act of 1969
NPDES ..... National Pollutant Discharge Elimination System
NPL..... National Priorities List
O&M..... Operation and Maintenance

OE..... Ordnance and Explosive
PAH ..... Polynuclear Aromatic Hydrocarbon
PETN ..... Pentaerythritol Tetranitrate
PPE ..... Personal Protective Equipment
QC ..... Quality Control
RA..... Risk Assessment
RCRA..... Resource Conservation and Recovery Act
RI ..... Remedial Investigation
RI/FS..... Remedial Investigation/Feasibility Study
ROD..... Record of Decision
RSAP ..... Reference Sampling and Analysis Program
sf..... square foot
SVOC..... Semivolatile Organic Compound
TBC..... To-Be-Considered
TCLP..... Toxic Characteristics Leachate Procedure
TEU..... Technical Escort Unit
TRV..... Toxicity Reference Value
UCA ..... Upper Confined Aquifer
UCU..... Upper Confining Unit
US..... United States
USACE ..... US Army Corps of Engineers
USAEHA..... US Army Environmental Hygiene Agency
USGS..... US Geological Survey
UXO..... Unexploded Ordnance
VOC..... Volatile Organic Compound
WTA..... Water Table Aquifer
YR..... Year

EXECUTIVE SUMMARY

The purpose of this Engineering Evaluation/Cost Analysis (EE/CA) is to evaluate potential alternatives for the non-time critical removal of source material from the Eastern Mounds in the New O-Field Pushout Area. Historically, a majority of the disposal activity at New O-Field (from the early-1950s to the late-1970s) involved open pit burning, which may have included wastes containing chlorinated solvents (Nemeth, 1989). As evidenced by recent site characterization activities, much of the burn pit residue was then pushed out into the marsh. Based on discussions with the State, the open dumping of waste has been prohibited in Maryland since the early 1900s. Information contained in the 1951 Annotated Code of Maryland, Article 43, Section 372, which is a revision of a previous law, states that open dumping is prohibited in the State of Maryland (Maryland Department of the Environment [MDE], 2001). In addition, this waste poses a potential risk to human health and the environment. Therefore, the Army is proposing a proactive approach to prevent further contamination of the marsh sediment, groundwater, and Watson Creek.

The sixteen mounds identified in this area range from 10 ft to 42 ft in diameter and 3 ft to 5 ft in height. During test digs in the mounds, the following waste materials were identified: 55 gallon (gal) drums, tanks, laboratory tubs, ordnance and explosive (OE) scrap, machinery, concrete, rebar, conduit, pipe, and red brick. The contents of the drums, tanks, laboratory containers, and potential vials are unknown. Based on the estimated size of the mounds recorded during site characterization activities, the total volume of contaminated media is approximately 338 cubic yards (cy) of waste and 507 cy of soil. The actual volume of waste will be field determined; but may be much less than the estimated value.

The waste identified in the mounds is believed to be the primary source of sediment contamination in this portion of the Pushout Area. This waste also presents a risk for further contaminant migration to groundwater and Watson Creek. Sediment sampling in the area has identified elevated metals, pesticides, volatile organic compounds (VOCs), and polynuclear aromatic hydrocarbons (PAHs) above Toxicity Reference Values (TRVs). Four of the elevated inorganics (arsenic, copper, silver, and zinc) and the pesticide breakdown product 4,4-dichlorodiphenyldichloroethylene (4,4-DDE) were identified as contaminants of concern in the Record of Decision (ROD) for Watson Creek (ICF Kaiser Engineers [ICF KE], 1997). And, although PETN was not detected in the sediment samples collected in the vicinity of the Eastern Mounds, it has been detected in the marsh and may be attributed to the significant volume of OE scrap in the Pushout Area. Well points within the marsh area also showed elevated metals, VOCs, and chemical warfare materiel (CWM) degradation products. Both the ROD and Long Term Monitoring Plan for Watson Creek (General Physics [GP], 2000) expressed concern with the migration of contaminants from New O-Field.

Like much of the Edgewood Area, there is potential for encountering OE-related items throughout New O-Field, due to past training and disposal operations. Although the likelihood of encountering intact unexploded ordnance (UXO) or CWM in the Eastern Mounds is relatively low, there is still a limited risk to humans and animals due to the presence of OE waste and the potential for encountering white phosphorus (which ignites spontaneously when exposed to air).

This EE/CA demonstrates that there are only a limited number of viable alternatives for addressing the source material in the Eastern Mounds. The four identified alternatives (No Action, Institutional Controls, Protective Cover, and Excavation and Off-Site Disposal) are evaluated using the criteria outlined in the *Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA* (EPA, 1993). A summary of compliance with these criteria (i.e., effectiveness, implementability, and cost) is provided in **Table ES-1**.

Conditions at the site meet the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) Section 300.415(b)(2) criteria for a non-time critical removal and approval of Alternative 4 (Excavation and Off-Site Disposal) is recommended. This proposed action will provide the following benefits to the Remedial Investigation/Feasibility Study for New O-Field:

1. Well installation in areas that have been historically prohibited due to the presence of metal anomalies (UXO avoidance) may be possible. This is critical because MDE has specified that additional wells will be needed to thoroughly investigate natural attenuation in the marsh (prior to completing the Feasibility Study).

2. Residual sediment contamination may no longer pose a risk to ecological receptors, once the waste materials have been removed and the site has been restored. However, if additional action is required, a less expensive in-situ remedy may be possible.
3. Removal of the source of contaminant migration to the marsh sediment may prevent further remedial action in Watson Creek. Long-term monitoring, as required by the Watson Creek ROD, has identified an increase in lead and 4,4-DDE in the sediment samples collected from the southwestern leg of the Creek. Therefore, further action may be required if sediment concentrations in Watson Creek increase to unacceptable levels. Removal of the source materials will also reduce the downward migration of contaminants into groundwater.

The total project cost, if approved, is estimated to be $558,200, which will be paid by the United States Army for the Department of Defense.

This EE/CA complies with the requirements of the Removal Action Procedures contained in 40 Code of Federal Regulations (CFR) 300.410 and 300.415, the Office of Solid Waste and Emergency Response Directives 9318-0-05 and 93650-0-038, and other related guidance. Specifically, the requirements of the Removal Action Procedures contained in 40 CFR 300.410 were met through the information gathered in the various investigations completed at the site.

TABLE ES-1. COMPARATIVE ANALYSIS OF ALTERNATIVES

Description	EFFECTIVENESS					IMPLEMENTABILITY			COST		
	Overall Protection of Human Health and the Environment	Compliance With ARARs	Long-Term Effectiveness And Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness*	Technical Feasibility	Administrative Feasibility	Availability of Services & Materials	Capital Cost	Annual O&M Cost	Total Present Worth (30 yrs, 5%)
Alternative 1: No Action	• Does not provide protection of human health or the environment.	• There are no action-, location-, or chemical-specific ARARs associated with this alternative.	• Does not provide long-term effectiveness and permanence.	• Does not reduce toxicity, mobility, or volume of contaminants.	• Not applicable.	• Not applicable.	• The five-year review is the only admin. action required, because contamination would remain in place.	• Not applicable.	$0	$1,100	$16,900
Alternative 2: Institutional Controls	• Provides limited protection of human health through the use of access restrictions and land-use controls. • Does not address environmental impacts.	• Same as Alt. 1.	• Same as Alt. 1.	• Same as Alt. 1.	• Same as Alt. 1.	• Same as Alt. 1.	• Requires coordination between the Army, EPA, & MDE to ensure that access restrictions and land-use controls remain in place.	• Same as Alt. 1.	$2,400	$2,040	$33,800
Alternative 3: Protective Cover	• Provides limited protection of human health and the environment. • Eliminates direct contact with source material; but may alter subsurface conditions, thus impacting natural attenuation. • Does not address the impact of sources on groundwater or soil/ sediment.	• There are no chemical-specific ARARs for debris. • Complies with action- and location-specific ARARs.	• Limits direct contact with waste. • But does not provide long-term effectiveness and permanence, because the waste materials would remain in place.	• Same as Alt. 1, except exposure to waste is minimized.	• Limited risk during implementation -- due to the potential for encountering UXO during brush clearance and initial stages of cover construction. • Covering the marsh with several feet of cover material may alter conditions for natural attenuation. • Approximately 3 months for construction.	• Moderately implementable. Cover construction is a conventional construction process, but may be challenged by the location in a wetland area and potential for encountering UXO.	• Requires on-site coordination with base support services (US Army TEU, DSHE Safety, & APG Fire Department. • Also requires coordination btw. the Army, EPA, & MDE to ensure long-term management & monitoring of the site.	• Specialized equipment and highly trained personnel would be required, but would be readily obtainable. • Higher levels of PPE and monitoring may be needed during grading operations.	$981,300	$4,150	$1,051,600
Alternative 4: Excavation & Off-Site Disposal	• Provides complete protection of human health and the environment by removing the source material.	• Same as Alt. 3.	• Provides long-term effectiveness and permanence.	• Reduces the volume of waste.	• Same as Alt. 3; except the potential for encountering UXO persists throughout the project duration (2 months).	• Moderately implementable. Excavation is a conventional construction process, but may be challenged by the potential for encountering UXO.	• Requires on-site coordination with base support services (US Army TEU, DSHE Safety, & APG Fire Department.	• Same as Alt. 3; however, higher levels of PPE and monitoring may be required for a longer duration.	$558,200	$0	$558,200

Notes:

APG = Aberdeen Proving Ground
ARARs = Applicable or Relevant and Appropriate Requirements
CWM = Chemical Warfare Materiel
DSHE = Directorate of Safety, Health and Environment
EPA = Environmental Protection Agency
MDE = Maryland Department of the Environment
NCP = National Oil and Hazardous Substances Pollution Contingency Plan
O&M = Operation and Maintenance
TEU = Technical Escort Unit
US = United States
UXO = Unexploded Ordnance

* Time estimate is for construction; therefore, does not take planning, design, regulatory review, down-time due to weather/safety, or long-term maintenance into consideration.

1.0 INTRODUCTION

IT Corporation, under contract with the Unite States Army Corps of Engineers (USACE), Baltimore District, for the Aberdeen Proving Ground (APG), Directorate of Safety, Health and Environment (DSHE), has been tasked to perform an Engineering Evaluation and Cost Analysis (EE/CA) for the Eastern Mounds in the New O-Field Pushout Area. This report has been prepared under the Total Environmental Restoration Contract (DACA31-95-D-0083), Delivery Order 0003.

1.1 PURPOSE

The purpose of this EE/CA is to evaluate potential alternatives for the non-time critical removal of source material from the Eastern Mounds in the New O-Field Pushout Area[1]. Historically, a majority of the disposal activity at New O-Field (from the early-1950s to the late-1970s) involved open pit burning, which may have included wastes containing chlorinated solvents (Nemeth, 1989). As evidenced by recent site characterization activities, much of the burn pit residue was then pushed out into the marsh. Based on discussions with the State, the open dumping of waste has been prohibited in Maryland since the early 1900s. Information contained in the 1951 Annotated Code of Maryland, Article 43, Section 372, which is a revision of a previous law, states that open dumping is prohibited in the State of Maryland (Maryland Department of the Environment [MDE], 2001). In addition, this waste poses a potential risk to human health and the environment.

The large volume of source material (including potential containers of unknown content) in the mounds presents a risk for further contaminant migration to marsh sediment, groundwater, and Watson Creek. Sediment sampling, within the portion of the marsh now referred to as the Eastern Mounds Area, identified elevated concentrations of metals, pesticides, volatile organic compounds (VOCs), and polynuclear aromatic hydrocarbons (PAHs) above Toxicity Reference Values (TRVs). Four of the elevated inorganics (arsenic, copper, silver, and zinc) and the pesticide breakdown product 4,4-dichlorodiphenyldichloroethylene (4,4-DDE) were identified as contaminants of concern in the Record of Decision (ROD) for Watson Creek (ICF Kaiser Engineers [ICF KE], 1997). And, although PETN was not detected in the sediment samples collected in the vicinity of the Eastern Mounds, it has been detected in the marsh and may be attributed to the significant volume of ordnance and explosive (OE) scrap in the Pushout Area. Well points within the marsh area also showed elevated metals, VOCs, and chemical warfare materiel (CWM) degradation products. Both the ROD and Long Term Monitoring Plan for Watson Creek (General Physics [GP], 2000) expressed concern with the migration of contaminants from New O-Field.

Like much of APG-EA, there is also potential for encountering OE-related items throughout New O-Field, due to past training and disposal operations. Although the likelihood of encountering intact unexploded ordnance (UXO) or CWM in the Eastern Mounds is relatively low, there is still a limited risk to humans and animals due to the presence of OE waste and the potential for encountering white phosphorus (which ignites spontaneously when exposed to air).

To date, there have been no formal removal actions initiated at this site. It should be noted that the underlying soil, sediment, and groundwater will be addressed by the ongoing Remedial Investigation/ Feasibility Study (RI/FS). However, this proposed removal action will provide the following benefits to the RI/FS program:

1. Well installation in areas that have been historically prohibited due to the presence of metal anomalies (UXO avoidance) may be possible. This is critical because MDE has specified that additional wells will be needed to thoroughly investigate natural attenuation in the marsh (prior to completing the FS).
2. Residual sediment contamination may no longer pose a risk to ecological receptors, once the waste materials have been removed and the site has been restored. However, if additional action is required, a less expensive in-situ remedy may be possible.

[1] New O-Field is located in a restricted area of APG. Unauthorized access is prevented through the employment of a wide variety of security measures; these measures include, but are not limited to, access control points, random patrols by security forces, and the employment of technical physical security devices.

3. Removal of the source of contaminant migration to the marsh sediment may prevent further remedial action in Watson Creek. Long-term monitoring, as required by the Watson Creek ROD, has identified an increase in lead and 4,4-DDE in the sediment samples collected from the southwestern leg of the Creek. Therefore, further action may be required if sediment concentrations in Watson Creek increase to unacceptable levels. Removal of the source materials will also reduce the downward migration of contaminants into groundwater.

All of the actions at this site are being performed through the initiative of DSHE. Participation of, and cooperation with, Federal, State, and local authorities and the local public will be actively pursued for the duration of this activity and for all environmental restoration activities at this facility. Participation of these entities is required for the environmental restoration process and aids in ensuring protection of human health and the environment. Federal, State, and local authorities will have input into the actions implemented at the facility through pre-planning meetings, plan review, and the public comment process. The concerns of the Federal, State, and local authorities and citizens will be solicited and the provisions of Federal, State, and local regulations will be given full consideration for all actions taken at this facility.

This EE/CA complies with the requirements of the Removal Action Procedures contained in 40 Code of Federal Regulations (CFR) 300.410 and 300.415, the Office of Solid Waste and Emergency Response Directives 9318-0-05 and 93650-0-038, and other related guidance. Specifically, the requirements of the Removal Action Procedures contained in 40 CFR 300.410 were met through the information gathered in the various investigations completed at the site.

1.2 REPORT ORGANIZATION

The remainder of this report is organized as follows:

Section 2 - Site Characterization. This section summarizes general site information including background; previous removal actions; source, nature, and extent of contamination; analytical data; streamlined risk assessment; and potential for encountering UXO/CWM during site activities.

Section 3 - Identification of Removal Action Objectives. This section defines the statutory limits on removal actions, determination of removal action scope, determination of removal schedule, planned remedial activities, Applicable or Relevant and Appropriate Requirements (ARARs), and To-Be-Considered (TBC) Guidance.

Section 4 - Identification and Analysis of Removal Action Alternatives. This section provides a brief discussion of the following alternatives: No Action, Institutional Controls, Protective Cover, and Excavation and Off-Site Disposal.

Section 5 - Comparative Analysis of Removal Action Alternatives. In this section, the four alternatives are compared based on their compliance with the criteria of effectiveness, implementability, and cost.

Section 6 - Recommendation. In this section, Excavation and Off-Site Disposal is selected as the proposed removal action.

Section 7 - References.

2.0 SITE CHARACTERIZATION

This section summarizes available data on the physical, demographic, and other characteristics of the site and surrounding areas.

2.1 BACKGROUND

APG is a 72,516-acre installation (39,882-acre land area) located in southern Harford County and northeastern Baltimore County, Maryland, on the western shore of the upper Chesapeake Bay (**Figure 2-1**). The installation is bordered to the east and south by the Chesapeake Bay; to the west by Gunpowder Falls State Park, the Crane Power Plant and residential areas; and to the north by the city of Aberdeen and towns of Edgewood, Joppatowne, Magnolia, and Perryman. APG is divided into two areas by the Bush River: the Edgewood Area (APG-EA) lies to the west and the Aberdeen Area (APG-AA) lies to the east.

Testing of ordnance was performed at various impact areas within the installation, including several areas located along the Gunpowder Neck of APG-EA. The potential for encountering UXO and/or intact or leaking liquid-filled rounds deposited during testing, exists in these impact areas. In addition to testing activities, disposal of UXO and other debris was conducted along the Gunpowder Neck. The O-Field Area (including both Old O-Field and New O-Field) was one of the major disposal areas at APG-EA (**Figure 2-2**). Based on historical records, nine trenches were used at New O-Field for disposal operations from 1950 to 1961. In later years, until disposal ended in the late 1970s, the primary activity at New O-Field was the destruction of materials by burning.

Physiography and Topography. The surface of the New O-Field Pushout Area is ordinarily covered with dense marsh grass (*phragmites*); however, the area was hand cleared in Summer 2000 and remains lightly vegetated. In coming months, the phragmites are expected to re-populate the area. New O-Field's topographic high is along Watson Creek Road and gently slopes downward toward the east, to the edge of Watson Creek.

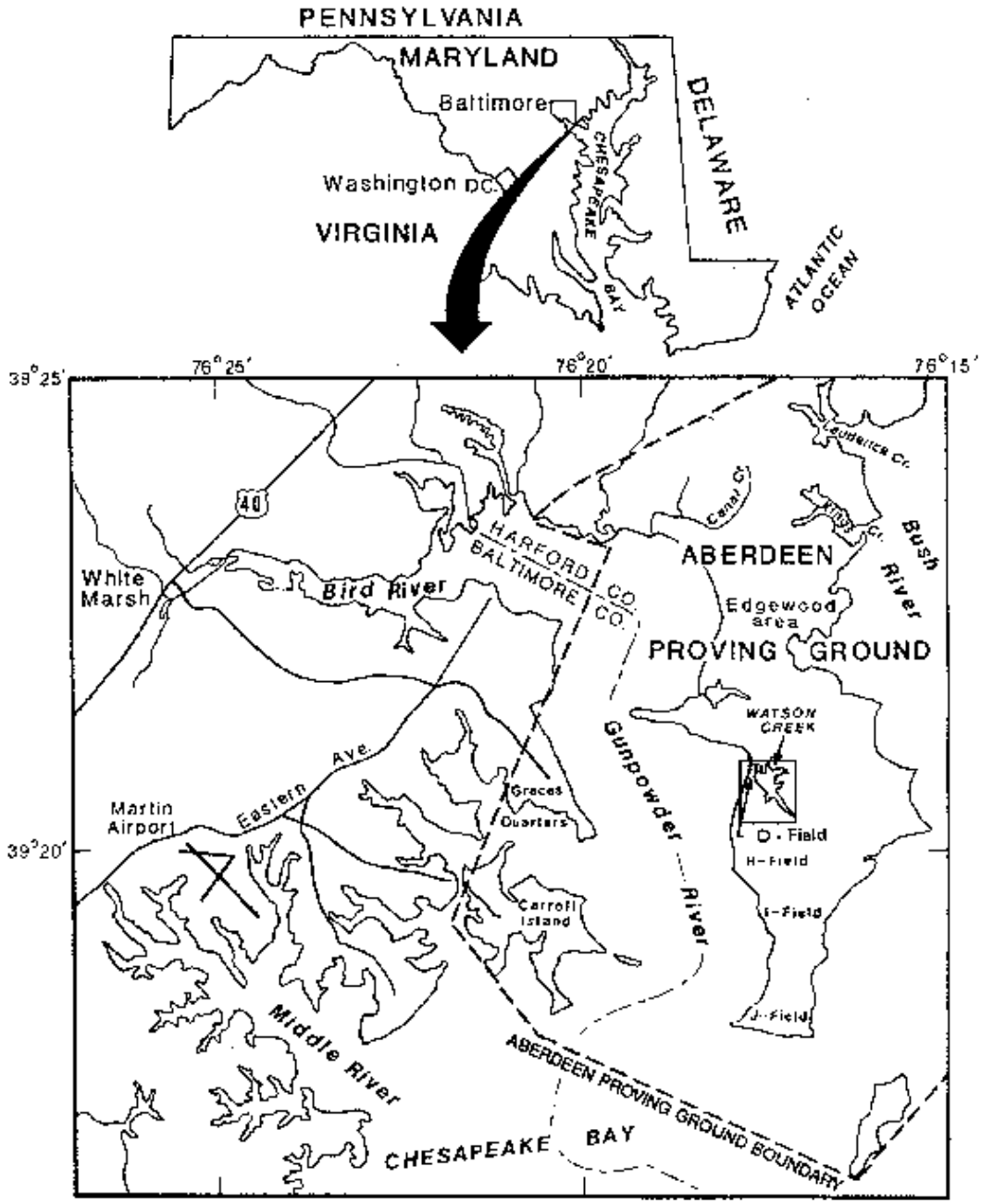
Soil Types. During site characterization activities, native soils were identified beneath a waste layer ranging from approximately 2 to 4 feet (ft) thick (General Physics [GP], 2001). Test dig samples were not analyzed for soil characteristics. However, soil samples collected from the upland area of New O-Field consisted of a mixture of silt, silty sand, and silty clay.

Regional Geology. The site is located on unconsolidated, interbedded sand, clay, and silt layers of the Atlantic Coastal Plain Physiographic Province. The Coastal Plain sediments begin at the Fall Line, locally just north of APG, and thicken to the east and southeast. The sediments are underlain by a basement complex of Precambrian and Paleozoic crystalline rocks and Mesozoic rift-basin sedimentary rocks. The depth to pre-Cretaceous basement rocks at O-Field is about 650 ft (Hansen and Edwards, 1986).

Locally, the unconsolidated sediments include the Potomac Group of Cretaceous age, which are overlain by the Talbot Formation of Pleistocene age (Owens, 1969). The Talbot Formation in the area is typically pale- to moderately-gray silt and graywacke sand. Pebbles and gravel are common. The formation also contains locally thick beds of massive dark-gray, clayey silt, having abundant leaf fossils (US Geological Survey [USGS], 1991).

Hydrogeology. Vroblesky and others (USGS, 1991) described two aquifers and two confining units present at O-Field to a depth of approximately 80 ft. They are designated (from shallowest to deepest) as the Water Table Aquifer (WTA), the Upper Confining Unit (UCU), the Upper Confined Aquifer (UCA), and the Lower Confining Unit (LCU). Data collected during the USGS investigation was obtained primarily from boreholes completed at Old O-Field. During the Remedial Investigation (RI), additional boreholes were completed at New O-Field. Lithologic descriptions and physical testing data obtained from these boreholes indicate that the water-bearing units and confining units may not be hydraulically distinct.

Surface Water Hydrology. The O-Field Study Area is bordered by Watson Creek to the north and east and the Gunpowder River to the west. Watson Creek receives both surface runoff and groundwater discharge from Old and New O-Field. Watson Creek has an 850-acre watershed that drains



SOURCE: USGS, 1989.

BALTIMORE DISTRICT
US Army Corps of Engineers

CONTRACT NO. DACA31-95-D-0083

FIGURE 2-1
ABERDEEN PROVING GROUND

the group
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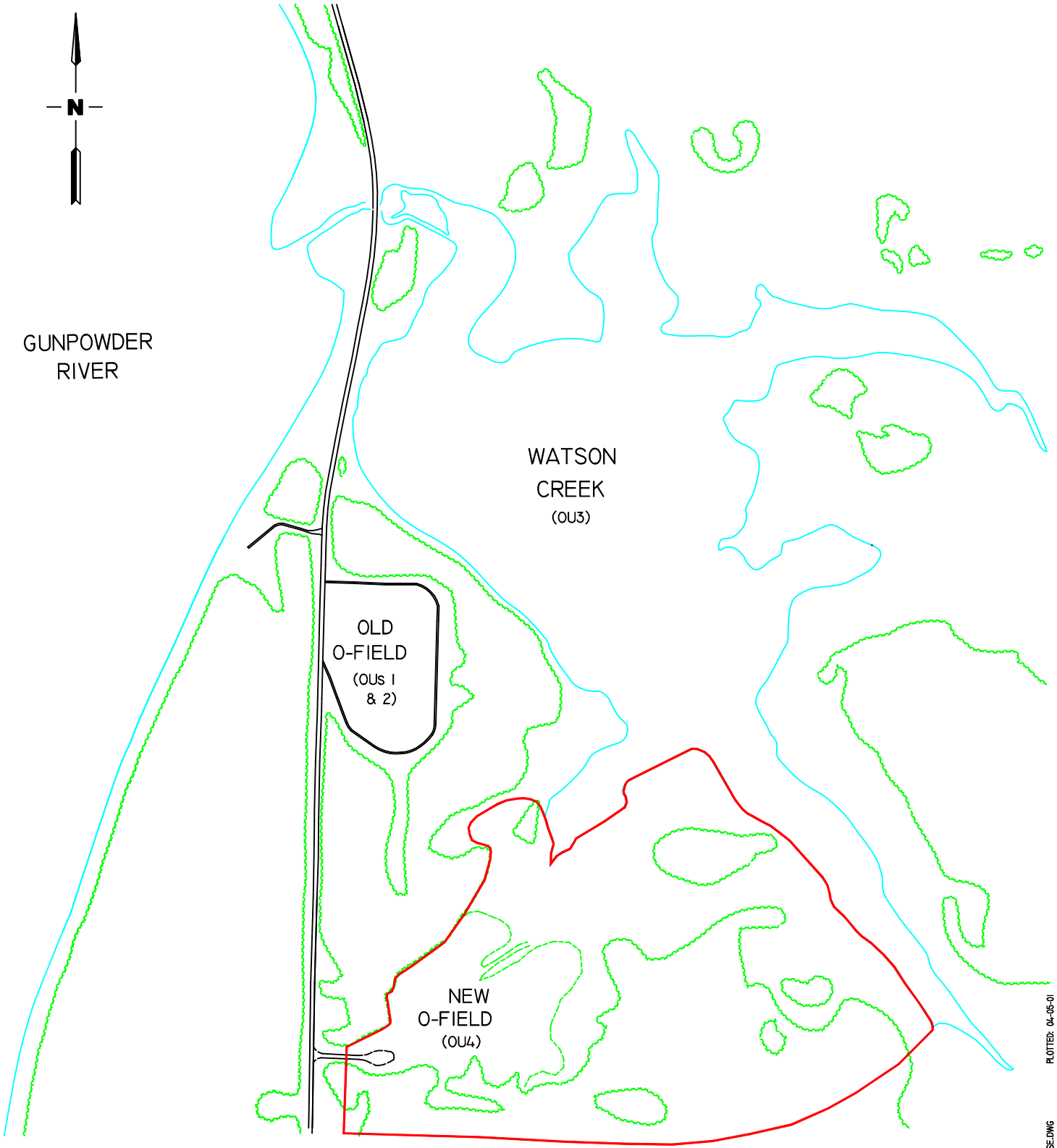
2113 Emmorton Park Rd.
Edgewood, MD 21040
(410) 612-6350

PREPARED JH
CHECKED TL
DATE 09-06-00
TASK NO. 306704
IT DWG NO.
FIG2-1.PPT

LOCATION OF ABERDEEN PROVING GROUND



LEGEND

- TREELINE
- WATER
- BOUNDARY OF NEW O-FIELD STUDY AREA

0 600
FEET

PLOTTED: 04-05-01

FILE: DISPOSE.DWG

US ARMY CORPS OF ENGINEERS

CONTRACT NO. DACA31-95-D-0083

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PREPARED: KDM/PMH
CHECKED: JJC
DATE: 09-06-00

TASK NO: 866703
DWG NO: FIG02-02.DWG

FIGURE 2-2
ABERDEEN PROVING GROUND

LOCATION OF THE O-FIELD STUDY AREA

into the Gunpowder River, which in turn drains into the Chesapeake Bay. Surface water exchange between Watson Creek and the Gunpowder River is restricted to a narrow culvert under Watson Creek Road. This culvert restricts tidal flushing of the creek (US Army Environmental Hygiene Agency [USAEHA], 1977).

2.2 PREVIOUS REMOVAL ACTIONS

There have been no formal removal actions undertaken at this site to date.

2.3 SOURCE, NATURE , AND EXTENT OF CONTAMINATION

This EE/CA addresses the Eastern Mounds in the New O-Field Pushout Area (**Figure 2-3)**. This area occupies approximately 63,067 sq. ft (1.4 acres) and encompasses sixteen mounds, ranging in size from 10 ft to 42 ft in diameter and 3 ft to 5 ft in height (GP, 2001). Based on these dimensions, the total volume of the mounds has been estimated as 845 cy, comprised of approximately 40% waste (338 cy) and 60% soil (507 cy)[2].

The following waste materials were identified during test digs in this area: 55 gallon drums, tanks, laboratory tubs, ordnance and explosive (OE) scrap, machinery, concrete, rebar, conduit, pipe, and red brick (**Table 2-1**). Several of these types of waste materials are shown in the photographs taken after the brush fire in 1997 (**Figure 2-4**). The contents of the drums, tanks, laboratory containers, and potential vials[3] are unknown. No reportable UXO items were identified in this area during the Site Characterization (GP, 2001).

The waste identified in the mounds is believed to be the primary source of sediment contamination in this portion of the Pushout Area. A summary of the sediment sampling conducted in this area is provided in the following section.

2.4 ANALYTICAL DATA

This EE/CA is targeted at the source material in the Eastern Mounds. It is not intended to address the underlying soil, sediment, or groundwater at New O-Field. These media will be addressed under the site-wide RI/FS program. Thus, the data discussed in this section are intended only to justify the removal of source material from this area.

2.4.1 Sediment Data

Four of the sediment locations sampled during the RI in 1993 (N-OFLD18) and 1997 (N-OFLD60, N-OFLD64, and N-OFLD70) were located in the vicinity of the Eastern Mounds (**Figure 2-3**). The inorganics detected above Reference Sampling and Analysis Program (RSAP) values are provided in **Table 2-2**.

Low levels of organic compounds were also detected in the sediment samples. Detected concentrations of VOCs ranged from 2.0 µg/kg (carbon disulfide, styrene, and trichloroethene) to 16 µg/kg (acetone)[4]. Two semivolatile organic compounds (SVOCs) were detected in sample N-OFLD64 (2,4,6-trichlorophenol at 55 µg/kg and di-n-butylphthalate at 67 µg/kg), but were not detected in the other samples. These VOCs and SVOCs may be attributed to the disposal of solvents and laboratory chemicals in the Pushout Area.

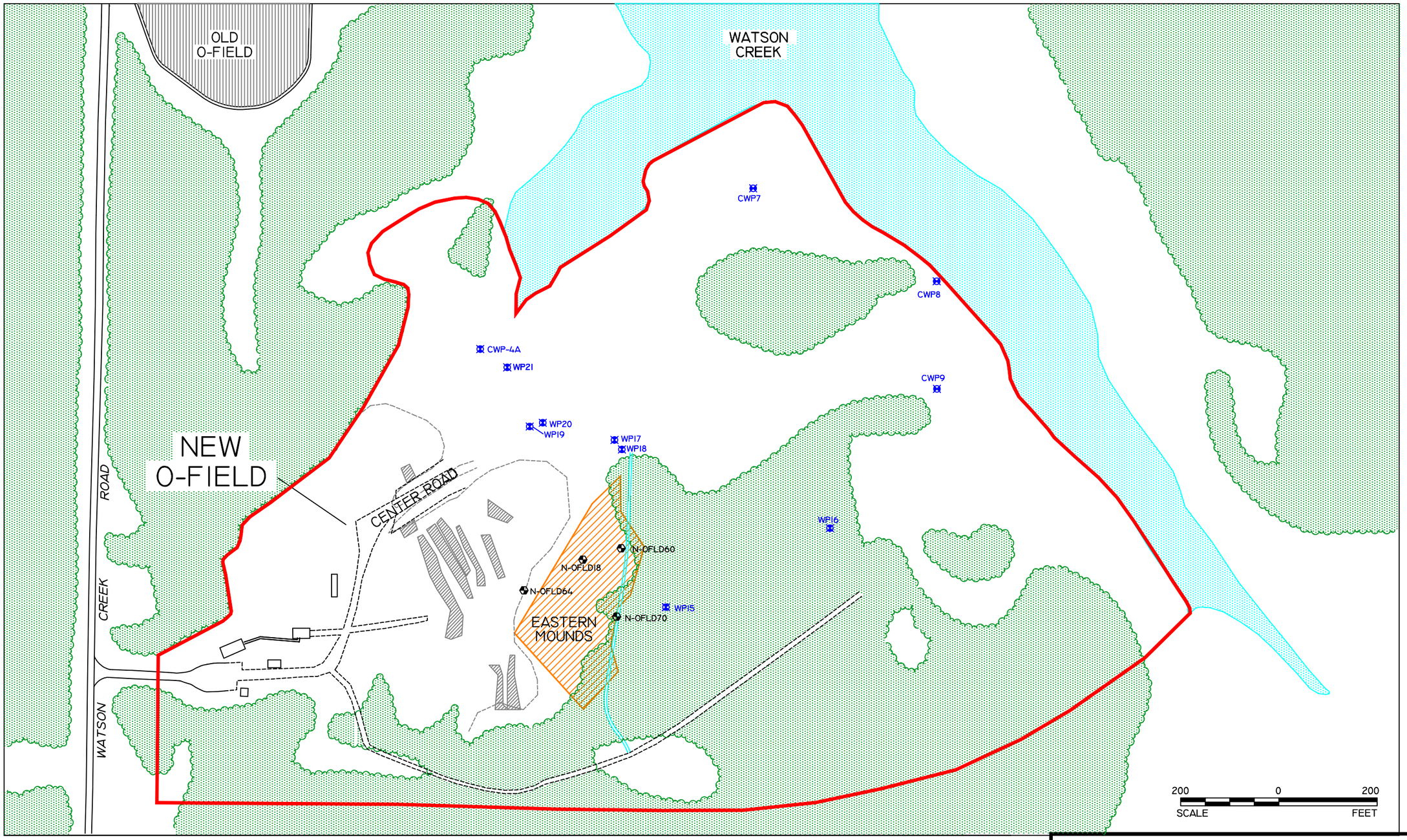
PAHs were detected in all three of the locations sampled in 1997, ranging from 0.571 µg/kg (pyrene) to 33.4 µg/kg (phenanthrene). These compounds are most likely present in the Pushout Area due to the incomplete combustion of waste materials in the burn pits.

---

[2] Conservative estimates for costing purposes only. The actual volume of waste will be field determined; but may be much less than the estimated value.

[3] Glass vials were discovered and photographed in 1997 (**Figure 2-4**). For safety reasons, DSHE personnel did not venture close enough to identify their contents. It is believed that these vials were located in the vicinity of the Eastern Mounds, but they were not found during the Site Characterization conducted in Summer 2000. However, this activity was focused on the investigation of metallic contacts (based on geophysical data); therefore, glass vials would only be found if they had metal caps or were enclosed in metal containers. Also, the area encompassing the mounds was not clear-cut in 2000; instead, lanes were cleared (40 ft apart and 10 ft wide) and any mounds identified in the lanes were then cleared of vegetation.

[4] Bis(2-ethylhexyl)phthalate was detected at 1,500 µg/kg in sediment sample N-OFLD18. However, the data was "B" qualified, because it was identified in the associated laboratory blank.



FILE: D:\OFIELD\AREA5-FIG02-03.DWG PLOT: 04-05-01

LEGEND:

- CLEARING
- SUSPECTED TRENCH LOCATION DETECTED BY GPR
- TRAIL/ DIRT ROADS
- TREELINE
- WATER
- BOUNDARY OF NEW O-FIELD STUDY AREA
- AREA ADDRESSED BY THE EE/CA
- N-OFLD18 SEDIMENT SAMPLE LOCATION
- WP15 WELL POINT LOCATION
- CWP7 CREEK WELL POINT LOCATION

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PREPARED BY:	PMH/DWM	TASK NO:	866703
CHECKED:	JHH	IT DWG NO:	AREA5-FIG02-03
DATE:	4-4-01		

FIGURE 2-3
ABERDEEN PROVING GROUND

APPROXIMATE BOUNDARY OF THE EASTERN MOUNDS IN THE PUSHOUT AREA

TABLE 2-1. TEST DIG DATA FROM THE NEW O-FIELD PUSHOUT AREA

DIG #	AREA #	SIZE (L x W x D)	DESCRIPTION
102	5	Surface	Concrete Mound, OE Scrap, Concrete Slabs 35 ft long x 3 ft wide
103	5	Surface	OE Scrap
104	5	Surface	OE Scrap
105	5	Surface	OE Scrap
106	5	36 x 36 x 8	OE Scrap
107	5	24 x 24 x 6	OE Scrap
108	5	Mound	15 ft dia, 3 ft high, OE Scrap, Concrete
109	5	Mound	10 ft dia, 3 ft high, OE Scrap
110	5	Mound	12 ft dia, 4 ft high, OE Scrap, Concrete
111	5	Surface	OE Scrap
112	5	12 x 12 x 8	OE Scrap
113	5	6 x 36 x 2	OE Scrap
114	5	Surface	OE Scrap
115	5	36 x 36 x 24	OE Scrap, Burn Residue
116	5	24 x 18 x 12	OE Scrap
117	5	12 x 6 x 1	OE Scrap
118	5	Mound	26 ft dia, 4 ft high, OE Scrap, 55 gal. Drum
119	5	12 x 12 x 1	OE Scrap
120	5	6 x 8 x 8	OE Scrap
121	5	6 x 6 x 6	OE Scrap
122	5	Surface	OE Scrap
123	5	Surface	OE Scrap
124	5	18 x 12 x 8	OE Scrap
125	5	12 x 10 x 4	OE Scrap
126	5	Mound	12 ft dia, 4 ft high, OE Scrap, Concrete
127	5	Mound	10 ft dia, 3 ft high, OE Scrap
128	5	6 x 4 x 2	Rebar
129	5	4 x 6 x 2	Rebar
130	5	Mound	12 ft dia, 4 ft high, 55 gal Drum, Stainless Drum, Concrete
131	5	Mound	18 ft dia, 4 ft high, 55 gal Drum, Rebar, Concrete
132	5	12 x 12 x 8	OE Scrap
133	5	Mound	42 ft dia, 5 ft high, Concrete, Rebar, Lab Tubs, Machinery, Constantina Wire, Water Pipes, Red Brick
134	5	Mound	20 ft dia, 4 ft high, Concrete, OE Scrap
135	5	12 x 10 x 4	OE Scrap
136	5	Surface	OE Scrap
137	5	Surface	OE Scrap

TABLE 2-1. TEST DIG DATA FROM THE NEW O-FIELD PUSHOUT AREA (CONTINUED)

DIG #	AREA #	SIZE (L x W x D)	DESCRIPTION
138	5	Surface	OE Scrap
139	5	18 x 12 x 6	OE Scrap
140	5	Mound	40 ft dia, 5 ft high, Concrete, Rebar, Stainless Tank, Steel Tank, Pipe
141	5	12 x 9 x 3	OE Scrap
142	5	12 x 12 x 9	OE Scrap
143	5	Mound	12 ft dia, 3 ft high, Metal Scrap
144	5	6 x 6 x 4	OE Scrap
145	5	Surface	OE Scrap
146	5	6 x 6 x 3	OE Scrap
147	5	12 x 9 x 7	OE Scrap
148	5	18 x 12 x 6	OE Scrap
149	5	Mound	15 ft dia, 4 ft high, Concrete, Rebar
150	5	Surface	OE Scrap
151	5	Mound	20 ft dia, 4 ft high, Concrete Stairs, Rebar
152	5	Mound	40 ft dia, 5 ft high, Concrete, Rebar, 55 gal Drums, Light Metal, Conduit, Pipe
153	5	Mound	35 ft dia, 4 ft high, Concrete, Rebar, Red Brick, Conduit

Source: General Physics, 2001.

TABLE 2-2. INORGANICS DETECTED IN SEDIMENT IN THE VICINITY OF THE EASTERN MOUNDS COMPARED TO BACKGROUND VALUES & DETECTED CONCENTRATIONS IN WATSON CREEK

Inorganics (mg/kg)	Concentrations Detected in New O-Field Sediment (1993 - 1997)(1)	Reference Sampling & Analysis Program (RSAP) Values(1,2)	Concentrations Detected in Watson Creek (1993 - 1996)(3)
Antimony	0.95 - 1.9	1.8	ND
Arsenic*	2.0 - 11.1	2.61 - 7.36	0.47 - 82.5
Barium	46.1 - 335	6.28 - 99.5	1.05 - 111
Cadmium	0.54 - 2.6	0.25 - 2.07	1.36 - 4.62
Copper*	36.1 - 83.0	2.88 - 74.3	0.74 - 305
Lead	32.6 - 167	3.56 - 91.1	1.05 - 109
Silver*	0.68 - 0.83	ND	0.14 - 7.34
Zinc*	73.9 - 635	9.83 - 284	16.2 - 1,130

* Identified as inorganic chemicals of concern (COCs) in Watson Creek sediment.

Sources: (1) ICF KE, 1999. [Samples collected in 1993 (N-OFLD18) and 1997 (N-OFLD60, 64, 70, & 70D).]
(2) USAEC, 1995.
(3) ICF KE, 1997.

FIGURE 2-4. WASTE MATERIALS IDENTIFIED IN THE PUSHOUT AREA

Miscellaneous Wastes

Laboratory Vials

Drums and Miscellaneous Wastes

The pesticides 4,4-dichlorodiphenyldichloroethane (4,4-DDD), 4,4-DDE, 4,4-dichlorodiphenyl-trichloroethane (4,4-DDT), alpha chlordane, dieldrin, and endosulfan were also detected, ranging from 2.4 µg/kg (dieldrin) to 30 µg/kg (DDT).

One CWM-related compound, diisopropylmethylphosphonate (DIMP) was detected in sediment sample N-OFLD64 in 1997 (at a concentration of 3.5 µg/kg, below the laboratory reporting limit of 10 µg/kg). The presence of DIMP, a GB-impurity and simulant, may be attributed to either the disposal of laboratory wastes or the destruction/disposal of simulant rounds. There were no other CWM degradation products or explosives identified in the remaining sediment samples collected from this area.

2.4.2 Groundwater Data

In 1997, groundwater samples were collected from seven newly-installed well points (WP15 through WP21) and four newly-installed creek well points (CWP-4A, CWP7, CWP8, and CWP9). Elevated concentrations of the following metals were detected in these samples: aluminum, antimony, barium, calcium, chromium, cobalt, iron, magnesium, manganese, mercury, nickel, potassium, sodium, vanadium, and zinc. Some of the highest concentrations of metals were found in WP17, WP18, WP19, and CWP9.

High concentrations of chlorinated VOCs (e.g., cis-1,2-dichloroethene and tetrachloroethene) were also detected in WP17 and WP18. Trace levels of SVOCs (e.g., benzothiazole, di-n-butylphthalate, and hexachlorobutadiene) and pesticides (e.g., DDD and DDE) were detected in several of the well points. The following CWM degradation products were also detected: 1,4-dithiane, 1,4-oxathiane, DIMP, isopropyl methylphosphonic acid (IMPA), and methyl phosphonic acid (MPA). Most of the highest concentrations of the organic compounds were detected downgradient of the disposal trenches and Pushout Area, but were at or below laboratory reporting limits nearest to the Creek.

2.5 STREAMLINED RISK EVALUATION

Although the likelihood of encountering intact UXO or CWM in the Pushout Area is relatively low (**Section 2.6**), there is still a limited risk to humans and animals due to the presence of OE waste and the potential for encountering white phosphorus (which ignites spontaneously when exposed to air). However, this risk cannot be accurately quantified due to the large number of unknowns.

Based on traditional risk assessment guidelines, there are no current or future human health risks (assuming industrial land-use) associated with the sediment samples collected in the vicinity of the Eastern Mounds in December 1997[5]. There is, however, potential for adverse effects to benthic organisms. The following excerpt from the 1998 Ecological Risk Assessment (ERA) summarizes the results for all of the sediment samples collected in 1997. These conclusions are relevant to this EE/CA, because as stated in **Section 2.4**, some of the highest concentrations of inorganics and PAHs were identified in the Pushout Area.

Organic chemicals were detected at concentrations above their Toxicity Reference Values (TRVs) at locations throughout the New O-Field marsh. A number of these chemicals, most notably acetone, bis(2-ethylhexyl)phthalate, and carbon disulfide were detected at their highest concentrations in the dense stands of the common reed (*Phragmites australis*), which occurs throughout the New O-Field marsh. Other chemicals, such as dieldrin, endrin ketone, and DDD were detected at their highest concentrations in the drainage transecting the New O-Field marsh (N-OFLD 69, N-OFLD 70, and N-OFLD 71).

A number of inorganic chemicals also were detected in the New O-Field marsh and drainage at concentrations above their TRVs, initially suggesting the potential for inorganic chemicals to adversely effect benthic organisms. However, with the exception of lead, all of the chemicals detected at concentrations above their TRVs were within or only slightly above (less than three times) the range of background concentrations, and/or only slightly exceeded their TRVs (Environmental Effects Quotient

[5] The 1995 Human Health Risk Assessment (RA), that evaluated the data collected in 1993 (i.e., sample location N-OFLD18), did not evaluate sediment or groundwater because it was assumed that humans would not come into contact with these media. Groundwater was also not evaluated in the 1998 RA, because it is not used as a drinking water source. Both RAs evaluated the ecological risk associated with sediment. However, the conclusions from the 1995 assessment were similar to those summarized above, so they were not repeated. Additional information regarding the two RAs can be found in the FS (ICF KE, 1999).

[EEQs] ranging from 1.6 for nickel to 6.1 for copper). Zinc was detected at a slightly higher concentration relative to background (up to seven times background concentration) and the zinc TRV (EEQ of up to 8.5 in the drainage).

Results of the chemical analysis indicate that organic chemicals and, to a lesser extent, inorganic chemicals have the potential to adversely affect benthic organisms in both the main body of the marsh and the drainage. Within the drainage, the potential for adverse effects was confirmed by bioassay results which indicate a significant reduction in *H. azteca* survival at N-OFLD 69, and a reduction in *H. azteca* growth at N-OFLD 69, N-OFLD 70, and N-OFLD 71. However, if adverse effects are occurring, they would be limited by the quality of habitat provided by the marsh and drainage. Throughout much of the New O-Field marsh, for example, *P. australis* stands have an extremely dense root structure limiting the amount of sediment available for colonization by benthic organisms. Furthermore, much of the New O-Field marsh and drainage periodically dries and only benthic organisms capable of withstanding dry periods would be able to colonize this water body. Accordingly, the potential for adverse effects would be limited by the quality of habitat present. What is likely to be more important than the potential for adverse effects to benthic organisms in the New O-Field marsh is the potential transport of chemicals to Watson Creek where a greater diversity of benthic organisms are expected to occur (ICF KE, 1999).

2.6 POTENTIAL FOR ENCOUNTERING UXO/CWM DURING SITE ACTIVITIES

Like much of APG-EA, there is potential for encountering OE-related items throughout New O-Field, due to past training and disposal operations. However, the likelihood of encountering intact UXO or CWM in the Pushout Area is relatively low. This is supported by the type, condition, and number of reportable UXO items identified over the past twelve years at New O-Field, including: i) information obtained from the APG UXO Database (GP, 1998); and ii) results from site characterization activities conducted in the Pushout Area (GP, 2001).

From January 1989 to April 1998[6], only forty (40) of the 3,319 reportable UXO items identified within the O-Field Study Area were found at New O-Field. These items included 27 bursters, five fuzes, two 40 mm high explosive (HE) grenades, four 4.2" mortars, one unknown smoke round, and one 155 mm projectile. According to US Army Technical Escort Unit (TEU) Incident Reports, only two of the items contained liquid (i.e., one of the 4.2" mortars and the 155 mm projectile). Neither item was armed or fuzed, but both were transported to N-Field for further investigation. The fill material in the first item is unknown. The second item was initially reported to contain GB, but the fill material was later identified as ethylene glycol.

Seven additional UXO items (one 4.2" mortar, one 105 mm projectile, one 155 mm projectile, and four 57 mm projectiles) were identified during the hand clearance of approximately 3.6 acres of marsh vegetation in the Pushout Area, conducted in Summer 2000 (GP, 2001). Six of the items showed evidence of demilitarization activities (i.e., empty, with holes drilled in the casings); and, the remaining item was identified as scrap. No reportable items were found during the 153 intrusive test digs[7] conducted in the Pushout Area.

The likelihood of encountering UXO/CWM in the Pushout Area is relatively low; however, a significant volume of OE scrap is anticipated. Thus, as a precaution during any future removal or intrusive activities in this area, it is recommended that trained UXO contractor personnel be available on site to screen all waste.

In the unlikely event that suspect UXO/CWM is identified, the site will be evacuated and APG emergency response personnel (i.e., Fire Department, U.S. Army TEU, and Installation Safety) will be contacted. The senior fire department official present will then determine whether to implement the Chemical Accident or Incident Response and Assistance (CAIRA) Plan [Annex C of the APG Disaster Control Plan (DCP)] or the UXO Operations Procedures [Annex S of the APG DCP].

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6 The UXO Database has not been updated since 1998; however, there were no reportable incidents at New O-Field from 1998 to 2000.

7 There were no reportable UXO items identified in the vicinity of the Eastern Mounds during the vegetation clearance activities or the performance of fifty-two test digs in this area (**Table 2-1)**.

3.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

The following Removal Action Objectives have been identified for the Eastern Mounds: i) reduce contaminant transport to Watson Creek by eliminating surface water exposure to source material; ii) eliminate further leaching of contaminants to New O-Field marsh sediment and groundwater; iii) eliminate human and animal exposure to waste; and iv) minimize the risks associated with potential UXO/CWM.

3.1 STATUTORY LIMITS ON REMOVAL ACTIONS

A removal action is defined as a cleanup or removal of released hazardous substances from the environment. According to the Environmental Protection Agency (EPA), removal actions are categorized as emergency, time-critical, or non-time critical, based on the urgency and threat of the release or potential release, and the subsequent time frame in which the action must be initiated. Emergency and time-critical removal actions must be initiated within 6 months; whereas, a non-time critical removal action can start later than 6 months after the determination that a response is necessary (EPA, 1993).

Removal actions are limited by statute to a maximum of $2 million and a duration of 12 months, unless otherwise exempted due to emergency or consistency (EPA, 1993). All of the alternatives discussed in this EE/CA can be accomplished within these limits.

3.2 DETERMINATION OF REMOVAL ACTION SCOPE

The scope of work for this proposed action includes the removal of source material from the Eastern Mounds in the New O-Field Pushout Area. As mentioned in **Section 2.3**, the total volume of contaminated media includes approximately 338 cy of waste and 507 cy of soil. The limits for the excavation have been developed using information obtained during the Site Characterization in the Pushout Area (GP, 2001). Confirmation through visual inspection would be implemented during excavation activities and would guide the limits of excavation for the purpose of determining when all waste materials have been removed. It should be noted that any residual soil contamination (i.e., beneath the mounds) will be addressed under the site-wide RI/FS program.

3.3 DETERMINATION OF REMOVAL SCHEDULE

The tentative start date for this action is contingent upon award of the remediation contract. The start date will be adjusted pending completion of the regulatory and public review/comment process. Work plan approval, weather, eagle-nesting season, and community comments will also affect the timing of project initiation. In accordance with statutory requirements, the duration of this removal action will not exceed 12 months.

3.4 PLANNED REMEDIAL ACTIVITIES

All components of this action will utilize standard construction and operating procedures, as well as routine sampling and analysis procedures. Details concerning operating procedures will be provided in a future operations work plan. Implementation of this action may result in short-term impacts, such as fugitive dust emissions, storm-water runoff, and precipitation/infiltration in the excavation areas. These potential problems will be eliminated using appropriate construction practices, such as water spraying, erosion and sediment control, and phased excavation or temporary sheeting. All transportation activities will comply with Federal, State, and local regulations.

3.5 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDERED GUIDANCE

The ARARs and TBC Guidance for addressing the waste in the Eastern Mounds are identified in this section. Proposed alternatives will comply with all chemical-specific, location-specific, and action-specific ARARs (and TBC Guidance).

The NCP (40 CFR 300.5) defines “applicable” requirements as: “those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environment or State environmental or facility citing laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site.” In addition to laws, ARARs may be regulations or guidance promulgated by Federal or State agencies. Only those

promulgated State standards that are equally or more stringent than Federal requirements may be applicable.

The NCP (40 CFR 300.5) further defines “relevant and appropriate” requirements as: “those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility citing laws that, while not “applicable” to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.” Like “applicable” requirements, the NCP also provides that only those promulgated State requirements that are equally or more stringent than corresponding Federal requirements may be relevant and appropriate.

USEPA identifies three basic types of ARARs: chemical-specific, action-specific, and location-specific. ARARs that must be considered for remedial actions in the Pushout Area are discussed in the sections below.

3.5.1 Chemical-Specific ARARs

Chemical-specific ARARs are generally health- or risk-based values which, when applied to site-specific conditions, result in numerical values. These values establish the acceptable concentration of a chemical that may be found in, or discharged to, the ambient environment. There are no chemical-specific ARARs for debris, aside from the ARARs for impacted media (i.e., soil, sediment, groundwater) which will be addressed under the site-wide RI/FS.

3.5.2 Location-Specific ARARs

Location-specific ARARs set restrictions on the types of activities which can be performed based on site specific characteristics or location. Alternative remedial actions may be restricted or precluded based on federal or state siting laws for hazardous waste facilities, and proximity to wetlands or floodplains or to man-made features such as existing landfills, disposal areas, and local historic buildings. **Table 3-1** lists the Federal and State location-specific ARARs that must be considered for remedial actions in the Pushout Area.

Faults. A total of 22 earthquake epicenters have been reported within the borders of the state of Maryland according to the Maryland Geologic Survey. The Earthquake Center has defined the seismic zone in which APG is located as Seismic Zone 1. This zone is at minimal risk from a large earthquake. The closest proximity of an area at moderate risk from a large earthquake (Zone 2 area) is located in western Maryland approximately 100 miles from APG (Jim Reger, Maryland Geologic Survey, 1993). Therefore, the Resource Conservation and Recovery Act (RCRA) regulation governing placement of hazardous wastes in fault zones is not an ARAR for this project.

Wetlands and Floodplains. The Flood Hazard Boundary Map and Flood Insurance Rate Maps, maintained by the Federal Emergency Management Agency (FEMA), indicate that some areas of APG are located within the approximate 100-year floodplain (FEMA, 1983). Therefore, the regulation prohibiting site modifications in a 100-year floodplain may be an ARAR.

Wetlands occur throughout the installation. The wetlands at APG are dominated by estuarine and palustrine emergent wetlands, although small pockets of forested wetlands also exist. If remedial actions are contemplated that would impact wetland areas, the regulations found in Executive Order 11988, Executive Order 11990, Clean Water Act Section 404 (regulated by the U.S. Army Corps of Engineers), and Clean Water Act Section 401 (regulated by the State of Maryland) may be ARARs.

Wilderness Areas, Wildlife Refuges, and Scenic Rivers. APG is bordered to the east and south by the Chesapeake Bay and to the west by Gunpowder Falls State Park. The upper Chesapeake Bay is the largest inland body of water on the Atlantic Coast. New O-Field is located in close proximity to the Gunpowder River and Watson Creek, which are both tidally influenced and may be considered part of the Chesapeake Bay estuarine system. The Chesapeake Bay supports commercial and recreational crabbing, fishing, and boating. Also, a large portion of APG is a designated wildlife refuge. The area south of O-Field is a designated refuge for migratory waterfowl.

TABLE 3-1. IDENTIFICATION OF LOCATION-SPECIFIC ARARS AND TBC GUIDANCE

Authority	Requirement	Status	Requirement Synopsis
Federal Regulatory Requirement	RCRA - Location Standards (40 CFR 264.18)	Relevant and Appropriate	This regulation outlines the requirements for constructing a RCRA facility on a 100-year floodplain. The facility must be designed, constructed, operated, and maintained to avoid washout by a 100-year flood, unless waste may be removed safely before floodwater can reach the facility or no adverse effects on human health and the environment would result if washout occurred.
	RCRA - Location Standards (40 CFR 264.18)	Relevant and Appropriate	This regulation prohibits new treatment, storage, or disposal of hazardous waste within 61 meters (200 feet) of a fault displaced in Holocene time.
	Executive Order 11988: Floodplain Management (40 CFR 6, Appendix A)	To Be Considered	Federal agencies are required to reduce the risk of flood loss, to minimize the impact of floods, and to restore and preserve the natural and beneficial values of floodplains.
	Executive Order 11990: Protection of Wetlands (40 CFR 6, Appendix A)	To Be Considered	Federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance the natural and beneficial values of wetlands.
	Clean Water Act, Section 404 (40 CFR 230.10; 33 CFR 320-330)	Relevant and Appropriate	This regulation prohibits discharge of dredge or fill material into wetlands without a permit. It provides for the enhancement, restoration, or creation of alternate wetlands.
	U.S. Army Corps of Engineers Nationwide Permit Program (33 CFR 330)	To Be Considered	This program prohibits any activity that adversely affects a wetland if a practicable alternative is available that has less effect.
	Fish and Wildlife Coordination Act (16 USC 661 *et seq*.)	Relevant and Appropriate	Actions that will impact fish and wildlife must include action to protect affected fish and wildlife resources. This law prohibits diversion, channeling, or other activity that modifies a stream or river and affects fish or wildlife.
	Coastal Zone Management Act of 1972	Relevant and Appropriate	This legislation is designed to encourage States to develop management plans to protect and preserve the coastal zone, and ensure that Federal actions are consistent with these management plans.
	Endangered Species Act of 1973 (16 USC 1531 et seq; 50 CFR 402)	Relevant and Appropriate	This law requires that action be taken to conserve endangered or threatened species. In addition, actions must not destroy or adversely modify critical habitat. Consultation with the Department of the Interior is required to ascertain that proposed actions will not affect any listed species.
	Migratory Bird Treaty Act (16 USC 703 et seq)	Relevant and Appropriate	Actions taken or funded, which result in the killing, hunting, taking, capturing of any migratory bird, part, nest, or egg is unlawful.
	Bald and Golden Eagle Protection Act (16 USC 668 et seq)	Relevant and Appropriate	This law requires that action be taken to conserve the endangered bald and golden eagles. In addition, actions must not destroy or adversely modify critical habitat.

TABLE 3-1. IDENTIFICATION OF LOCATION-SPECIFIC ARARS AND TBC GUIDANCE (CONTINUED)

Authority	Requirement	Status	Requirement Synopsis
	National Archaeological and Historic Preservation Act (16 USC 469); National Historic Landmarks Program (36 CFR 65)	Relevant and Appropriate	Federal agencies must take action to recover and preserve artifacts within areas where action may cause irreparable harm, loss, or destruction of significant artifacts.
State Regulatory Requirement	Chesapeake Bay Commission (Annotated Code of Maryland, Natural Resources Article, Title 9.302)	To Be Considered	Outlines bay-wide policy for the protection of tidal and non-tidal wetlands.
	Maryland Wetlands Law (Maryland Natural Resources Code Title 9 - Wetlands and Riparian Rights)	Relevant and Appropriate	Regulates permitting and reporting of filling and/or dredging operations in wetlands.
	Maryland Wetlands Regulation (COMAR 26.23)	Applicable	Outlines authorized uses of and prohibited activities in wetlands.
	Maryland Threatened and Endangered Species Regulations	Relevant and Appropriate	Threatened and endangered species are defined in Natural Resources Article, § 10-2A-01, Annotated Code of Maryland. Species in need of conservation are listed in COMAR 08.03.08.
	Chesapeake Bay Commission (COMAR 27.01.03 and 27.01.09)	Relevant and Appropriate	Regulations permitting and reporting of filling and/or dredging operations in wetlands.

If remedial actions are contemplated that would impact these areas, the regulations found in the Fish and Wildlife Coordination Act and the Migratory Bird Treaty Act may be ARARs. In addition, regulations cited in the Chesapeake Bay Commission policy for tidal and non-tidal wetlands may be considered TBC guidance.

Cultural and Historical Considerations. Based on a review of cultural and historic data in APG's GIS (demolished building data), there are no points of interest in the area potentially affected by remedial actions in the New O-Field Pushout Area (IT, 2001). If a remedial action is selected, consultation with the State Historic Preservation Office will occur (in compliance with 36 CFR 800).

Rare, Threatened or Endangered Species. The existence of only one threatened animal species, the bald eagle (*Haliaeetus leucocephalus*), has been confirmed in the vicinity of New O-Field (Pottie, 1999). An active bald eagle nest is located approximately 600 m northeast of New O-Field in a wooded area south of Watson Creek. This nest is one of 30 potential nesting sites which has been identified at the Installation. Overall, the Installation provides habitat for as much as 40% to 50% of the Chesapeake Bay's winter population of bald eagles (USATHAMA,1991). An approved plan requires that a 500 m radius (1 km circle around each nest) buffer zone be maintained between site activities and eagle nests. Though outside of the 500 m buffer zone, any work planned at New O-Field during nesting season (mid-December through mid-May) must be coordinated with Mr. Jim Pottie of DSHE, and may require coordination with the U.S. Fish and Wildlife Service. Based on a review of an ongoing endangered plant study at APG, no Federal or State endangered plant species have been found, to date, in the area of New O-Field (Pottie, 1999).

If an alternative requiring site modifications is selected, the regulations found in the Endangered Species Act of 1973, Bald and Golden Eagle Protection Act of 1940, Migratory Bird Treaty Act of 1918, Maryland Environmental Policy Act of 1973, Maryland Endangered Species Act of 1971, and Maryland Nongame and Endangered Species Conservation Act of 1975 may be relevant and appropriate.

3.5.3 Action-Specific ARARs

Action-specific ARARs are generally technology or activity-based requirements on actions taken with respect to hazardous substances. These requirements are triggered by the particular activities that are selected to accomplish a remedy. Thus, action-specific requirements do not in themselves determine the remedial alternative; rather, they indicate how a selected alternative must be achieved. Action-specific ARARs are summarized in **Table 3-2**.

National Environmental Policy Act of 1969 (NEPA). This report, which has been prepared in accordance with the NCP (40 CFR 300), is intended to comply with NEPA (42 U.S.C. 4371 et seq.), as codified by 40 CFR 1500-1508. It satisfies the intent of NEPA through the discussion of the document's purpose and need for action, description of the affected environment, description of alternatives and environmental consequences, and discussion of public participation.

Excavation and Disposal. Because all disposal activities ceased prior to November 1980, RCRA requirements are not applicable to this project, provided that disposed materials remain in place. RCRA requirements may be considered relevant and appropriate due to the similarity of the site to a RCRA-regulated site. Should any active remedy be selected, such as excavation, then RCRA requirements will be applicable.

Remedial actions which require excavation and/or treatment result in the generation of waste that must be disposed of properly. Under the Land Disposal Restrictions (LDRs) of RCRA (40 CFR 268.43), hazardous waste may not be landfilled without meeting the prescribed treatment standard. Prior to disposal, the soil/sediment would be tested using the Toxicity Characteristic Leaching Procedure (TCLP) (40 CFR 261.24) to determine its suitability for disposal in a solid waste landfill.

The Military Munitions Rule (MMR), 40 CFR 260 et al., is another action-specific ARAR. This rule, which became effective August 12, 1997, specifies that UXO is considered a RCRA solid waste when it is abandoned. It is also considered a hazardous waste after it has been removed, because it is reactive (capable of detonation or explosive reaction). Therefore, removed UXO are required to comply with appropriate RCRA transportation and disposal requirements.

TABLE 3-2. IDENTIFICATION OF ACTION-SPECIFIC ARARS AND TBC GUIDANCE

Authority	Requirement	Status	Requirement Synopsis
Federal Regulatory Requirement	National Environmental Policy Act (NEPA) of 1969	Applicable	Prior to major Federal actions which may significantly affect environmental quality, environmental impact must be assessed; alternatives must be considered; actions should be taken to protect, restore, and enhance the human environment; and adverse environmental effects should be detailed.
	Resource Conservation and Recovery Act (RCRA) - Closure and Post-Closure (40 CFR 265.310)	Relevant and Appropriate	This regulation details specific requirements for closure and post-closure care of hazardous waste landfills (interim status standards).
	RCRA - Groundwater Monitoring (40 CFR 265.91)	Relevant and Appropriate	The requirements of a groundwater monitoring system are detailed in this section.
	RCRA - Land Disposal Restrictions (40 CFR 268.43)	Relevant and Appropriate	This regulation establishes restrictions for the burial of wastes and hazardous materials, as well as Best Demonstrated Available Technology (BDAT) standards.
	RCRA - Identification and Listing of Hazardous Waste (40 CFR 261)	Applicable	This regulation provides guidance for classifying wastes as hazardous under RCRA.
	Military Munitions Rule (MMR) (40 CFR 260)	Applicable	This rule, which became effective August 12, 1997, specifies that UXO is considered a RCRA solid waste when it is abandoned. It is also considered a hazardous waste because it is reactive (capable of detonation or explosive reaction).
	National Pretreatment Standards (40 CFR 403)	Relevant and Appropriate	This regulation sets standards to control pollutants that pass through or interfere with treatment processes in publicly-owned treatment works or which may contaminate sewage sludge.
	National Pollutant Discharge Elimination System (NDPES) (40 CFR 122 - 125)	Applicable	This regulation establishes requirements for pollutant discharge from any point source into U.S. waters, including control technologies, water quality standard compliance, discharge limitations, monitoring, and permitting.
	U.S. Department of Transportation Rules for Transportation of Hazardous Materials (49 CFR 107, 171.1 - 172.558)	Applicable	This regulation provides requirements for transportation of hazardous waste.
State Regulatory Requirement	Maryland Environmental Policy Act of 1973 (Annotated Code of Maryland, Natural Resources Article, Title 1)	Relevant and Appropriate	State actions must be conducted in a manner which provides for the protection, preservation, and enhancement of the environment.

TABLE 3-2. IDENTIFICATION OF ACTION-SPECIFIC ARARS AND TBC GUIDANCE (CONTINUED)

Authority	Requirement	Status	Requirement Synopsis
State Regulatory Requirement (Continued)	Maryland Erosion and Sediment Control Regulations (COMAR 26.17.01)	Applicable	An erosion and sediment control plan must be approved by the MDE for a disturbed area greater than 5,000 square feet or 100 cubic yards.
	Maryland Stormwater Management Regulations (COMAR 26.17.02)	Applicable	This regulation established design criteria for stormwater control from construction activities, such as maintained pre-development runoff characteristics, and reduction of stream channel erosion, sedimentation, and pollution.
	Maryland Non-Tidal Waters and Floodplains Regulations (COMAR 26.17.04)	Applicable	This regulation governs the construction, reconstruction, repair, or alteration of a dam, reservoir, or waterway obstruction or any change of the course, current, or cross section of a stream or body of water within the State including any changes to the 100-year frequency floodplain of free-flowing waters.
	Maryland Solid Waste Regulations (COMAR 26.04.07)	Applicable	Solid waste landfills must have a liner system that is designed, constructed, and installed to facilitate collection of leachate and prevent migration of pollutants out of the landfill. Leachate collection systems must also be installed to collect and remove leachate.
	Maryland Solid Waste Regulations (COMAR 26.04.07.19)	Applicable	The final cover of an industrial waste landfill must consist of a minimum of 2 feet of compacted earthen material. the site shall be graded to minimize runoff onto the fill area of the landfill, prevent erosion and ponding within the fill areas, and drain water from the surface of the landfill.
	Maryland Solid Waste Regulations (COMAR 26.04.07.21 and COMAR 26.04.07.22)	Applicable	Closure of an industrial waste landfill shall include construction of a cap that is designed to minimize infiltration into the landfill.

Capping. Capping involves covering a site to reduce direct human and animal exposure to contaminants and to minimize infiltration of precipitation and subsequent vertical migration. RCRA regulations allow closure with waste and contaminated soils either removed (clean closure) or intentionally left in place. The design and maintenance requirements for caps are contained in 40 CFR 265.301 - 265.310. In addition, groundwater monitoring requirements are described in 40 CFR 265.91. Because RCRA is relevant and appropriate, some of these conditions may be waived.

The State of Maryland requirements for design, use, and closure of a solid waste landfill are described in the Maryland Solid Waste Regulations. In particular, the requirements of COMAR 26.04.07, 26.04.19, and 26.04.20 may be applicable to any capping option. For actions involving clearance of vegetation and construction of a cap or cover, the Maryland stormwater management and sediment and erosion control regulations may be ARARs. Requirements for hazardous waste landfills contained in 40 CFR 264.310 and COMAR 26.13.05.14J may also be applicable to capping options.

4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

In this section, the following four alternatives for addressing the Eastern Mounds in the New O-Field Pushout Area are discussed:

- No Action;
- Institutional Controls;
- Protective Cover; and
- Excavation and Off-Site Disposal.

There are only a limited number of viable alternatives for addressing the surface and near surface source material in this area. The four identified alternatives are evaluated using the criteria outlined in the *Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA* (EPA, 1993).

4.1 ALTERNATIVE 1: NO ACTION

Under this alternative, no action would be taken to address the waste in the Eastern Mounds. The land-use condition assumed under the No Action scenario includes unrestricted residential, industrial, or recreational use. It also assumes that existing institutional controls at the site, such as access and land-use restrictions, would no longer be maintained.

4.1.1 Effectiveness

Overall Protection of Human Health and the Environment. This alternative is not protective of human health or the environment for three reasons: i) surface water, which discharges to Watson Creek, is exposed to source material; ii) humans and animals are not restricted from direct contact with waste; and iii) contaminant leaching to sediment and groundwater is not prevented.

Compliance with ARARs. There are no chemical-specific ARARs for debris, aside from the ARARs and TBCs for impacted media (i.e., soil, sediment, groundwater), which would be addressed under a separate action. There are also no action- or location-specific ARARs which would apply to this alternative.

Long-Term Effectiveness and Permanence. This alternative would not meet this criterion because no measures to remove or contain the source material would be implemented.

Reduction of Toxicity, Mobility, or Volume Through Treatment. There would be no reduction of toxicity, mobility, or volume because no active treatment or containment would be implemented under this alternative.

Short-Term Effectiveness. There would be no short-term risks associated with the No Action alternative because no remedial activities would be conducted.

4.1.2 Implementability

Technical Feasibility. There would be no technical feasibility concerns associated with the No Action alternative because no remedial activities would be conducted.

Administrative Feasibility. The only administrative action associated with this alternative would be the performance of Five-Year Reviews. These reviews would coincide with the reviews for the entire O-Field Study Area.

Availability of Materials and Services. There are no materials or services required for this alternative.

State Acceptance. There are no comments available for evaluation of the "State Acceptance" criterion at this time because the regulators have not been provided with a formal opportunity to review the detailed analysis of alternatives. State representatives will review this alternative and provide comments which will be addressed in the final version of this EE/CA. Determination of final concurrence by the State will be provided at the conclusion of the public review period and documented in the Action Memorandum.

Community Acceptance. There are no comments available for evaluation of the "Community Acceptance" criterion at this time because the public has not been provided with a formal opportunity to review the detailed analysis of alternatives. It is anticipated that the public will provide formal comments during the public comment period. These comments will then be addressed in the Action Memorandum.

4.1.3 Cost

There are no costs associated with active remediation or monitoring activities under the No Action alternative; however, there are costs associated with five-year reviews because the source of contamination would remain in place. As a result, the total present worth of this alternative is approximately $16,900, calculated over 30 years at a discount rate of 5%. These costs are outlined in **Table 4-1**.

4.2 ALTERNATIVE 2: INSTITUTIONAL CONTROLS

The purpose of institutional controls is to limit human exposure to the waste in the mounds. This alternative would include the following components: access restrictions and land-use controls (LUCs), public education programs, and five-year reviews.

Access Restrictions and LUCs. Institutional controls such as access restrictions and LUCs are currently in place at New O-Field. This site is located in a restricted area; therefore, access is strictly enforced by APG security. The restricted area is also subject to random patrols by law enforcement personnel. Additional access restrictions may be required in the future, if APG security practices are downgraded; however, this is not anticipated considering the current activities at APG. The existing fence at New O-Field has posted warning signs restricting otherwise authorized personnel from entering the marsh and wooded areas due to the potential for encountering UXO. The existing fence and warning signs would be maintained as part of this alternative. The need for additional signs along with the final wording, location, and number of signs would be determined during the work plan development phase and through negotiations with the EPA and the Maryland Department of the Environment (MDE).

Under this alternative, LUCs would include: 1) the prohibition of activities in this area, other than maintenance; 2) inputting these restrictions into GIS, which is utilized in the development of APG's Real Property Master Plan; and 3) incorporation of these restrictions/prohibitions into any real property documents necessary for transferring ownership from the Army, in the unlikely event that the Army sells this property. The real property documents would also include a discussion of the National Priorities List (NPL) status, as well as a description of contamination at the site. In addition, DSHE would certify to the EPA on an annual basis that there have been no violations of these prohibitions. Should a violation occur, a description of the violation and corrective actions to be taken would be provided.

Public Education Programs. Educational programs would be developed to inform workers and local residents of the hazards due to the presence of source material (including potential UXO).

Five-Year Reviews. This alternative would not allow for unrestricted use and exposure; therefore, the site would be reviewed every five years. All available data would be analyzed as part of the five-year review process to determine whether additional remedial actions or site controls would be required.

4.2.1 Effectiveness

Overall Protection of Human Health and the Environment. The strict access restrictions already in place at APG, along with additional LUCs, security measures, and maintenance of warning signs would provide limited protection of human health. However, it would not protect the environment because surface water exposure to source material (i.e., potential continuing source to Watson Creek), animal contact with waste, and contaminant leaching to sediment and groundwater would not be prevented.

Compliance with ARARs. There are no chemical-specific ARARs for debris, aside from the ARARs and TBCs for impacted media (i.e., soil, sediment, groundwater), which would be addressed under a separate action. There are also no action- or location-specific ARARs which would apply to this alternative.

TABLE 4-1. ESTIMATED COSTS FOR NO ACTION

ITEM	UNITS	UNIT COST	QUANTITY	TOTAL
CAPITAL COSTS				
N/A	N/A	N/A	N/A	$0.00
Subtotal				**$0.00**
		SUBTOTAL		**$0.00**
		PROJECT MANAGEMENT AND BASE SUPPORT @ 10%		$0.00
		CONTINGENCY @ 10%		$0.00
		TOTAL CAPITAL COST		**$0.00**
ANNUAL O&M COSTS				
5-Year Review (on an annual basis)	Report	$1,000.00	1	$1,000.00
		SUBTOTAL		**$1,000.00**
		CONTINGENCY @ 10%		$100
		ANNUAL O&M TOTAL		$1,100
		PRESENT WORTH (30 YR @ 5%)		**$16,900.00**
TOTAL COST				**$16,900.00**

GENERAL:

a. Costs are based on existing site knowledge and are for evaluating remedial alternatives only.
b. Please refer to Appendix A for detailed assumptions and calculations.

ABBREVIATIONS:
O&M - Operation & Maintenance; N/A - Not Applicable; YR - Year

Long-Term Effectiveness and Permanence. Access restrictions and LUCs could provide effective long-term control of human contact and prevent activities which would disturb the source material. However, this alternative would not address the environmental concerns associated with surface water runoff to Watson Creek, animal contact with waste, or contaminant leaching to sediment and groundwater.

Reduction of Toxicity, Mobility, or Volume Through Treatment. There would be no reduction in the toxicity, mobility, or volume of the source material, because there would be no active removal and/or treatment conducted under this alternative.

Short-Term Effectiveness. There would be no short-term risks associated with this alternative because no active remedial action would be conducted.

4.2.2 Implementability

Technical Feasibility. There would be no technical feasibility concerns associated with this alternative because no remedial activities would be conducted.

Administrative Feasibility. The only administrative action associated with this alternative would be the performance of five-year reviews. These reviews would coincide with the reviews for the entire O-Field Study Area.

Availability of Materials and Services. The only materials required for this alternative (i.e., fencing and warning signs) are readily obtainable.

State Acceptance. There are no comments available for evaluation of the "State Acceptance" criterion at this time because the regulators have not been provided with a formal opportunity to review the detailed analysis of alternatives. State representatives will review this alternative and provide comments which will be addressed in the final version of this EE/CA. Determination of final concurrence by the State will be provided at the conclusion of the public review period and documented in the Action Memorandum.

Community Acceptance. There are no comments available for evaluation of the "Community Acceptance" criterion at this time because the public has not been provided with a formal opportunity to review the detailed analysis of alternatives. It is anticipated that the public will provide formal comments during the public comment period. These comments will then be addressed in the Action Memorandum.

4.2.3 Cost

Costs associated with this alternative are provided in **Table 4-2**. These costs assume that administrative actions would be accomplished as part of a site-wide institutional controls program; therefore, administrative costs are equal to 20% of the estimated expense. As such, the capital cost for this alternative is $2,400 and the annual operation and maintenance (O&M) is approximately $2,040. The total present worth of capital and annual O&M costs is approximately $33,800, calculated over 30 years at a discount rate of 5%. Detailed cost calculations are provided in **Appendix A**.

4.3 ALTERNATIVE 3: PROTECTIVE COVER

Under this alternative, the mounds would be graded and a Protective Cover would be placed over the entire area. This alternative serves to: i) reduce the contamination of surface water runoff; ii) eliminate human and animal exposure to waste; and iii) minimize the risk of an unplanned detonation. However, contaminants would continue to leach into the sediment and groundwater beneath the cover material.

Either sand or soil could be used to construct the cover. However, sand is more capable of dispersing blast effects than other types of soil due to the fact that sand grains are not as cohesive as other soil materials and would absorb blast impulses as the energy passes through the sand bed. In addition, shock waves and blast overpressures are attenuated to a greater extent within the air-filled interstices of a sand bed than in less-porous materials where shock is transmitted through the solid matrix. Also, individual sand particles absorb energy by easily shattering and forming smaller grain sizes. In soils which are less porous, more cohesive, or shatter less from blast energy, there is less reduction in blast energy (Backofen, 1976; Bush, 1946).

TABLE 4-2. ESTIMATED COSTS FOR INSTITUTIONAL CONTROLS

ITEM	UNITS	UNIT COST	QUANTITY	TOTAL
CAPITAL COSTS				
Administrative Costs[1]	Site	$2,000	1.0	$2,000.00
Subtotal				**$2,000.00**
		SUBTOTAL		**$2,000.00**
		PROJECT MANAGEMENT AND BASE SUPPORT @ 10%		$200.00
		CONTINGENCY @ 10%		$200.00
		TOTAL CAPITAL COST		**$2,400.00**
ANNUAL O&M COSTS				
Administrative Actions[2]				
5-Year Review (on an annual basis)	Report	$1,000.00	1	$1,000.00
Public Education	Lump Sum	$500.00	1	$500.00
Institutional Controls/Oversight	Lump Sum	$250.00	1	$250.00
Long-Term Maintenance				
Maintenance of Fence/Warning Signs	Lump Sum	$100.00	1	$100.00
		SUBTOTAL		**$1,850.00**
		CONTINGENCY @ 10%		$190
		ANNUAL O&M TOTAL		$2,040
		PRESENT WORTH (30 YR @ 5%)		**$31,400.00**
TOTAL COST				**$33,800.00**

GENERAL:

a. Costs are based on existing site knowledge and are for evaluating remedial alternatives only.
b. Please refer to Appendix A for detailed assumptions and calculations.

ABBREVIATIONS:
O&M - Operation & Maintenance; YR - Year

NOTES:

[1] Costs include GIS entry of land-use restrictions into the Master Plan and other administrative setup costs.
[2] Assumes that administrative actions will be accomplished as part of a site-wide program; thus, costs are approximately 20% of the estimated total.

The following components discussed in **Section 4.2** would also be included as part of Alternative 3: access restrictions and LUCs, public education programs, and five-year reviews. The following additional components are discussed below: site preparation (including removal of vegetation, roadway construction, and establishment of site facilities), cover design and construction, construction of an alternate wetland, closure report, and topographic survey.

Removal of Vegetation. The ground surface must be cleared and grubbed of all vegetation (approximately 1.4 acres) to minimize the generation of gases due to decaying vegetation under the cover.

Establishment of Site Facilities. The costs for site facilities assume that the decontamination pad, materials staging area, and any necessary road upgrades were conducted during previous site activities. Therefore, costs are provided only for the rental of an office trailer and portable toilet.

Cover Design and Construction. The cover would consist of a minimum of 3 ft of sand (or soil); geotextile material; 6 inches of crushed stone (animal intrusion barrier); another layer of geotextile; 6 inches of topsoil; and vegetation. If sand is used, this minimum thickness would contain the detonation of a munition with an explosive weight up to 1 pound (Backofen, 1976; US Army, 1986). Costs assume that conventional equipment would be used, but that UXO contractor personnel would be available on site to identify any potential surface UXO.

Appropriate erosion control measures would also be implemented (including silt fencing and berms, as needed). Long-term maintenance of the cover would include periodic mowing, inspection, and repairs due to settling and erosion.

Construction of an Alternate Wetland. Construction of a cover on the surface of the marsh is likely to alter the nature of the site; therefore, construction of an alternate wetland may be required. Costs for construction of an alternate wetland would include site selection, land purchase[8], planning, and construction.

Closure Report and Topographic Survey. Once the cover has been installed, a closure report would be prepared and a topographic survey would be conducted.

4.3.1 Effectiveness

Overall Protection of Human Health and the Environment. The cover, constructed of either sand or soil, would provide limited protection of human health and the environment by reducing the contamination of surface water runoff and eliminating human and animal exposure to waste. However, it would not completely eliminate contaminant loading to the Creek because infiltration in the form of rain, surface water, and groundwater would permeate the cover.

If constructed of sand, this alternative would minimize the impact of an unplanned detonation, because the minimum 3 ft thickness would be adequate to prevent breaching of the surface by munitions containing up to 1 pound of explosive material. This would be greater than the explosive weight in the types of munitions found at New O-Field [i.e., 57 mm shells contain 0.012 lb of tetryl and 155 mm projectiles contain up to 0.66 lb of tetryl/trinitrotoluene (Yon, 1994)].

Compliance with ARARs. There are no chemical-specific ARARs for debris, aside from the ARARs and TBCs for impacted media (i.e., soil, sediment, groundwater), which would be addressed under a separate action. This alternative would be designed to comply with all action- and location-specific ARARs.

Long-Term Effectiveness and Permanence. The strict access restrictions already in place at APG, along with construction of the cover, additional land-use restrictions, security measures, and maintenance of warning signs would limit human contact and prevent activities which would disturb the waste. However, this alternative would not provide long-term effectiveness and permanence because the source material would be left in place. Further, if source removal is selected as the final remedy in the ROD for New O-Field (anticipated in 2003), removal of the sand cover and source material may eventually be required.

[8] Although Army property would most likely be selected for the alternate wetland, costs for land purchase have been included for equitable comparison of alternatives.

Reduction of Toxicity, Mobility, or Volume Through Treatment. There would be no reduction in toxicity, mobility, or volume of the source material, because no active removal or treatment would be implemented. Exposure to the waste would, however, be minimized through construction of the cover.

Short-Term Effectiveness. Due to the location of New O-Field in the southern portion of the Gunpowder Neck, short-term risks to the public are not anticipated. Potential short-term risks to workers and the environment would be reduced through the use of good engineering practices. Personnel working at the site would be equipped with proper personal protective equipment (PPE) and monitoring equipment to minimize potential exposure. Standard dust-suppression techniques and containment would also be utilized to minimize the windblown emission of contaminated dusts. Silt fences and berms (as needed) would be utilized for erosion control. Skilled UXO contractor personnel would also be present on site during brush clearance and the initial stages of cover construction, to identify any potential surface UXO.

The placement of three feet of cover material in the marsh could also impact the natural attenuation of organic contaminants, by altering microbial diversity and oxidation-reduction (redox) conditions. While the cover material could enhance the degradation rates of some compounds, others could be significantly retarded. For instance, the cover material could transform the surface and shallow regions of the marsh from aerobic to anaerobic conditions, which favor the degradation of parent chlorinated compounds (i.e., tetrachloroethene, trichloroethene, and tetrachloroethane). On the contrary, the aerobic degradation of daughter products (i.e., vinyl chloride), could be negatively impacted.

Due to the proximity of the site to an active bald eagles nest (**Section 3.5.2**), construction activities would not be conducted during eagle-nesting season (mid-December through mid-May). Implementation of this alternative would require approximately 3 months for site setup and construction. Planning, design, regulatory review, down-time due to weather/safety, and long-term O&M are not considered in the estimate for implementation time.

4.3.2 Implementability

Technical Feasibility. This alternative would be moderately implementable. While cover construction is typically a conventional construction process, the placement of sand or soil in this wetland area would be challenging. For example, compaction of the sand/soil will not be possible, because the underlying soil is water-logged. Additional structural support, such as sheet piling, may also be needed to reinforce the boundary of the cover. The potential for encountering UXO further complicates implementation of this alternative.

Yet, once the initial layers of the cover are placed, site restoration would be a relatively simple process. Periodic maintenance including visual inspections and mowing would be required to ensure that effectiveness of the cover is not compromised.

Administrative Feasibility. Administrative implementation of this alternative would require coordination between the Army, EPA, and MDE to ensure continuity of the long-term management and monitoring of the site.

Availability of Materials and Services. Specialized equipment and highly trained personnel would be required for this alternative, but would be readily available.

State Acceptance. There are no comments available for evaluation of the "State Acceptance" criterion at this time because the regulators have not been provided with a formal opportunity to review the detailed analysis of alternatives. State representatives will review this alternative and provide comments which will be addressed in the final version of this EE/CA. Determination of final concurrence by the State will be provided at the conclusion of the public review period and documented in the Action Memorandum.

Community Acceptance. There are no comments available for evaluation of the "Community Acceptance" criterion at this time because the public has not been provided with a formal opportunity to review the detailed analysis of alternatives. It is anticipated that the public will provide formal comments during the public comment period. These comments will then be addressed in the Action Memorandum.

4.3.3 Cost

Costs associated with the components of this alternative are provided in **Table 4-3**. Capital costs are estimated at $981,300 and annual O&M costs are estimated at $4,150. The total present worth of

TABLE 4-3. ESTIMATED COSTS FOR THE PROTECTIVE COVER

ITEM	UNITS	UNIT COST	QUANTITY	TOTAL
CAPITAL COSTS				
Reporting/Work Plans				
Addendum to Work Plan	Report	$1,000	1.0	$1,000.00
Cap Design (30%, 60%, 90%, 100% submittals)	Report	$30,000	1.0	$30,000.00
Closure Report (one report for the entire Pushout Area)	N/A	N/A	N/A	N/A
Subtotal				**$31,000.00**
Site Set-Up				
Office/Storage Trailer & Portable Toilet [1,2]	Month	$650	3.0	$1,950.00
Office/Storage Trailer Setup (setup during previous site activities)	N/A	N/A	N/A	N/A
Decontamination Pad (setup during previous site activities)	N/A	N/A	N/A	N/A
Staging Area (setup during previous site activities)	N/A	N/A	N/A	N/A
Erosion Control Measures (silt fencing and berms, as needed)	LF	$3.00	1,000	$3,000.00
Subtotal				**$4,950.00**
Site Preparation				
Heavy Brush, Medium to Heavy Trees, Clear [3]	Acre	$900	1.4	$1,260.00
UXO Support During Brush Clearance [1]	Day	$1,800	10.0	$18,000.00
Subtotal				**$19,260.00**
Grading of Mounds				
UXO Support (2 teams) [1]	Day	$3,600	13	$46,800.00
Mechanical Excavation & Grading (90% time, 100 CY/DAY) [4]	CY	$100	760	$76,000.00
Mechanically Assisted Manual Excavation (10% of time, 15 CY/DAY) [5]	CY	$714	84	$59,976.00
Subtotal				**$182,776.00**
Construction of Cover				
UXO Support (2 teams) [1]	Day	$3,600	40	$144,000.00
Field Personnel (QC, Supervisor, & 2 Technicians w/Per Diem)	Day	$1,970	40	$78,800.00
Bin Block Containment Wall [6]	Block	$46	333	$15,318.00
Sand (3 ft thick - over entire area) [6]	CY	$20	7,007	$140,140.00
Rough Grading of Sand [3]	SY	$3.54	7,007	$24,805.00
Geotextile (above sand & gravel layers) [3]	SY	$2.20	14,015	$30,833.00
Gravel (6" thick - animal intrusion barrier) [3]	CY	$25	1,168	$28,963.00
Spread Gravel [3]	SY	$2.13	7,007	$14,925.00
Subtotal				**$477,784.00**
Site Restoration				
Topographic Survey (post-construction)	Acre	$1,100	1.4	$1,540.00
Construction of Alternate Wetland	Acre	$50,000	1.4	$70,000.00
Topsoil (6" lifts, furnished & placed) [3]	CY	$23.40	1,168	$27,331.00
Seeding, Vegetative Cover [3]	Acre	$2,196	1.4	$3,074.00
Subtotal				**$101,945.00**
		SUBTOTAL		**$817,715.00**
		PROJECT MANAGEMENT AND BASE SUPPORT @ 10%		$81,771.50
		CONTINGENCY @ 10%		$81,771.50
		TOTAL CAPITAL COST		**$981,300.00**
ANNUAL O&M COSTS				
Administrative Actions [7]				
5-Year Review (on an annual basis)	Report	$1,000.00	1	$1,000.00
Public Education	Lump Sum	$500.00	1	$500.00
Institutional Controls/Oversight	Lump Sum	$250.00	1	$250.00
Long-Term Maintenance				
Sand Cover Maintenance	Year	$1,500.00	1	$1,500.00
Mowing	Events	$80.00	10	$800.00
Maintenance of Fence/Warning Signs	Lump Sum	$100.00	1	$100.00
		SUBTOTAL		**$4,150.00**
		CONTINGENCY @ 10%		$420
		ANNUAL O&M TOTAL		$4,570
		PRESENT WORTH (30 YR @ 5%)		**$70,300.00**
TOTAL COST				**$1,051,600.00**

TABLE 4-3. ESTIMATED COSTS FOR THE PROTECTIVE COVER (CONTINUED)

GENERAL:

a. Costs are based on existing site knowledge and are for evaluating remedial alternatives only.
b. Please refer to Appendix A for detailed assumptions and calculations.

ABBREVIATIONS:

CY - Cubic Yard; H&S - Health & Safety; LF - Linear Foot; N/A - Not Applicable; O&M - Operation & Maintenance; QC - Quality Control; SY - Square Yard; YR - Year

NOTES:

[1] Costs based on a vendor quote.
[2] The total estimated length of time for site activities is 10 days for site setup & brush removal, 13 days for mound grading, and 40 days for cover installation.
[3] Based on costs obtained from RS Means Environmental Remediation Unit Cost Book (1999), inflated 4% per year.
[4] Excavation rate of 100 cy/d based on similar removal operations at APG. Includes QC, H&S, oversight, and field personnel, equipment, & operators.
[5] Excavation rate of 15 cy/d (including downtime) based on similar removal operations at APG and site conditions. Crew cost of $10,700 per day or $714/cy. Includes QC, H&S, oversight, and field personnel, equipment, and operators.
[6] Based on actual costs for materials at Old O-Field (1996), inflated 4% per year.
[7] Assumes that administrative actions will be accomplished as part of a site-wide program; thus, costs are approximately 20% of the estimated total.

capital and annual O&M costs calculated over 30 years at a discount rate of 5% is $1,051,600. Detailed cost calculations are provided in **Appendix A**.

4.4 ALTERNATIVE 4: EXCAVATION AND OFF-SITE DISPOSAL

This alternative involves excavation and off-site disposal of all waste materials recovered from the Eastern Mounds. As mentioned in **Section 2.3**, the sixteen mounds contain 55 gallon drums, tanks, laboratory tubs, OE scrap, machinery, concrete, rebar, conduit, pipe, and red brick (GP, 2001). The contents of the containers are unknown. The wastestream anticipated from the mounds has been estimated as 40% waste and 60% soil[9], with a total volume of approximately 845 cy.

The site preparation activities discussed in **Section 4.3** are also included as components of this alternative. Details regarding excavation, waste handling, transportation, and off-site disposal are provided below.

Excavation. The UXO contractor will establish safe zones prior to excavation. Upon completion of the surface clearance, low ground pressure excavation equipment will be used. If the number of anomalies detected by the magnetometer prevents the use of mechanical equipment for excavation, then the soil would be hand excavated and screened by trained UXO contractor personnel. The cost estimate assumes that mechanically assisted manual excavation will be required for approximately 10% of the total volume, at an average rate of 15 cy per day (including downtime). The remainder of the volume would be mechanically excavated using conventional equipment, at an average rate of 100 cy per day. The estimated length of time required for excavation is three weeks.

Dewatering may be required during removal of the Eastern Mounds due to the shallow depth to groundwater in the marsh. Costs for rental of a water storage tank and sump pump, piping, chemical analysis, and transportation to the O-Field Groundwater Treatment Facility (GWTF) have been included in the estimate.

The limits of the removal action will be field determined based on visual inspection. Excavation will be halted when it appears that native soil has been encountered. NOTE: Residual soil/sediment contamination will be addressed by the site-wide RI/FS program.

During excavation, contaminated particulates may be generated and dispersed into the atmosphere. Air monitoring, including continuous monitoring for VOCs and dust, would be conducted during all excavation activities. Windblown emissions of contaminated dusts and transport of contamination in surface runoff will be controlled using a water spray or plastic sheeting. Silt fences, berms, and other structures will be utilized as needed to prevent surface runoff and erosion of contaminated soil.

Waste Handling and Transportation/Disposal. Waste materials recovered from this area will be hand-screened for UXO and then mechanically-sorted. After separation from the soil matrix, the waste will be segregated and disposed in accordance with APGR 200-60. For cost estimating purposes, it is assumed that 20% of the waste will be recyclable metal and 20% will be concrete that can be demolished on-site and reused at APG. Based on the waste characterization samples collected from this area in October 2000, the soil from the mounds will be classified as non-hazardous[10]. The costs assume that approximately 760 tons of soil will require off-site disposal; whereas, all liquid wastes will be treated at the O-Field GWTF.

Site Restoration. Unlike activities in the northern portion of the Pushout Area, the removal of the waste from the Eastern Mounds will not require any subsurface excavation. Therefore, backfill will not be necessary. Site restoration activities will include grading and re-vegetation. Either a thin seed bed (harvested from a marsh without phragmites) could be placed in the disturbed area or the phragmites (common reed) could be allowed to re-vegetate the area.

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[9] Conservative estimate for costing purposes only.

[10] The waste characterization sample collected from the Eastern Mounds (A5-H140) was analyzed for TCLP parameters (VOCs, SVOCs, pesticides/polychlorinated biphenyls, herbicides, total metals, pH, reactivity, and ignitability), explosives, organosulfur compounds (including 1,4-dithiane and 1,4-oxathiane), and gross alpha/beta. All detections were below TCLP hazardous waste thresholds (GP, 2001).

Closure Report. After the removal action has been completed and the final inspection approved by the Army, a Closure Report will be completed. Compilation of the information for the report will occur throughout the duration of the removal action. The report will include site drawings, sample data, copies of all manifests, and a detailed narrative of the removal action.

4.4.1 Effectiveness

Overall Protection of Human Health and the Environment. The source material would be removed under this alternative; thereby providing full protection of human health and the environment.

Compliance with ARARs. There are no chemical-specific ARARs for debris, aside from the ARARs and TBCs for impacted media (i.e., soil, sediment, groundwater), which will be addressed under a separate action. This alternative would be designed to comply with all action- and location-specific ARARs.

Long-Term Effectiveness and Permanence. This alternative provides long-term effectiveness and permanence because all source material would be removed from this area.

Reduction of Toxicity, Mobility, or Volume Through Treatment. This alternative would reduce the toxicity, mobility, and volume of contaminants on-site through the removal of all waste. No change in toxicity or mobility within the waste would be provided unless stabilization is required prior to disposal; however, this would result in an increase in total volume for disposal.

Short-Term Effectiveness. Due to the location of New O-Field in the southern portion of the Gunpowder Neck, short-term risks to the public are not anticipated. Potential short-term risks to workers and the environment would be reduced through the use of good engineering practices. Personnel working at the site would be equipped with proper personal protective equipment (PPE) and monitoring equipment to minimize potential exposure. Standard dust-suppression techniques and containment would also be utilized to minimize the windblown emission of contaminated dusts. Silt fences and berms (as needed) would be utilized for erosion control. Skilled UXO contractor personnel would also be present on site during excavation and waste handling activities, to reduce the likelihood of an unplanned detonation.

Due to the proximity of the site to an active bald eagles nest (**Section 3.5.2**), construction activities would not be conducted during eagle-nesting season (mid-December through mid-May). Implementation of this alternative would require approximately 2 months for site setup and construction. Planning, design, regulatory review, down-time due to weather/safety, and long-term O&M are not considered in the estimate for implementation time.

4.4.2 Implementability

Technical Feasibility. This type of removal action has been successfully conducted at various study areas at APG. UXO contractor personnel are specially trained for this type of activity; however, if manual excavation is required it could be an arduous process.

Administrative Feasibility. Implementation of this alternative would require on-site coordination with base support services (i.e., U.S. Army TEU, DSHE Safety, and the APG Fire Department) to ensure adequate response personnel in the event of an emergency.

Availability of Materials and Services. Specialized equipment and highly trained personnel would be required for this alternative, but would be readily available.

State Acceptance. There are no comments available for evaluation of the "State Acceptance" criterion at this time because the regulators have not been provided with a formal opportunity to review the detailed analysis of alternatives. State representatives will review this alternative and provide comments which will be addressed in the final version of this EE/CA. Determination of final concurrence by the State will be provided at the conclusion of the public review period and documented in the Action Memorandum.

Community Acceptance. There are no comments available for evaluation of the "Community Acceptance" criterion at this time because the public has not been provided with a formal opportunity to review the detailed analysis of alternatives. It is anticipated that the public will provide formal comments during the public comment period. These comments will then be addressed in the Action Memorandum.

4.4.3 Cost

Costs associated with the components of this alternative are provided in **Table 4-4**. Capital costs are estimated at $558,200. There are no anticipated long term O&M costs; therefore, the total present worth of capital and annual O&M costs calculated over 30 years at a discount rate of 5% is $558,200. Detailed cost calculations are provided in **Appendix A**.

TABLE 4-4. ESTIMATED COSTS FOR EXCAVATION AND OFF-SITE DISPOSAL

ITEM	UNITS	UNIT COST	QUANTITY	TOTAL
CAPITAL COSTS				
Reporting/Work Plans				
Addendum to Work Plan	Report	$1,000	1.0	$1,000.00
Closure Report (one report for the entire Pushout Area)	N/A	N/A	N/A	N/A
Subtotal				**$1,000.00**
Site Set-Up				
Office/Storage Trailer & Portable Toilet [1,2]	Month	$650	2.0	$1,300.00
Office/Storage Trailer Setup (setup during previous site activities)	N/A	N/A	N/A	N/A
Decontamination Pad (setup during previous site activities)	N/A	N/A	N/A	N/A
Staging Area (setup during previous site activities)	N/A	N/A	N/A	N/A
Erosion Control Measures (silt fencing and berms, as needed)	LF	$3.00	1,000	$3,000.00
Subtotal				**$4,300.00**
Site Preparation				
Heavy Brush, Medium to Heavy Trees, Clear [3]	Acre	$900	1.4	$1,260.00
UXO Support During Brush Clearance [1]	Day	$1,800	10	$18,000.00
Subtotal				**$19,260.00**
Dewatering				
Water Storage Tank (rental of 21,000 gallon tank w/trailer) [1]	Month	$1,850	1.0	$1,850.00
Pump (2-20 GPM)	Month	$300	1.0	$300.00
Piping from Pump to Tank (assume 100 ft total) [1]	20 ft	$105	5.0	$525.00
Analytical (metals, VOCs, & CWM degs) - one sample/tank + dup [1]	Sample	$750	2.0	$1,500.00
Subtotal				**$4,175.00**
Excavation & Materials Handling				
UXO Support During Excavation & Materials Handling (2 teams) [1]	Day	$3,600	16	$57,600.00
Mechanical Excavation (90% time, 100 CY/DAY) [4]	CY	$100	760	$76,000.00
Mechanically Assisted Manual Excavation (10% of time, 15 CY/DAY) [5]	CY	$714	84	$59,976.00
Screening Equipment (purchased during previous site activities)	N/A	N/A	N/A	N/A
Subtotal				**$193,576.00**
Waste Characterization/Confirmation [6]				
Off-Site Lab Analytical for Full TCLP (21 day TAT)	Sample	$901	8	$7,208.00
Subtotal				**$7,208.00**
Waste Transportation/Disposal [7]				
Non-Recycleable Waste T&D (50% of waste volume) [8]	CY	$133	169	$22,477.00
Overpacks of Containerized Wastes (10% of waste volume)[8]	Ton	$800	34	$27,200.00
Recycleable Waste - T only (20% of waste volume) [9]	Load	$120	4	$480.00
Concrete - On-Site Demolition (20% of waste volume) [3]	CY	$120	68	$8,160.00
Non-Hazardous Soil T&D [8,10]	Ton	$160	760	$121,600.00
Decon/Dewatering Water (Transportation to O-Field GWTF) [1]	Trip	$500	1.0	$500.00
Subtotal				**$180,417.00**
Site Restoration				
Rough Grading [3]	SY	$3.54	7007	$24,805.00
Topsoil (6" lifts, off-site) [3]	CY	$23.40	1168	$27,331.00
Seeding, Vegetative Cover [3]	Acre	$2,196	1.4	$3,074.00
Subtotal				**$55,210.00**
		SUBTOTAL		**$465,146.00**
		PROJECT MANAGEMENT AND		$46,514.60
		CONTINGENCY @ 10%		$46,514.60
		TOTAL CAPITAL COST		**$558,200.00**
ANNUAL O&M COSTS				
N/A	N/A	N/A	N/A	N/A
		SUBTOTAL		**$0.00**
		CONTINGENCY @ 10%		$0
		ANNUAL O&M TOTAL		$0
		PRESENT WORTH (30 YR @ 5%)		**$0.00**
TOTAL COST				**$558,200.00**

TABLE 4-4. ESTIMATED COSTS FOR EXCAVATION AND OFF-SITE DISPOSAL (CONTINUED)

GENERAL:

a. Costs are based on existing site knowledge and are for evaluating remedial alternatives only.
b. Please refer to Appendix A for detailed assumptions and calculations.

ABBREVIATIONS:

APG - Aberdeen Proving Ground; CY - Cubic Yard; H&S - Health & Safety; LF - Linear Foot; N/A - Not Applicable; O&M - Operation & Maintenance; QC - Quality Control; SY - Square Yard; YR - Year

NOTES:

[1] Costs based on a vendor quote.

[2] The total estimated length of time for site activities is 10 days for brush removal, 13 days for soil removal, 3 days for materials handling, and 5 days for restoration.

[3] Based on costs obtained from RS Means Environmental Remediation Unit Cost Book (1999), inflated 8%.

[4] Excavation rate of 100 CY/DAY based on similar removal operations at APG. Includes QC, H&S, oversight, and field personnel, equipment, & operators.

[5] Excavation rate of 15 CY/DAY (including downtime) based on similar removal operations at APG and site conditions. Crew cost of $10,700/d, or $714/cy. Includes QC, H&S, oversight, and field personnel, equipment, and operators.

[6] Confirmation sampling may be conducted as needed, in conjunction with ongoing RI/FS activities.

[7] Assumes that the material recovered from the mounds is 40% waste/60% soil. The wastestream is assumed to be 50% "XXX" waste, 10% containerized material (requiring overpacking), 20% recyclable metal, and 20% concrete. The estimated volume is based on the dimensions of the 16 mounds identified in the Site Characterization Report (GP, 2000), which ranged from 10 to 42 ft in diameter and 3 to 5 ft in height (total of approx. 845 cy).

[8] Costs obtained from APG's Hazardous Waste Branch (2001).

[9] Transportation costs for metal recycling assume 18 cy per truck load. If the metal and concrete cannot be recycled/reused, total capital costs could increase by $11,200.

[10] Non-hazardous soil may be used as fill material on APG. Costs for use on-site entail only transportation and spreading costs ($10/ton). If non-hazardous soil is disposed on-site, total capital costs could be reduced to $421,400.

5.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

The following four remedial alternatives were evaluated for the Eastern Mounds in the New O-Field Pushout Area:

- Alternative 1: No Action;
- Alternative 2: Institutional Controls;
- Alternative 3: Protective Cover; and
- Alternative 4: Excavation and Off-Site Disposal.

A comparative analysis of the four alternatives is provided in **Table 5-1**.

5.1 EFFECTIVENESS

5.1.1 Overall Protection of Human Health and the Environment

Alternative 1 does not provide protection of human health or the environment, because no institutional controls or remedial actions would be implemented. Alternative 2 prevents human contact with the source material through the implementation of institutional controls. However, it would not protect the environment because surface water exposure to source material (i.e., potential continuing source to Watson Creek), animal contact with waste, and contaminant leaching to sediment and groundwater would not be prevented.

Alternative 3 provides limited protection of human health and the environment by reducing the contamination of surface water runoff and eliminating human and animal exposure to waste. However, it would not completely eliminate contaminant loading to the Creek because infiltration in the form of rain, surface water, and groundwater would permeate the cover. The cover would also reduce, but not eliminate, the potential risks associated with an unplanned detonation.

Alternative 4 protects human health and the environment by removing the source material from this area.

5.1.2 Compliance with ARARs

There are no chemical-specific ARARs for debris or UXO, aside from the ARARs and TBCs for impacted media (i.e., soil, sediment, and groundwater), which will be addressed under a separate action. All four alternatives would comply with action- and location-specific ARARs.

5.1.3 Long-Term Effectiveness and Permanence

Alternatives 1 and 2 do not provide long-term effectiveness or permanence because the source material would remain in place and no active controls would be taken to reduce exposure. Alternative 3 would eliminate exposure to waste and reduce the risk of an unplanned detonation; but would not prevent future contaminant leaching to sediment and groundwater. Further, if source removal is selected as the final remedy in the ROD for New O-Field (anticipated in 2003), removal of the sand cover and source material may eventually be required. In contrast, Alternative 4 would provide long-term effectiveness and permanence through the removal of the source material.

5.1.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

Alternatives 1 and 2 would not reduce the toxicity, mobility, or volume of the source material, because no active remedial actions would be conducted. Alternative 3 would not reduce toxicity, mobility, or volume, but would minimize exposure. Whereas, Alternative 4 would reduce the volume of source material.

5.1.5 Short-Term Effectiveness

Alternatives 1 and 2 do not involve any risk to the community, workers, or the environment, because no active remedial activities would take place.

Alternatives 3 and 4 pose limited risks to workers and the environment, but these risks would be reduced through the use of good engineering practices (i.e., proper PPE, air monitoring, dust suppression,

TABLE 5-1. COMPARATIVE ANALYSIS OF ALTERNATIVES

Description	EFFECTIVENESS					IMPLEMENTABILITY			COST		
	Overall Protection of Human Health and the Environment	Compliance With ARARs	Long-Term Effectiveness And Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness*	Technical Feasibility	Administrative Feasibility	Availability of Services & Materials	Capital Cost	Annual O&M Cost	Total Present Worth (30 yrs, 5%)
Alternative 1: No Action	• Does not provide protection of human health or the environment.	• There are no action-, location-, or chemical-specific ARARs associated with this alternative.	• Does not provide long-term effectiveness and permanence.	• Does not reduce toxicity, mobility, or volume of contaminants.	• Not applicable.	• Not applicable.	• The five-year review is the only admin. action required, because contamination would remain in place.	• Not applicable.	$0	$1,100	$16,900
Alternative 2: Institutional Controls	• Provides limited protection of human health through the use of access restrictions and land-use controls. • Does not address environmental impacts.	• Same as Alt. 1.	• Same as Alt. 1.	• Same as Alt. 1.	• Same as Alt. 1.	• Same as Alt. 1.	• Requires coordination between the Army, EPA, & MDE to ensure that access restrictions and land-use controls remain in place.	• Same as Alt. 1.	$2,400	$2,040	$33,800
Alternative 3: Protective Cover	• Provides limited protection of human health and the environment. • Eliminates direct contact with source material; but may alter subsurface conditions, thus impacting natural attenuation. • Does not address the impact of sources on groundwater or soil/ sediment.	• There are no chemical-specific ARARs for debris. • Complies with action- and location-specific ARARs.	• Limits direct contact with waste. • But does not provide long-term effectiveness and permanence, because the waste materials would remain in place.	• Same as Alt. 1, except exposure to waste is minimized.	• Limited risk during implementation -- due to the potential for encountering UXO during brush clearance and initial stages of cover construction. • Covering the marsh with several feet of cover material may alter conditions for natural attenuation. • Approximately 3 months for construction.	• Moderately implementable. Cover construction is a conventional construction process, but may be challenged by the location in a wetland area and potential for encountering UXO.	• Requires on-site coordination with base support services (US Army TEU, DSHE Safety, & APG Fire Department. • Also requires coordination btw. the Army, EPA, & MDE to ensure long-term management & monitoring of the site.	• Specialized equipment and highly trained personnel would be required, but would be readily obtainable. • Higher levels of PPE and monitoring may be needed during grading operations.	$981,300	$4,150	$1,051,600
Alternative 4: Excavation & Off-Site Disposal	• Provides complete protection of human health and the environment by removing the source material.	• Same as Alt. 3.	• Provides long-term effectiveness and permanence.	• Reduces the volume of waste.	• Same as Alt. 3; except the potential for encountering UXO persists throughout the project duration (2 months).	• Moderately implementable. Excavation is a conventional construction process, but may be challenged by the potential for encountering UXO.	• Requires on-site coordination with base support services (US Army TEU, DSHE Safety, & APG Fire Department.	• Same as Alt. 3; however, higher levels of PPE and monitoring may be required for a longer duration.	$558,200	$0	$558,200

Notes:

APG = Aberdeen Proving Ground
ARARs = Applicable or Relevant and Appropriate Requirements
CWM = Chemical Warfare Materiel
DSHE = Directorate of Safety, Health and Environment
EPA = Environmental Protection Agency
MDE = Maryland Department of the Environment
NCP = National Oil and Hazardous Substances Pollution Contingency Plan
O&M = Operation and Maintenance
TEU = Technical Escort Unit
US = United States
UXO = Unexploded Ordnance

* Time estimate is for construction; therefore, does not take planning, design, regulatory review, down-time due to weather/safety, or long-term maintenance into consideration.

and erosion control measures). Due to the proximity of the site to an active bald eagles nest (**Section 3.5.2**), construction activities would not be conducted during eagle-nesting season (mid-December through mid-May).

Alternative 3 would also likely alter subsurface conditions in the marsh; thus, impacting natural attenuation. However, it is difficult at this point to estimate whether the overall impacts would be positive or negative. Care would be taken to minimize the impact on surrounding wetland areas. A summary of environmental considerations is provided in **Table 5-2**.

The total estimated time required to implement each of the remedial alternatives is provided in order from the shortest to the longest: Alternatives 1 and 2 (0), Alternative 3 (3 months), and Alternative 4 (2 months). These time estimates are for construction only; therefore, do not take planning, design, regulatory review, down-time due to weather/safety, or long-term maintenance into consideration.

5.2 IMPLEMENTABILITY

5.2.1 Technical Feasibility

Technical feasibility is not a concern for Alternatives 1 and 2, because no remedial actions would take place. The construction of a sand or soil cover (Alternative 3) would be challenged due to the location in a wetland area. For example, compaction of the sand/soil will not be possible, because the underlying soil is water-logged. Additional structural support, such as sheet piling, may also be needed to reinforce the boundary of the cover. In contrast, Alternative 4 is technically feasible, involving a proven technology for removal of the wastes.

5.2.2 Administrative Feasibility

There are no administrative concerns for Alternatives 1 and 2, with the exception of preparation of Five-Year Reviews for Alternative 2. Alternatives 3 and 4 will require extensive coordination with base support services (i.e., U.S. Army TEU, DSHE Safety, and the APG Fire Department) to ensure adequate response personnel in the event of an emergency.

5.2.3 Availability of Services and Materials

There are no services or materials required for Alternatives 1 and 2, because no active remedial action will be conducted. Alternatives 3 and 4 both require specialized equipment and highly trained personnel, but they would be readily obtainable.

5.2.4 State and Community Acceptance

Neither state representatives nor the public have been provided with a formal opportunity to review the detailed analysis of alternatives. Comments received during the review period will be incorporated into the final Action Memorandum.

5.3 COST

Total capital costs and annual O&M costs were estimated for each of the alternatives. Based on these estimated costs, the total present worth from least to most expensive is: Alternative 1 ($16,900), Alternative 2 ($33,800), Alternative 3 ($1,051,600), and Alternative 4 ($558,200).

TABLE 5-2. SUMMARY OF ENVIRONMENTAL IMPACTS

	Alternative 1: No Action	**Alternative 2: Institutional Controls**	**Alternative 3: Protective Cover**	**Alternative 4: Excavation & Off-Site Disposal**
Wetlands	None	None	Placement of a sand (or soil) cover in this area will change the characteristics of the marsh. Construction of an alternate wetland may be required.	Waste materials are located within the New O-Field marsh; thus, care must be taken to minimize the impact on the wetland area.
Archeological Resources	None	None	None	None
Threatened/Endangered Species	None	None	Care must be taken to schedule construction activities around eagle-nesting season.	Care must be taken to schedule construction activities around eagle-nesting season.
Sediment and Erosion Control	None	None	Requires approval of a sediment and erosion control plan.	Requires approval of a sediment and erosion control plan.
Noise Pollution	None	None	Noise will be generated due to the use of large construction equipment. Controls may be required to minimize impacts during construction.	Noise will be generated due to the use of large construction equipment. Controls may be required to minimize impacts during excavation.
Hazardous Waste	None	None	The cover will prevent human and animal exposure to waste (including potential UXO).	Waste in this area will be removed, thus eliminating any risk to humans or the environment.
Air Pollution	None	None	Airborne emissions of dust and contaminants will be continuously monitored. Dust suppression measures, such as water spray and containment, will be used as needed.	Airborne emissions of dust and contaminants will be continuously monitored. Dust suppression measures, such as water spray and containment, will be used as needed.

6.0 RECOMMENDATION

This EE/CA represents the selected removal action for the Eastern Mounds in the New O-Field Pushout Area, developed in accordance with CERCLA as amended and consistent with the NCP. This decision is based on the administrative record for the site. The action recommended for this site is Excavation and Off-Site Disposal. Visual observations during excavation activities will ensure that all waste has been removed from the area.

Conditions at the site meet the NCP Section 300.415(b)(2) criteria for a removal and approval of the proposed removal action is recommended. The total project cost, if approved, is estimated to be $558,200, which will be paid by the US Army for the Department of Defense.

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APPENDIX A

DETAILED COST CALCULATIONS

DETAILED COSTS FOR TABLE 4-1: ALTERNATIVE 1 - NO ACTION

I. CAPITAL COSTS

None.

II. ANNUAL O&M COSTS

A. Five Year Reviews: Preparation of one report every five years. Assumes that the Five-Year Review will be accomplished as part of a site-wide program; therefore, costs are equal to 20% of the total expense.

Unit Cost = $25,000 per report

Estimated Annual Cost = $5,000 x 0.2 = $1,000 per year

NOTE: There would be no other costs associated with this alternative.

DETAILED COSTS FOR TABLE 4-2: ALTERNATIVE 2 – INSTITUTIONAL CONTROLS

I. CAPITAL COSTS

A. Administrative Costs: This includes GIS entry of land-use restrictions into the Master Plan and other administrative setup costs.

Estimated Cost* = $10,000 x 0.2 = $2,000

II. ANNUAL O&M COSTS

ADMINISTRATIVE ACTIONS

A. Five Year Reviews: Preparation of one report every five years.

Unit Cost = $25,000 per report (costs spread over 5 years)

Estimated Cost* = $5,000 x 0.2 = $1,000 per year

B. Public Education: Costs associated with public meetings, presentations, etc.

Estimated Cost* = $2,500 x 0.2 = $500 per year

C. Institutional Controls/Oversight: In addition to startup costs, there would be annual costs associated with access restrictions, land-use controls, etc.

Estimated Cost* = $1,250 x 0.2 = $250 per year

LONG-TERM MAINTENANCE

D. Maintenance of the Fence and Warning Signs: A galvanized chain-link fence with warning signs is currently posted at New O-Field. However, the following annual costs would be anticipated over the 30 year maintenance period:

Estimated Cost* = $500 x 0.2 = $100 per year

* Assumes all administrative costs will be accomplished as part of a site-wide institutional controls program; therefore, costs are equal to 20% of the total expense.

DETAILED COSTS FOR TABLE 4-3: ALTERNATIVE 3 - PROTECTIVE COVER

I. CAPITAL COSTS

REPORTING/WORK PLANS

A. Addendum to Work Plan: Cost includes draft and final versions of the addendum.

Estimated Cost = $1,000

B. Cap Design: Cost includes 30%, 60%, 90%, and 100% design submittals. Miscellaneous costs include CADD support, oversized drawing reproduction, etc.

Estimated Cost = $30,000

SITE SETUP

C. Site Facilities: Cost includes rental of an office trailer and portable toilet.

- Office/Storage Trailer - One office trailer (50' x 12') furnished with air conditioning and no hookups. Assume a 50 mile round trip (for delivery).

  Unit Costs = $550 per month for rental of trailer (Vendor quote – includes delivery)

- Toilet - One portable chemical toilet (Vendor quote)

  Unit Cost = $100 per month

Estimated Total Cost = $650 x 3 months = $1,950

D. Erosion Control: Costs include silt fencing and berms (as needed).

Unit Cost = $3.00 per ft

Approx. Perimeter of Area = 1,000 ft

Estimated Total Cost = $3 x 1,000 ft = $3,000

SITE PREPARATION

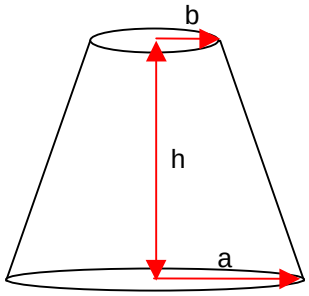
E. Vegetation Clearance: Costs include labor and equipment required for clearing heavy brush & trees.

Unit Cost for heavy brush & trees = $828.78 per acre (RS Means, 1999)

Unit Cost for UXO Support = $1,800 per day

Total Estimated Cost = [(1.4 acres x $828.78) x 1.08] + [$1,800 x 10 days] = $19,260

F. Grading of Mounds: Assumes that mounds will be graded using a combination of mechanical excavation (100 cy/day, 90% of time) and mechanically assisted manual excavation (15 cy/day, 10% of time). UXO support personnel will be required for the duration. Using the formula for a frustum of a cone:



Volume = $[(\pi * h) / (3 * (a - b))] * [a^3 - b^3]$

a (bottom radius, ft)	15	12
b (top radius, ft)	10	8
h (height, ft)	3	4
Volume (cy)	13.8	11.8

Test Dig Reference #	Diameter (ft)	Height (ft)	Estimated Top (ft)	Estimated Volume (cy)
108	15	3	10.0	13.8172
109	10	3	6.7	6.1410
110	12	4	8.0	11.7907
118	26	4	17.3	55.3506
126	12	4	8.0	11.7907
127	10	3	6.7	6.1410
130	12	4	8.0	11.7907
131	18	4	12.0	26.5290
133	42	5	28.0	180.5446
134	20	4	13.3	32.7519
140	40	5	26.7	163.7593
143	12	3	8.0	8.8430
149	15	4	10.0	18.4229
151	20	4	13.3	32.7519
152	40	5	26.7	163.7593
153	35	4	23.3	100.3026
			TOTAL	844.4862

Total Volume of Mounds = 845 cy
Volume (Mechanical Excavation) = 845 cy x 0.9 = 760 cy
Volume (Mech-Assisted Manual Excavation) = 84 cy

Time required for grading mounds = (760 ÷ 100 cy/day) + (84 cy ÷ 15 cy/day) = 13.2 days

Cost for UXO Support = $1,800 per day (per team) x 2 teams x 13 days = $46,800
Cost for Mech-Assisted Manual Excavation = 84 cy x $714 per cy = $59,976
Cost for Mechanical Excavation & Grading = 760 cy x $100 per cy = $76,000

Estimated Cost = $46,800 + $59,976 + $76,000 = $182,776

CONSTRUCTION OF COVER

G. Construction Labor: Costs include a QC person, field supervisor, and 2 field technicians.

Unit Cost = $70 per hour (QC person)
= $60 per hour (field supervisor)
= $37.50 per hour (field technicians)
= $83 per diem

Total Cost (per day) = ($70 + $60 + 2 x $37.50) x 8 hrs + ($83 x 4 people) ≈ $1,970 per day

Estimated Total Cost = $1,970 x 40 days = $78,800

H. UXO Support: Includes costs for 2 teams per day.

Unit Cost for UXO Support = $1,800 per day (per team)

Total Estimated Cost = $1,800 x 2 teams x 40 days = $144,000

I. Construction of Cover: Costs include placement of an average of 3 feet of sand (or soil), 2 layers of geotextile, 6 inches of gravel (animal intrusion barrier), 6 inches of topsoil, and vegetation. Costs include delivery and placement. Also includes the cost for a concrete retaining wall constructed with bin blocks (approximately 6' x 2' x 1.5' per block). RS Means costs have been inflated 4% per year.

Unit Cost = $46 per block (Based on actual costs incurred at Old O-Field)

= $20 per cy for sand (Based on actual costs incurred at Old O-Field for delivered sand)

= $3.28 per sy for rough grading of sand (RS Means, 1999)

= $2.04 per sy for geotextile material (RS Means, 1999)

= $22.96 per cy for gravel (RS Means, 1999)

= $1.97 per sy for spreading gravel (RS Means, 1999)

= $21.63 per cy for topsoil (RS Means, 1999)

= $2,033 per acre for seeding (RS Means, 1999)

Approx. Perimeter of Area = 1,000 ft

Total Surface Area = 63,067 sf ÷ 9 ft^2/sy = 7,007 sy

No. of Blocks Needed = (1,000 ft per row ÷ 6 ft wide blocks) x 2 rows = 333 blocks
Cost of Blocks = 333 blocks x $46 = $15,318

Volume of Sand = 63,067 sf x 3 ft thick ÷ 27 ft^3/cy = 7,007 cy
Cost of Sand = ($20 x 7,007 cy) + ($3.28 x 1.08 x 7,007 sy) ≈ $164,945

Area for Geotextile = 7,007 sy
Cost for Geotextile = $2.04 x 1.08 x 2 layers x 7,007 cy ≈ $30,833

Volume of Gravel = 63,067 sf x 0.5 ft thick ÷ 27 ft^3/cy = 1,168 cy
Cost of Gravel = ($22.96 x 1.08 x 1,168 cy) + ($1.97 x 1.08 x 7,007 sy) ≈ $43,888

Volume of Topsoil = 63,067 sf x 0.5 ft thick ÷ 27 ft^3/cy = 1,168 cy
Cost of Topsoil = $21.63 x 1.08 x 1,168 cy ≈ $27,331

Area for seeding = 7,007 sy
Cost for Seeding = $2,033 x 1.08 x 1.4 acre ≈ $3,074

Estimated Total Cost = $15,318 + $164,945 + $30,833 + $43,888 + $27,331 + $3,074 = $285,389

SITE RESTORATION

J. Topographic Survey: Costs for topographic survey of the area after construction is completed.

Unit Cost = $1,100 per acre

Estimated Cost = $1,100 x 1.4 acres = $1,540

K. Construction of an Alternate Wetland: Once complete, the cover will change the nature of the marsh; therefore, construction of an alternate wetland would be required. Costs include land selection, planning, and construction of the wetland.

Unit Cost = $50,000 per acre

Estimated Cost = $50,000 x 1.4 acres = $70,000

II. ANNUAL O&M COSTS

ADMINISTRATIVE ACTIONS

A-D. Five Year Reviews, Public Education, Institutional Controls/Oversight, and Maintenance of Fence and Warning Signs: Same as Table 4-2.

LONG-TERM MAINTENANCE

E. Maintenance of Cover: Costs include mowing and cover maintenance.

- Mowing - Assume that the area would be mowed approximately once every two weeks for 5 months per year (May to September).

  Unit Cost = $80 per week

- Maintenance of Cover - Maintenance may include repairing the cover due to settling and erosion.

  Unit Cost = $1,500 per year

Estimated Total Cost = ($80 x 10 times) + $1,500 = $2,300 per year

DETAILED COSTS FOR TABLE 4-4: ALTERNATIVE 4 - EXCAVATION AND OFF-SITE DISPOSAL

I. CAPITAL COSTS

REPORTING/WORK PLANS

A. Addendum to Work Plan: Cost includes draft and final versions of the addendum.

Estimated Cost = $1,000

SITE SETUP

B. Site Facilities: Cost includes rental of an office trailer and portable toilet.

- Office/Storage Trailer - One office trailer (50' x 12') furnished with air conditioning and no hookups. Assume a 50 mile round trip (for delivery).

  Unit Costs = $550 per month for rental of trailer (Vendor quote – includes delivery)

- Toilet - One portable chemical toilet (Vendor quote)

  Unit Cost = $100 per month

Estimated Total Cost = $650 x 2 months = $1,300

C. Erosion Control: Costs include silt fencing and berms (as needed).

Unit Cost = $3.00 per ft

Approx. Perimeter of Area = 1,000 ft

Estimated Total Cost = $3 x 1,000 ft = $3,000

SITE PREPARATION

D. Vegetation Clearance: Costs include labor and equipment required for clearing heavy brush & trees.

Unit Cost for heavy brush & trees = $828.78 per acre (RS Means, 1999)

Unit Cost for UXO Support = $1,800 per day

Total Estimated Cost = [(1.4 acres x $828.78) x 1.08] + [$1,800 x 10 days] = $19,260

DEWATERING

E. Dewatering: Due to the location of the excavation in the marsh, extensive dewatering may be required. Costs include tank and pump rental and analytical costs. The costs also assume that all water will be treated at the GWTF.

Unit Costs = $1,850 for rental of 21,000 gallon tank w/ trailer (Vendor quote)

= $300 per month for pump rental (Vendor quote)

= $105 per 20 ft for piping from pump to tank (Vendor quote)

= $750 per sample (metals, VOCs, & CWM degs) - one sample/tank + dup

Total Estimated Cost = ($1,850 x 1 mo.) + ($300 x 1 mo.) + ($105 x 5) + ($750 x 2 samples) = $4,175

EXCAVATION AND MATERIALS HANDLING

F. Excavation: Assumes that a combination of mechanical excavation (100 cy/day, 90% of time) and mechanically assisted manual excavation (15 cy/day, 10% of time) will be used. UXO support personnel will be required for the duration.

Total Volume of Mounds = 845 cy (refer to Page A-4)

Volume (Mechanical Excavation) = 845 x 0.9 = 760 cy
Volume (Mech-Assisted Manual Excavation) = 84 cy

Time required for excavation = (760 ÷ 100 cy/day) + (84 cy ÷ 15 cy/day) = 13.2 days
Time required for additional waste handling = 13 days x 0.25 = 3 days

Cost for UXO Support = $1,800 per day (per team) x 2 teams x 16 days = $57,600
Cost for Mech-Assisted Manual Excavation = 84 cy x $714 per cy = $59,976
Cost for Mechanical Excavation & Grading = 760 cy x $100 per cy = $76,000

Estimated Cost = $57,600 + $59,976 + $76,000 = $193,576

G. Waste Characterization: Assumes that approximately 8 samples will be analyzed for full TCLP criteria.

Unit Costs = $901 per sample (Vendor quote)

Estimated Total Cost = 8 x $901 = $7,208

H. Transportation and Disposal: Assumes that the material excavated from mounds is 40% waste and 60% soil. Costs assume 50% of the waste volume would be considered "XXX" (non-regulated waste), 10% will be containerized (requiring overpacking), 20% will be recycleable, and 20% will be concrete. Also assumes 1.5 tons per cubic yard. (Costs obtained from APG.)

Unit Costs = $133 per cy "XXX" waste (Transportation and Disposal, T&D)

= $800 per ton ($0.40 per lb) for overpacking drums of solvent, etc. (T&D)

= $120 per load for recycleable waste (Transportation only)

= $120 cy for on-site demolition

= $160 per ton ($0.08 per lb) for bulk non-hazardous soil (T&D)

= $500 per trip for decon/dewatering water (Transportation only)

Total Debris = 845 cy x 0.4 = 338 cy
Total Soil = 845 cy x 0.6 = 507 cy

Total "XXX" Waste = 338 cy x 0.5 = 169 cy
Total Overpacked Waste = 338 cy x 0.1 = 34 cy
Total Recycleable Waste = 338 cy x 0.2 = 68 cy ÷ 18 cy/load ≈ 4 loads
Total Concrete = 338 cy x 0.2 = 68 cy
Total Non-Haz. Soil = 507 cy x 1.5 tons/cy = 760 tons

Total Cost = (169 cy x $133) + (34 cy x $800) + (4 loads x $120) + (68 cy x $120)
+ (760 tons x $160) + ($500 x 1)

= $22,477 + $27,200 + $480 + $8,160 + $121,600 + $500 = $180,417

SITE RESTORATION

I. Site Restoration: Includes costs for rough grading, topsoil, and seeding.

Unit Costs = $3.28 per sy for rough grading (RS Means, 1999)

= $21.63 per cy for topsoil (RS Means, 1999)

= $2,033 per acre for seeding (RS Means, 1999)

Area for grading = 63,067 sf ÷ 9 sf/sy = 7,007 sy

Total Cost = ($3.28 x 1.08 x 7,007 sy) + ($21.63 x 1.08 x 1,168 cy) + ($2,033 x 1.08 x 1.4 ac)
= $24,805 + $27,331 + $3,074 = $55,210

II. ANNUAL O&M COSTS

None.