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Final

Feasibility Study
Site 4
St. Juliens Creek Annex
Chesapeake, Virginia

Prepared for

Department of the Navy
Atlantic Division
Naval Facilities Engineering Command
Norfolk, Virginia

Contract No. N62470-95-D-6007
CTO-0027

March 2004

Prepared by

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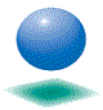

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Executive Summary

This report presents the Feasibility Study for Site 4, Landfill D, at the St. Juliens Creek Annex (SJCA) in Chesapeake, Virginia. CH2M HILL has prepared this report under the Naval Facilities Engineering Command, Atlantic Division (LANTDIV) Comprehensive Long-Term Environmental Action Navy II (CLEAN II) Contract N62740-93-D-4072, Contract Task Order (CTO) 027, for submittal to LANTDIV, the U.S. Environmental Protection Agency (USEPA), and the Virginia Department of Environmental Quality (VDEQ).

Site 4 consisted of a series of unlined trenches and a landfill that reportedly operated from 1970 to 1981. Site 4 covers an estimated 10 acres, divided into three distinct areas based on differences in surface topography and vegetation:

- **Upland area** includes roughly 3.4 acres in the site's northern portion. This area is relatively flat and grassy-covered with little to no brush.
- **Slope area** is west and south of the upland area and comprises approximately 4.8 acres. The area slopes west and south from the upland area to the wetland area of Site 4, described below. Surface vegetation is heavy and consists of low- to medium-dense brush (Honeysuckle, Briars) and stands of mature hardwood and pine trees.
- **Wetland area**—Consists of roughly 1.9 acres in the Site 4's southern portion. Blows Creek, adjacent and south of the wetland area, regularly inundates it.

Along the site's eastern boundary, a drainage ditch diverts stormwater run-on from the upland and slope areas into Blows Creek.

This FS used information gathered from various previous investigations at Site 4, including the Initial Assessment Study (IAS) (NEESA, 1981), Phase II Resource Conservation Recovery Act (RCRA) Facility Assessment (RFA) (A.T. Kearney, 1989), Relative Risk Ranking (RRR) System Data Collection Report (CH2M HILL, 1996), and Remedial Investigation/Human Health Risk/Ecological Risk Assessment (RI/HHRA/ERA or RI) (CH2M HILL, 2003b). The data from these investigations were compiled and evaluated to identify risks posed by Site 4 to human and ecological receptors. Based on the human health and ecological risk assessments results, the following Remedial Action Objectives (RAOs) were established for Site 4:

- Prevent or minimize direct contact of human and ecological receptors with landfill contents.
- Reduce infiltration and any resulting leaching of contaminants from the landfill into groundwater.
- Prevent overland flow entering the site (surface water run-on) and control surface water run-off and erosion.

Presumptive remedies were considered to develop remedial action alternatives for Site 4. Presumptive remedies are preferred remedial technologies that USEPA has identified for

common categories of sites, based on successful implementation of the technologies during previous remedial actions. USEPA has established a presumptive remedy of containment for CERCLA Municipal Landfill Sites (USEPA, 1993a). Municipal landfills are facilities where a combination of household, commercial, and, to a lesser extent, industrial wastes has been co-disposed. USEPA has stated that the presumptive remedy for municipal landfills may also apply to military landfills (USEPA, 1996). The presumptive remedy of containment was applied to Site 4 for the following reasons:

- The landfill is of significant size (10 acres).
- The Site 4 landfill contents are non-hazardous.
- High-hazard military-specific wastes (e.g., unexploded ordnance [UXO]) are not believed to be present in the landfill.

Although the presumptive remedy of containment normally eliminates excavation from consideration as a potential remedial alternative, excavation and offsite disposal was also considered as a potentially viable remedial technology for contamination at Site 4. This technology was considered because the navy would like to compare the feasibility of complete removal of Site 4.

The following remedial alternatives for Site 4 were developed during the FS:

- Alternative 1—No Action
- Alternative 2—Soil Cover
- Alternative 3—RCRA Subtitle D Cap
- Alternative 4—Excavation and Offsite Disposal of Landfill Materials

With the exception of the No Action alternative, each remedial alternative shared the following common components:

- Clearing and grubbing of the upland and slope areas
- Removal of 7.5-ton counterweights from the upland area (consolidation of weights into cover or cap alternative, off-site disposal for complete removal alternative)
- Removal of debris from the wetland area (consolidation of debris into cover or cap alternative, off-site disposal for complete removal alternative)
- Installation of rip-rap upgradient of wetlands
- Sediment removal from the eastern drainage ditch
- Improvements to the eastern drainage ditch
- Construction of a new drainage ditch along the western site boundary (Alternatives 2 and 3 only)

A comparative analysis of each remedial alternative was completed by evaluating the alternatives against the following seven National Contingency Plan (NCP) criteria:

- Protection of human health and the environment
- Compliance with ARARs

- Long-term effective and permanence
- Reduction of toxicity, mobility, and volume
- Short-term effectiveness
- Implementability
- Cost

The Proposed Remedial Action Plan (PRAP) and the Record of Decision (ROD) will address two additional criteria, state acceptance and community acceptance.

Based on the comparative analysis, Alternative 2—Soil Cover was selected as the recommended remedial alternative for Site 4. This alternative would protect human health and the environment by removing contaminated sediment and preventing direct exposure to contaminated soil and landfill contents. Further, the alternative would reduce any future potential risk associated with contaminants leaching into the Columbia and Yorktown aquifers. Alternative 2 complies with chemical-, location-, and action-specific ARARs. With an appropriate O&M plan, Alternative 2 would have a high degree of long-term effectiveness and permanence. Alternative 2 would also be effective in the short-term and it is implementable using standard construction methods and equipment. Other than No Action, Alternative 2 is the most cost-effective of all the alternatives considered for Site 4.

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Acronyms and Abbreviations

AOC	Areas of Concern
ARAR	applicable or relevant and appropriate requirement
BERA	Baseline Ecological Work Plan
bgs	below ground surface
CDN	geocomposite drainage net
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN II	Comprehensive Long-Term Environmental Action Navy II
CTO	Contract Task Order
DRMO	Defense Reutilization and Marketing Office
ERA	Ecological Risk Assessment
FS	Feasibility Study
HHRA	Human Health Risk Assessment
IAS	Initial Assessment Study
IRP	Installation Restoration Program
LANTDIV	Naval Facilities Engineering Command, Atlantic Division
mg/kg	milligrams per kilogram
NACIP	Naval Assessment and Control of Installation Pollutants
NAVFACENGCOM	Naval Facilities Engineering Command
NEESA	Naval Engineering and Environmental Support Activity
NCP	National Contingency Plan
O&M	operation and maintenance
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PPE	personal protective equipment
ppm	parts per million
PRAP	Proposed Remedial Action Plan
PWC	Public Works Center
RAO	Remedial Action Objective
RBC	risk-based criteria
RCRA	Resource Conservation Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation

RI	Remedial Investigation
ROD	Record of Decision
RRR	Relative Risk Ranking
SARA	Superfund Amendments and Reauthorization Act
SIMA	Shore Intermediate Maintenance Activity
SJCA	St. Juliens Creek Annex
SPAWAR	Space and Naval Warfare Systems Command
SVOCs	semivolatile organic compounds
SWMU	Solid Waste Management Unit
TBC	to be considered
TCLP	Toxicity Characteristic Leaching Procedure
USEPA	U.S. Environmental Protection Agency
UXO	unexploded ordnance
VDEQ	Virginia Department of Environmental Quality
VSI	visual site inspection

SECTION 1

Introduction

This report presents the Feasibility Study (FS) for Site 4, Landfill D, at the St. Juliens Creek Annex (SJCA), in Chesapeake, Virginia (Figure 1-1). This FS report is prepared by CH2M HILL under the Naval Facilities Engineering Command (NAVFACENGCOM), Atlantic Division (LANTDIV) Comprehensive Long-Term Environmental Action Navy II (CLEAN II) Contract Number N62470-93-D-4072, Contract Task Order (CTO) 027, for submittal to LANTDIV, the U.S. Environmental Protection Agency (USEPA), and the Virginia Department of Environmental Quality (VDEQ).

The FS was prepared in accordance with the process outlined in the Navy's Installation Restoration Program (IRP), which is consistent with the National Contingency Plan (NCP) and Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA).

1.1 Objectives and Approach

The FS report presents the development and evaluation of remedial action alternatives at Site 4. The criteria for selecting remedies under CERCLA specify that remedial actions must satisfy the following objectives:

- Protect human health and the environment.
- Comply with applicable or relevant and appropriate requirements (ARARs) of federal and state environmental laws within a reasonable timeframe.
- Be cost-effective.
- Use permanent solutions and alternative treatment technologies to the maximum extent possible.
- Satisfy the regulatory preference for treatment that reduces contaminant toxicity, mobility, or volume as a principle element.

The Navy will use the above objectives together with appropriate FS guidance to select an appropriate remedial action alternative at Site 4. To meet the objectives listed above, the scope of the FS includes:

- Identifying and describing candidate remedial action alternatives.
- Conducting a detailed analysis of the remedial action alternatives in accordance with the nine standard USEPA requirements.
- Providing a comparative analysis of each alternative's ability to satisfy the nine criteria detailed in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) §300.430(E)(9)(iii).

1.2 Report Organization

The FS report is organized into the following sections:

- Section 1—Introduction
- Section 2—Site Description, History, and Previous Investigations
- Section 3—Remedial Action Objectives and ARARs
- Section 4—Identification and Screening of Remedial Technologies
- Section 5—Description and Evaluation of Remedial Alternatives
- Section 6—Summary and Conclusions
- Section 7—References

An Executive Summary is presented at the beginning of this report. Figures and tables referenced within the text are at the end of each section. Appendixes are at the end of the report.

SECTION 2

Site Description, History, and Previous Investigations

The SJCA and Site 4 description, background information, and summaries of previous investigations are included in this section.

2.1 Site Description and History

The following sections provide a descriptive summary of both SJCA and Site 4, including discussion of the base mission and history as well as the site's history and current setting.

2.1.1 St. Juliens Creek Annex Description and History

The SJCA Facility is situated at the confluence of St. Juliens Creek and the Southern Branch of the Elizabeth River in the City of Chesapeake, southeastern Virginia (Figure 1-1). The facility covers approximately 490 acres and includes administrative buildings, wharf areas to the Elizabeth River, a central heating plant, numerous non-operational industrial facilities, and miscellaneous structures.

The facility is bordered on the north by the Norfolk and Western Railroad, the City of Portsmouth, and residential areas; west, by residential areas; south, by St. Juliens Creek; and east by the Southern Branch of the Elizabeth River (Figure 1-1). Most surrounding areas are developed and include residences, schools, recreational areas, and shipping facilities for several large industries. The Norfolk Naval Shipyard is approximately 1.5 miles (mi.) north. Some undeveloped areas are in various areas surrounding the facility.

St. Juliens Creek Annex began operations as a naval ammunition facility in 1849. For a majority of its history, the SJCA facility has been used for the storage and transportation of ammunition and ordnance. Processes and operations at the SJCA facility have included general ordnance operations involving wartime transfer of ammunition to various other U.S. Naval facilities throughout the United States and abroad. In addition, the Annex has been involved in specific ordnance operations and processes including those involving black powder operations, smokeless powder operations, projectile loading operations, mine loading, tracer mixing, testing operations, and decontamination operations.

The SJCA facility has also been involved in non-ordnance operations, including degreasing operations, paint shops, machine shops, vehicle and locomotive maintenance shops, pest control shops, battery shops, print shops, electrical shops, boiler plant operations, wash rack operations, potable water, salt water fire protection systems, and fire training operations. Many of these operations have been discontinued, such as locomotive maintenance and printing. Materials stored at the SJCA facility have included oil, ordnance materials, and non-ordnance chemicals. Various parts of the facility are used to store small amounts of waste before transfer to accumulation points.

Activity at SJCA has decreased in recent years. The current primary mission of SJCA is to provide a radar testing range and various administrative and warehousing facilities for nearby Norfolk Naval Shipyard and other local Naval activities. St. Juliens Creek Annex also provides administrative offices, light industrial shops, storage facilities, Defense Reutilization and Marketing Office (DRMO) storage, Space and Naval Warfare Systems Command (SPAWAR), Shore Intermediate Maintenance Activity (SIMA), a radar testing facility, and a cryogenics school for various naval commands.

2.1.2 Site 4 Description

Site 4 covers an estimated 10 acres, approximately 300 ft south of Site 3 (Figure 2-1). The areal extent of Site 4 was previously reported to be about 5 acres. A review of historical aerial photographs and site reconnaissance during Phase I of the RI show that the extent of Site 4 is greater than previously thought, extending west from the original site boundary.

Site 4 can be divided into three distinct areas based on differences in surface topography and vegetation (Figures 2-2 and 2-3):

- **Upland area**—Comprises roughly 3.4 acres in the site's northern portion. This area is relatively flat and grassy-covered with little to no brush.
- **Slope area**—Located west and south of the upland area and comprises approximately 4.8 acres. The area slopes to the west and south from the upland area to the wetland area of Site 4, described below. Surface vegetation is heavy in this area and consists of low to medium dense brush (Honeysuckle, Briars) and stands of mature hardwood and pine trees.
- **Wetland area**—Consists of roughly 1.9 acres in the southern portion of Site 4. The wetland area is regularly inundated by Blows Creek, which lies adjacent and south of the wetland area.

Along the eastern boundary of Site 4, a drainage ditch diverts stormwater run-on from the site's upland and slope areas into Blows Creek (Figure 2-2). An east-west trending drainage ditch is also present along the northern site boundary of Site 4 (Figure 2-2). This ditch appears to receive only surface water run-off from the site's northern portion as well as run-off from adjacent northern areas, which eventually discharges into the wetlands on the site's western side.

2.1.3 Site 4 History

Disposal history at Site 4 is based on information provided in the Initial Assessment Study (IAS) conducted by NEESA in 1983, the Resource Conservation Recovery Act (RCRA) Facility Assessment (RFA) conducted by A.T. Kearney in 1989, and historical aerial photographs. Though SJCA has been active in ordnance related activities, there is no record of ordnance material being disposed at the site. The first indication of activity at Site 4 is a trench identified on a historic aerial photograph from 1961. This trench was approximately 1,000 ft long and was located parallel to and about 500 ft north of Blows Creek. The original trench and others were filled with soil from subsequent trenches. It is not known how many trenches were eventually dug (A.T. Kearney, 1989).

The IAS indicates that around 1970, sanitary landfill operations began at Site 4 in the marshes of Blows Creek. Primarily trash and wet garbage were disposed of. Sanitary landfill operations continued until 1976, at which time trash and garbage were hauled to an off-site facility and inert material was then disposed of at the landfill (NEESA, 1981). The RFA indicates that refuse was disposed of at Site 4 between 1970 and 1981. The wastes managed were primarily trash, wet garbage, construction material, and out-dated civil defense stores. Although the RFA indicated that some solvents, acids, bases, and some polychlorinated biphenyls (PCBs) were disposed of at Site 4, it is assumed that these materials were disposed of prior to 1976 as the IAS states that only inert material was disposed of after 1976. Wastes disposed of at Site 4 were estimated at 1, 500,000 cubic ft. According to Base Public Works Center (PWC) personnel, the PCBs most likely came from ballast containers for fluorescent light fixtures (A.T. Kearney, 1989). It is not known whether or not these ballasts were sealed units.

Sample results from the RI conducted from 1997 to 2001, do not indicate the presence of chlorinated solvents or hazardous materials in soil or groundwater at the site. Based on the findings of the RI and historic disposal dates, Site 4 does not require closure as a hazardous waste landfill.

2.2 Previous Investigations

A summary of previous investigations and results conducted at Site 4 is provided in the following sections.

2.2.1 Initial Assessment Study (IAS)

In 1981, the Navy conducted the IAS as part of the Naval Assessment and Control of Installation Pollutants (NACIP) Program. The purpose was to identify and assess sites that posed a potential threat to human health or the environment because of contamination from past handling of (and operations involving) hazardous materials.

The IAS indicated that a sanitary landfill was started at Dump D (Site 4) in 1970. The landfill operation consisted of a series of unlined trenches filled with trash and wet garbage and the disposal of inert material. The IAS indicated that the first trench was approximately 1,00 ft long and was located parallel to and 500 ft north of Blows Creek. As the trenches were filled, parallel trenches were dug and covered with soil from subsequent trenches. Sanitary landfill operations continued until 1976, at which time trash and garbage were hauled to an off-site facility and inert material was then disposed of at the landfill (NEESA, 1981).

The identified sites, including Site 4, were determined not to pose a threat to human health and the environment, and no confirmation study was recommended.

2.2.2 Phase II RCRA Facility Assessment (RFA)

In 1989, A.T. Kearney, Inc. and K.W. Brown and Associates, Inc. prepared a Phase II RFA. The RFA included a preliminary review of all available relevant documents and a visual site inspection (VSI) for 34 Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs). RCRA Facility Investigations (RFIs) were recommended at 11 SWMUs and AOCs. No sampling was conducted during the RFA. Site 4 was included in this RFA.

The RFA indicated that the use of Dump D (Site 4) was discontinued in 1981. The wastes disposed of were estimated at 1,500,000 cubic ft and included trash, wet garbage, construction materials, solvents, pesticides, acids, bases, PCBs, and out-dated civil defense stores. According to personnel at the Base PWC, the PCBs most likely came from ballast containers for fluorescent light fixtures. It is not known whether or not these ballast containers were sealed units. Drums of unknown materials were stored on the surface and buried at Site 4 and several tanks with undetermined wastes were also once stored in the area. During the 1989 RFA, Site 4 was recommended for an RFI due to the high potential for release to soil due to the unlined nature of the waste disposal area and the moderate to high potential for release to surface water via runoff and groundwater discharge due to the proximity to Blows Creek.

2.2.3 Relative Risk Ranking System Data Collection Report (RRR)

In April 1996, CH2M HILL produced a RRR System Data Collection Report for the SJCA. The report contained results from sampling at 21 sites where data had not previously been available. The sampling effort's goal was to gather data for the Navy to perform assessments of the sites to rank and prioritize response based on level of risk.

Site 4 was sampled as part of the RRR System Data Collection. Two surface soil and three groundwater samples were collected from Site 4. Analytical results were not validated. Pesticides and PCBs were detected in surface soil samples at Site 4. Several polycyclic aromatic hydrocarbons (PAHs) were also observed in the surface soil samples.

Acetone was detected in one groundwater sample located in the northeastern corner of Site 4. No other organic compounds were detected in groundwater samples. Several inorganic analytes were detected in both soil and groundwater samples.

2.2.4 Background Investigation

A Background Investigation was performed at SJCA in 2001 (CH2M HILL, 2001). The investigation's objective was to establish background concentrations of metals, pesticides, and PAHs in surface and subsurface soil and groundwater for use in comparison to IRP site data to better identify release-related constituents of concern. Due to the limited number of groundwater monitoring wells, the groundwater data were inconclusive. Therefore, additional shallow monitoring wells were installed and an additional round of groundwater sampling was conducted in 2003. The results of this sampling event will be submitted in 2004 as an addendum to the *Final Background Investigation Report* (CH2M HILL, 2001).

2.2.5 Baseline Ecological Risk Assessment (BERA) for Blows Creek

The work plan for the Blows Creek Baseline Ecological Risk Assessment (BERA) was finalized in August 2003 (CH2M HILL, 2003a). Field work for the BERA was completed in September 2003. The findings of the BERA will be used to assess potential ecological risk in Blows Creek associated with adverse affects from Navy IRP sites, including Site 4, as well as other non-Navy potential sources. The BERA sampling included sediment samples from the wetland area and eastern drainage ditch adjacent to Site 4. This FS addresses the remedial alternatives for the upland landfill of Site 4; potential historical releases to Blows Creek from Site 4 will be addressed in the BERA.

2.2.6 Remedial Investigation (RI)

The *Final Remedial Investigation/Human Health Risk Assessment/Ecological Risk Assessment Report for Sites 3, 4, 5, and 6, St. Juliens Creek Annex* was completed in March 2003. Surface and subsurface soil, shallow (Columbia Aquifer) and deep (Yorktown Aquifer) groundwater, sediment, and surface water samples were collected and analyzed to characterize the nature and extent of contamination and potential human health and ecological risks posed by contaminants at each site. Additionally, trenching and a geophysical investigation were conducted to determine the horizontal extent of waste and tidal studies were conducted to assess tidal influences of Blows Creek on the Columbia and Yorktown Aquifers. The field activities were conducted in three phases. CDM Federal conducted the first and second from June to November 1997 and from April to October 1999, respectively. CH2M HILL conducted the third phase from June to August 2001.

The RI concluded that there is potential risk to human and ecological receptors from exposure to chemicals in soil (primarily inorganics and PAHs). An FS was recommended to evaluate remedial alternatives. Mitigation of risk through remedial actions for soil will also eliminate concern for continued transport of potential contaminants to Blows Creek via the site-related drainage ditches.

No human health risk drivers were identified for the Columbia Aquifer groundwater. Although human health risk drivers (inorganics and semivolatile organic compounds [SVOCs]) were identified for the deeper Yorktown Aquifer, the SJCA Tier I Partnering Team risk managed constituents found in the Yorktown Aquifer groundwater based on the concentrations of compounds as compared to background and screening values, the low risks identified with the SVOC compounds, and the nature of the groundwater flow conditions.

Further evaluation of the potential for adverse effects to aquatic life in Blows Creek sediment was recommended based on elevated chemical concentrations of inorganics, pesticides, and PAHs. A BERA field investigation was conducted in September 2003 to evaluate sediment in the Blows Creek watershed including the wetland area associated with Site 4 and the portion of the drainage ditch which exhibited elevated mercury concentrations.

Because surface water is transient at Site 4 and the upland ditches provide minimal ecological habitat, there was no significant risk to human health and the environment identified from direct exposure to surface water.

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LEGEND

Site Locations

Activity Boundary

N

0 800 1600 Feet

Figure 2-1
Site Location Map
Site 4 FS
St. Juliens Creek Annex
Chesapeake, Virginia

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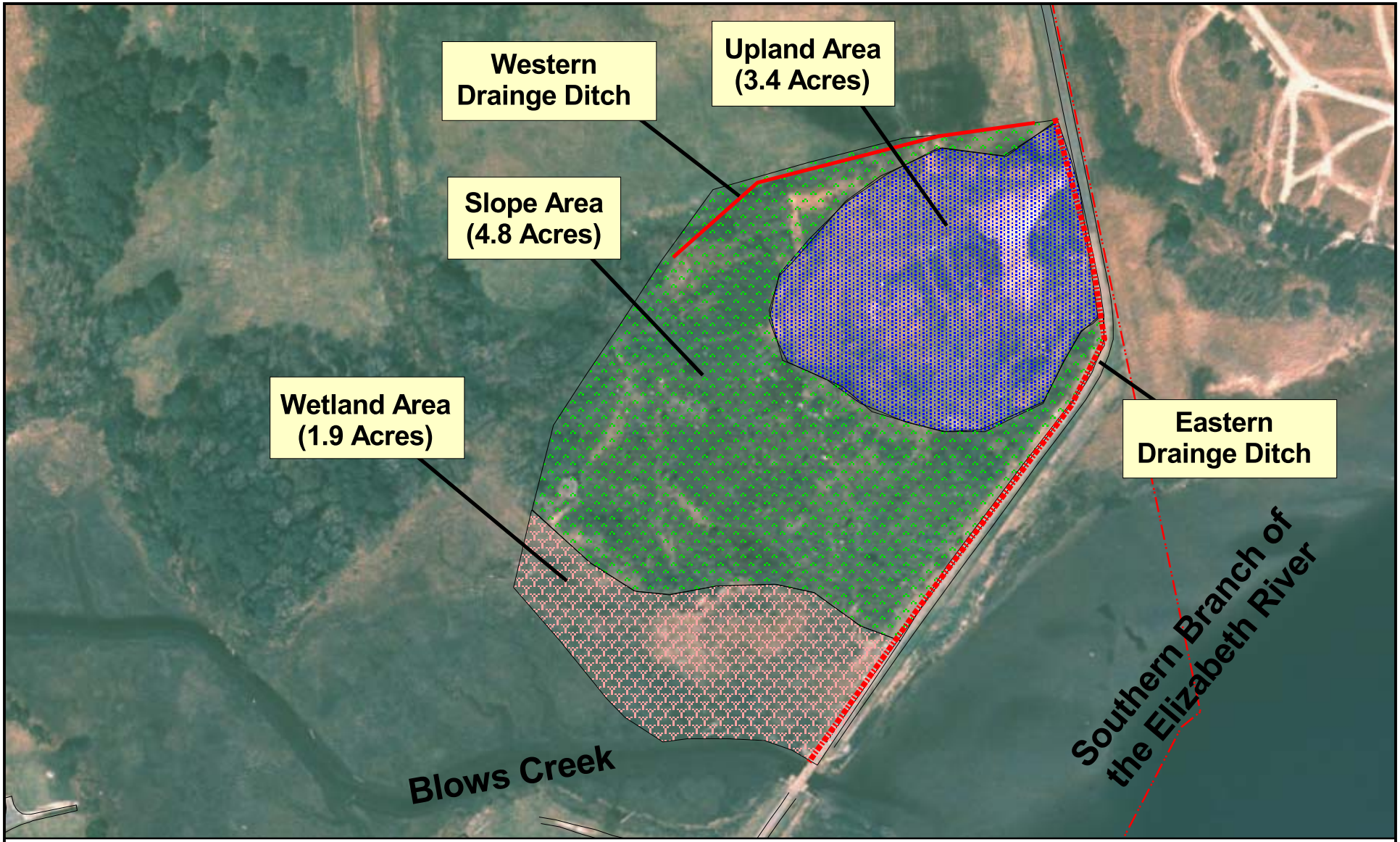

LEGEND
- Upland
- Slope
- Wetland
- Activity Boundary

N

0 300 600 Feet

Figure 2-2
Site 4 Features
Site 4 FS
St. Juliens Creek Annex
Chesapeake, Virginia

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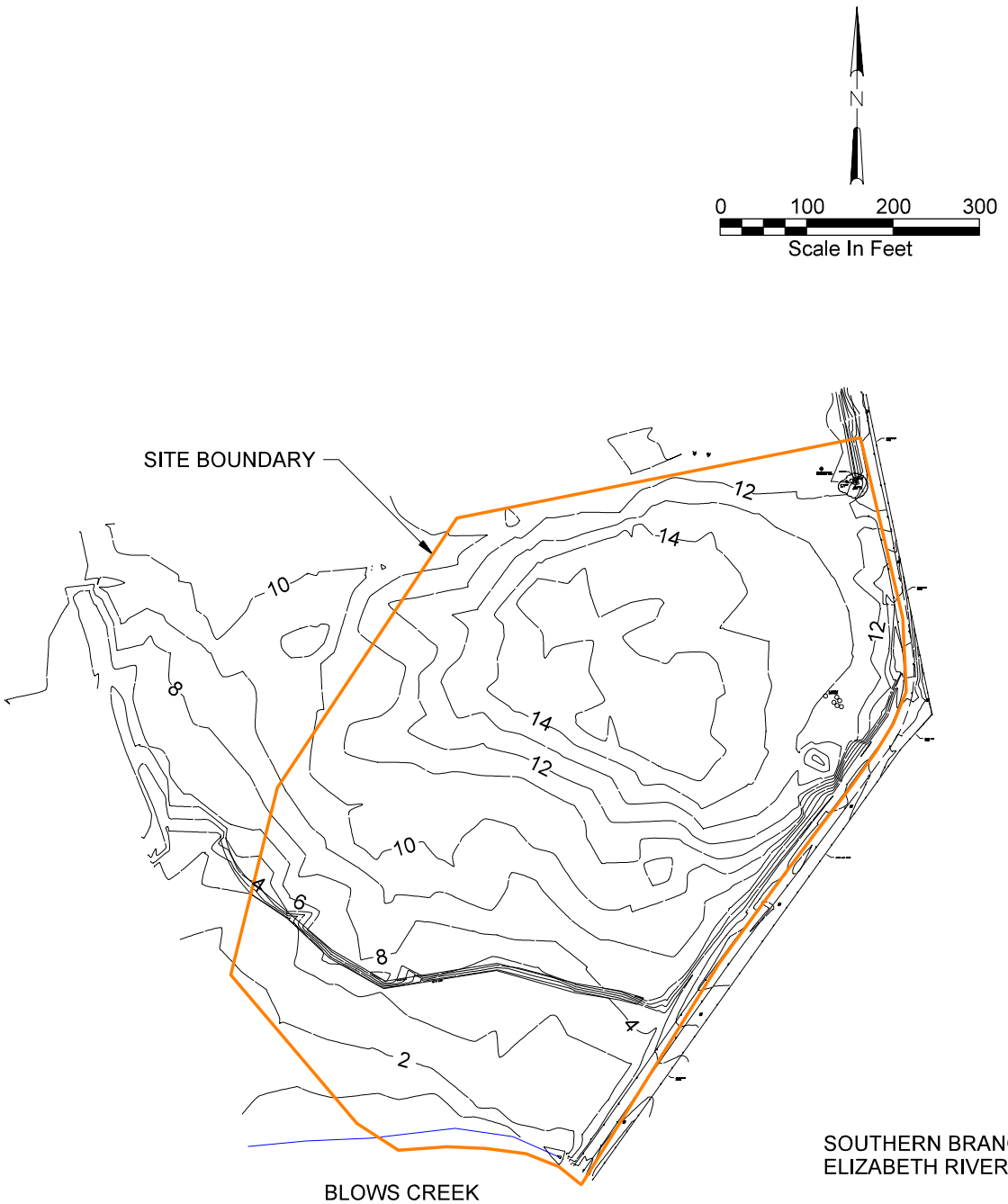

2 CONTOUR LINE

ELEVATIONS ARE SHOWN
IN FEET ABOVE MEAN SEA LEVEL

FIGURE 2-3
SITE 4 SURFACE TOPOGRAPHY
SITE 4
ST. JULIENS CREEK ANNEX, CHESAPEAKE, VA

CH2MHILL

8804fig04.dlv

SECTION 3

Remedial Action Objective and ARARs

This section presents general and site-specific remedial action objectives (RAOs) and identifies corresponding applicable or relevant and appropriate requirements (ARARs) for Site 4.

Because the site characterization and remediation process at SJCA is being conducted in accordance with the guidelines established under CERCLA, the general RAOs are defined by the National Contingency Plan (NCP) and CERCLA as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). CERCLA defines the statutory requirements for developing remedies.

Site-specific RAOs relate to specific contaminated media and the potential exposure routes. Site-specific RAOs, which require an understanding of the contaminants and the physical properties in their respective media, are based on an evaluation of the risks to public health and to the environment and evaluation of the ARARs.

Section 121(d) of SARA mandates that site remediation under CERCLA must achieve a level or standard of control for hazardous substances that at least attains such levels as specified in ARARs. Only promulgated Federal and State laws and regulations can be considered ARARs. In addition to ARARs, proposed rules, guidance documents, directives, etc., that may impact the conduct of a CERCLA action are called "to be considered" (TBC) documents.

3.1 NCP and CERCLA Objectives

The NCP requires that the selected remedy meet the following general RAOs:

- Each remedial action selected shall be protective of human health and the environment [40 Code of Federal Regulations (CFR) 300.430 (f)(ii)(A)].
- Onsite remedial actions selected must attain those ARARs identified at the time of the Record of Decision (ROD) signature [40 CFR 300.430 (f)(ii)(B)].
- Each remedial action selected shall be cost-effective. A remedy shall be cost-effective if its costs are proportional to its overall effectiveness [40 CFR 300.430 (f)(ii)(D)].
- Each remedial action shall use permanent solutions and alternative treatment technologies or resource-recovery technologies to the maximum extent practicable {40 CFR 300.430 (f)(ii)(E)].

The statutory scope of CERCLA was amended by SARA to include the following general objectives for remedial action at all CERCLA sites:

- Remedial actions "shall attain a degree of cleanup of hazardous substances, pollutants, and contaminants released into the environment and of control of further releases at a

minimum, which assures protection of human health and the environment" (Section 121(d)).

- Remedial actions "in which treatment that permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants is a principal element" (Section 121(b)) are preferred. If the treatment or recovery technologies selected are not a permanent solution, an explanation must be published.
- The least-favored remedial actions are those that include "offsite transport and disposal of hazardous substances or contaminated materials without treatment where practicable treatment technologies are available" (Section 121(b)).
- The selected remedy must comply with or attain the level of any "standard, requirement, criteria, or limitation under Federal environmental law…or any promulgated standard, requirement, criteria, or limitation under a State environmental or facility siting law that is more stringent than any Federal standard, requirement, criteria, or limitation" (Section 121(d)(2)(A)).

3.2 Site-Specific Remedial Action Objectives

Both the level of contamination and the potential exposure routes are considered when developing site-specific RAOs for protecting public health and the environment. The future protection of environmental resources and the means of minimizing long-term disruption to existing facility operations are also considered.

The site-specific RAOs for Site 4 are as follows:

- Prevent or minimize direct contact of human and ecological receptors with landfill contents.
- Reduce infiltration and any resulting leaching of contaminants from the landfill into groundwater.
- Prevent surface water run-on and control surface water run-off and erosion.

As discussed in Section 4, this FS will utilize the presumptive remedy of containment, as outlined by the NCP for landfill sites (USEPA, 1993a), to meet the site-specific RAOs. The remedial action alternatives developed in subsequent sections of the FS will utilize containment technologies that will cover the landfill with allowance for covers that extend beyond the limits of the landfill boundary.

Remedial action alternatives must meet standards as defined by the ARARs of USEPA and the Commonwealth of Virginia. If the ARARs do not address a particular situation, remedial actions must be based on the TBC criteria or guidelines. ARARs and the TBC criteria are described below.

3.3 Applicable or Relevant and Appropriate Requirements

The purpose of this section is to identify and summarize those Federal and State laws, regulations, and guidance that affect remediation activities at Site 4.

As required by Section 121 of CERCLA, remedial actions carried out under Section 104 or secured under Section 106 must attain the levels of standards of control for hazardous substances, pollutants, or contaminants specified by the ARARs of federal and commonwealth environmental laws and commonwealth facility-siting laws, unless waivers are obtained. According to USEPA guidance, remedial actions should also be based on non-promulgated TBC criteria or guidelines if the ARARs do not address a particular situation.

ARARs are identified by the USEPA as either being applicable to a situation or relevant and appropriate to it. These distinctions are critical to understanding the constraints imposed on remedial alternatives by environmental regulations other than CERCLA. The definitions of ARARs below are from the USEPA guidance (USEPA, 1988).

"Applicable requirements" are standards and other environmental protection requirements of federal or state law dealing with a hazardous substance, pollutant, or contaminant and its remedial action.

"Relevant and appropriate requirements" are standards and environmental protection criteria of federal or state law that, although not "applicable" to a hazardous substance or remedial action, address situations sufficiently similar to those at the site that their use is suitable.

A requirement may be "relevant" to a particular situation but not "appropriate" because of differences in the duration of the regulated activity or the physical characteristics of the affected media.

A relevant and appropriate requirement must be met as if it were applicable. Relevant and appropriate requirements more stringent than applicable requirements take precedence. However, more discretion is allowed in determining relevant and appropriate requirements than in determining applicable requirements.

Another factor in determining which response or remedial requirements must be met is whether the requirement is substantive or administrative. Onsite CERCLA response actions must meet substantive, but not administrative, requirements. Substantive requirements are those dealing directly with actions or with conditions in the environment. Administrative requirements implement the substantive requirements by prescribing procedures such as fees, permitting, and inspection that make substantive requirements effective. This distinction applies to onsite actions only; offsite response actions are subject to all applicable standards and regulations, including administrative requirements such as permits.

Many Federal and State programs have criteria, advisories, guidelines, and proposed standards that provide recommended procedures if no ARARs exist or the existing ARARs are inadequate. In such instances, these TBC criteria or guidelines should be used to set remedial action levels.

There are three classifications of ARARs and TBCs: chemical-specific, location-specific, and action-specific ARARs. Potential chemical-, location-, and action-specific ARARs for Site 4 are presented in the following subsections.

The remedial action alternatives developed in this FS were analyzed for compliance with the potential Federal and State ARARs. The analysis involved identifying potential requirements for each of the alternatives, evaluating their applicability or relevance and

appropriateness, and determining if the remedial alternatives can achieve the ARARs. The results of the ARAR evaluation are found in Appendix A.

3.3.1 Chemical-Specific ARARs and TBC Criteria

Chemical-specific ARARs set health-based concentration limits or discharge limits in various environmental media for specific hazardous substances, pollutants, or contaminants. Examples of federal chemical-specific ARARs for Site 4 are Toxicity Characteristic Leaching Procedure (TCLP) regulatory levels, which are used to determine whether excavated materials from Site 4 would be classified as a hazardous waste. Although this classification is not anticipated during a remedial action at Site 4, excavated materials will require laboratory analyses via TCLP to properly classify the material for disposal. TBC criteria would include USEPA Region III risk-based criteria (RBC) and other site specific human health and ecological risk based criteria developed for Site 4. A summary of federal and commonwealth chemical-specific ARARs and TBC criteria is provided in Table A-1 of Appendix A.

3.3.2 Location-Specific ARARs and TBC Criteria

Location-specific requirements are design requirements or activity restrictions based on a site's geographic position. An example of a federal location-specific ARAR is Executive Order 11988, which requires that actions taken within a floodplain avoid adverse effects and minimize potential harm to the environment. An analysis of federal and commonwealth location-specific ARARs and TBC criteria is presented in Table A-2 of Appendix A.

3.3.3 Action-Specific ARARs and TBC Criteria

Action-specific requirements set performance, design, or other standards for particular activities in managing hazardous substances or pollutants. RCRA Subtitle D regulations are an example of federal action-specific ARARs for Site 4. These regulations provide criteria for selecting the appropriate offsite disposal facility for materials excavated from the site. The analysis of federal and commonwealth action-specific ARARs is presented in Table A-3 of Appendix A.

SECTION 4

Identification and Screening of Remedial Technologies

USEPA has established presumptive remedies for common categories of CERCLA sites. Presumptive remedies are preferred remedial technologies that have been implemented successfully in the past at certain categories of sites.

USEPA has established a presumptive remedy of containment for CERCLA Municipal Landfill Sites (USEPA, 1993a). Municipal landfills are facilities in which a combination of household, commercial, and, to a lesser extent, industrial wastes have been co-disposed. Per the USEPA Directive No. 9355.0-67FS, *Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills* (USEPA, 1996), the presumptive remedy for municipal landfills may also apply to military landfills (USEPA, 1996) if the facilities meet certain requirements. By comparing site characteristics of Site 4 against the requirements set forth in USEPA's 1996 Directive, the presumptive remedy of containment was deemed applicable to Site 4 for the following reasons:

- The landfill is of significant size (10 acres)
- The contents of the Site 4 landfill are assumed to be non-hazardous based on the type of material reportedly placed at the landfill, and RI analytical results. Based on the dates of disposal, Site 4 is not classified as a hazardous waste landfill and does not require a RCRA Subtitle C Cap. Additionally, based on the dates of disposal and the type of materials disposed of at Site 4, a RCRA Subtitle D Cap is also not required but is included for comparative purposes.
- High-hazard military-specific wastes (e.g., unexploded ordnance [UXO]) are not believed to be present in the landfill

Per another USEPA Directive (*Presumptive Remedies: Policy and Procedures*, No. 9355.0-47FS, September 1993b), presumptive remedies eliminate the need for a broad identification and screening of remedial technologies, a standard step in the FS process. Although the presumptive remedy of containment normally eliminates excavation from consideration as a potential remedial alternative, excavation and offsite disposal was also considered as a potentially viable remedial technology for contamination at Site 4. This technology was considered because buried wastes are not believed to be present at depths greater than 5 ft below ground surface (bgs) at Site 4.

Section 5A provides a description and evaluation of site-specific remedial alternatives for Site 4.

SECTION 5

Description and Evaluation of Remedial Alternatives

Remedial alternatives, including the no action alternative, were developed for Site 4 with the goal of meeting the RAOs identified in Section 3. The detailed evaluation for each alternative against the seven NCP criteria is addressed in this section.

In the following analysis, the sitewide remedial alternatives are evaluated based on each of the seven NCP criteria and in relation to one another. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative, while keeping the potential risks in mind. The comparative analysis will focus on factors that provide distinctions between the alternatives.

5.1 Development of Remedial Alternatives

Four remedial alternatives were developed from the technologies retained following the screening process. The remedial alternatives include the following:

- Alternative 1—No Action
- Alternative 2—Soil Cover
- Alternative 3—RCRA Subtitle D Cap
- Alternative 4—Excavation and Offsite Disposal of Landfill Materials

5.1.1 Common Elements of All Alternatives

Several elements are common to all of the remedial alternatives considered in this FS report. These elements are discussed in the following sections.

5.1.1.1 Clearing and Grubbing

Portions of the site will need to be cleared prior to the commencement of any remedial action. The upland area consists of grassy ground cover with little to no brush. However, the slope area between the upland and wetlands areas consists of a variety of low to medium dense brush (Honeysuckle, Briars) and stands of mature hardwood and pine trees.

Brush and trees cleared from the site will be transported to an offsite location for disposal. No onsite stockpiling or burning will be permitted. Brush and trees within the wetland area are addressed in Section 5.1.1.3.

5.1.1.2 Consolidation or Removal of 7.5-Ton Weights

It has been observed that seven 7.5-ton counterweights are located on top of the ground surface in the upland area. If the alternatives where either a cover or cap is selected, Alternative 2 or 3, these counterweights will be broken up and consolidated the cover or cap

design. If the alternative of complete removal is selected, Alternative 4, then the counterweights will be broken up and hauled offsite as construction debris.

5.1.1.3 Surface Debris Removal from Wetland Area

In May 2003, a site walk was conducted to assess the conditions and types of surface debris at Site 4. During the site walk, it was observed that the northern portion of the wetland area—the area along the toe of slope between the slope and wetland areas—contained little debris. However, a 30x80-ft long swath against Blows Creek was observed to have the highest density of surface debris in the area. Surface debris extended along the edge of Blows Creek for a most of the site. The debris primarily consisted of 8x 8-in. railroad ties in various stages of decay. Other debris included corrugated panels (suspected of containing asbestos), glass, metal cylinders, pipes, and wooden boards. It is unlikely that debris was intentionally buried beneath the ground surface in the wetland area because of the shallow interface between ground water and surface water.

For each remedial alternative considered in the FS, the debris within the wetland area will be removed. For Alternatives 2 and 3, the material will be consolidated into landfill cover or cap. If complete removal of Site 4 is selected, Alternative 4, the debris will be hauled offsite for appropriate disposal.

The surface material will be removed in such a manner as to cause minimal impact to the existing wetland system. To minimize impacts to the wetland area, low-pressure equipment and/or logging mats will be used to remove surface debris from the wetland area. In addition, efforts will be made to spare the higher quality wetland plants during debris removal. Wetland restoration may also include some surficial sediment scraping to lower the ground elevation in order to promote flooding within the wetland area via tidal cycles. These tidal inundations would result in the natural restoration of the wetland area. Under each remedial alternative, it is anticipated that all vegetation will be allowed to recover naturally as opposed to non-natural restoration of wetland vegetation.

A BERA sampling event for the Blows Creek watershed was conducted in September 2003. Sampling included the collection of sediment samples from the wetland area and eastern drainage ditch of Site 4. BERA sampling results will be used to assess the impact to the Blows Creek watershed (including the wetland area of Site 4), recommend further action, and develop remedial goals, if necessary. Therefore, confirmatory sampling following the debris removal from the wetland area at Site 4 will not be collected.

5.1.1.4 Installation of Rip-Rap Upgradient of Wetlands

Rip-rap will be placed along the toe of the slope adjacent to and upgradient of the wetland area. The rip-rap will minimize the erosion of the slope area during high-tide events. Slope erosion could result in the premature loss of wetland area because of the settlement of fines in standing water bodies within the wetland area. The area at the toe of the slope in which rip-rap will be placed is estimated to be 10 ft wide by 600 ft long.

5.1.1.5 Sediment Removal from Eastern Drainage Ditch

Because of the ecological and human-health risks associated with contaminated sediment in the eastern drainage ditch, each remedial alternative will include the removal and offsite

disposal of sediment from this ditch. One foot of sediment will be removed from the floor and side-slopes (each assumed to be 5 ft long) of the drainage ditch.

5.1.1.6 Stormwater Drainage Ditch Improvements and Construction

Based upon previous site visits and a review of surface topography at Site 4, stormwater runoff appears to convey via surficial sheet flow to drainage swales along the eastern and western boundaries, with discharge into the tidal wetlands of Blows Creek. The culvert underneath of the apparent former landfill entrance accepts flow from Site 3 to the north. The culvert's outlet was not located during previous site visits but appears to parallel the eastern side of the landfill and discharge into a drainage swale.

As part of each remedial alternative considered in the FS, an open stormwater drainage ditch will be constructed along the eastern boundary of Site 4. The drainage ditch will be designed to convey stormwater runoff from locations upgradient of Site 4, as well as runoff that falls within Site 4 boundaries. The drainage ditch will be lined with a synthetic geotextile membrane and rip-rap in order to minimize stormwater erosion and contact with native soil. The ditch will traverse approximately 1,000 ft and discharge its load into the tidal wetlands of Blows Creek south of Site 4.

Under Alternatives 2 and 3 only, a new drainage ditch will be constructed along the site's western boundary. This ditch will be lined with erosion matting and graded to convey runoff from the vegetated soil cover to the wetland area adjacent to Blows Creek.

5.2 Evaluation Criteria for Remedial Alternatives

The remedial alternatives developed for Site 4 were evaluated against a common set of criteria. Each alternative was developed to address threats to human health posed by contamination present at Site 4. The NCP requires that the remedial alternatives be evaluated against the nine criteria listed below, as defined in the NCP. This FS addresses the first seven and the ROD for Site 4 will address the last. The nine criteria are:

- Protection of human health and the environment
- Compliance with applicable or relevant and appropriate requirements (ARARs)
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

The detailed alternative analysis is the means for assembling and evaluating technical and policy considerations to develop the rationale for selecting a remedy. The following paragraphs define and detail each of the nine criteria.

5.2.1 Protection of Human Health and the Environment

This evaluation is an assessment of whether each alternative achieves and maintains adequate protection of human health and the environment. The overall appraisal of protection draws on the assessments conducted under other evaluation criteria, especially long term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. Another consideration is the statutory preference for onsite remedial actions.

5.2.2 Compliance with ARARs

This evaluation criterion is used to determine whether an alternative would meet all federal, commonwealth, and local ARARs. When an ARAR is not met, the basis for justifying one of the six waivers allowed under CERCLA would be discussed.

5.2.3 Long-Term Effectiveness and Permanence

Under this criterion the results of a remedial alternative are evaluated in terms of the risk remaining at the site after response objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the actions or controls that may be required to manage the risk posed by treatment residuals or untreated wastes. Factors to be considered and addressed are magnitude of residual risk, adequacy of controls, and reliability controls. Magnitude of residual risk is the assessment of the risk remaining from untreated waste or treatment residuals after the response objectives have been met. Adequacy and reliability of controls is the evaluation of the controls that can be used to manage treatment residuals or untreated wastes that remain at the facility. The evaluation may include an assessment of institutional controls to determine whether they are sufficient to ensure that any exposure to human and ecological receptors is within protective levels.

5.2.4 Reduction of Toxicity, Mobility, and Volume

This evaluation criterion addresses the statutory preference for selecting remedial actions that, as their principal element, use technologies that permanently remediate and significantly reduce the toxicity, mobility, or volume of the hazardous substances. This preference is satisfied when treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, reduction in the total mass of toxic contaminants, irreversible reduction of contaminant mobility, or reduction of total volume of contaminated media. When evaluating this criterion, and assessment is made as to whether remediation is used to reduce the principal threats, including the extent to which toxicity, mobility, or volume are reduced either separately or in combination with one another. Factors that would be focused upon include:

- Remediation processes employed by the remediation
- Amount of hazardous materials that would be remediated
- Degree of expected reduction in toxicity, mobility, or volume measured as a percentage of reduction

- Degree to which the remediation would be irreversible
- Type and quantity of treatment residuals that would remain following remediation
- Whether the alternative would satisfy the statutory preference for treatment as a principal element

5.2.5 Short-Term Effectiveness

This evaluation criterion addresses the alternative's effects during the construction and implementation phase until remedial action objectives (RAOs) are met. Alternatives would be evaluated with respect to their effects on human health and the environment during implementation of the remedial action. The following factors regarding the remedial action objectives would be addressed for each alternative:

- Protection of the community during remedial actions
- Protection of workers during remedial actions
- Environmental impacts during remedial actions
- Time until RAOs are achieved

5.2.6 Implementability

The implementability criterion addresses the technical and administrative feasibility of executing an alternative and the availability of various services and materials required during its implementation. Technical feasibility includes construction, operation, reliability of technology, ease of undertaking additional remedial action, and monitoring. Administrative feasibility refers to the activities needed to coordinate with other offices and agencies (e.g., local permits). Availability of services and materials includes availability of adequate off-facility treatment, storage capacity, and disposal services; necessary equipment and specialists; services and materials; and prospective technologies.

5.2.7 Cost

For the cost analysis of alternatives, the expenditures required to complete each remedial action are estimated in terms of both capital and annual operation and maintenance (O&M) costs. Using these values, a present worth calculation for each alternative can then be made for comparison.

Capital costs consist of direct and indirect costs. Direct costs include the cost of construction, equipment, land and site development, treatment, transportation, and disposal. Indirect cost includes engineering expenses, license or permit costs and contingency allowances.

Annual O&M costs are the post-construction costs required to ensure the continued effectiveness of the remedial action. Components of annual O&M cost include the cost of operating labor, maintenance materials and labor, auxiliary materials and energy, residue disposal, purchased services, administration, maintenance reserve and contingency funds, rehabilitation, monitoring, and periodic site reviews.

Expenditures that occur over a time period are analyzed using present worth, which discounts all future costs to a common base year. Present worth analyses allows the cost of remedial action alternatives to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all cost associated with the life of the remedial project. Assumptions associated with present worth calculations include a discount rate of 5.1 percent (OMB Circular No. A-94, Appendix C, Revised January 2003), cost estimates in the planning years in constant dollars, and a period of performance that would vary depending on the activity, but would not exceed 30 years (http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html).

The cost estimates for this section are provided to an accuracy within +50 to –30 percent. The alternative cost estimates are in 2003 dollars and based on conceptual design from information available at the time of this study. Cost units were estimated from standard cost estimating manuals (e.g., R.S. Means), comparable projects (e.g., engineering experience), and quotations. The actual project cost would depend on the final scope and design of the selected remedial action, the schedule of implementation, competitive market conditions, and other variables. Most of these factors are not expected to affect the relative cost difference between alternatives.

5.2.8 State Acceptance

This assessment evaluates the possible commonwealth technical and administrative issues regarding each alternative. This report does not discuss this criterion, which would be addressed in the Proposed Remedial Action Plan (PRAP) and Record of Decision (ROD).

5.2.9 Community Acceptance

This assessment evaluates the possible public technical and administrative issues and concerns regarding each of the alternatives. This report does not discuss this criterion, which would be addressed in the PRAP/ROD.

5.3 Detailed Description of Remedial Alternatives

A detailed description of each alternative is provided below. Section 5.4 and Table 5-1 provide detail on the evaluation and comparison of the alternatives considered for Site 4 against evaluation criteria.

5.3.1 Alternative 1—No Action

The no action alternative is required by the NCP and serves as the baseline alternative. All other remedial action alternatives are judged against the no action alternative. Under this alternative, no controls or remedial technologies would be implemented. CERCLA (Section 121(c)), as amended by SARA (1986), requires that the site be reviewed every 5 years since contamination would remain onsite. It is assumed that the current level of maintenance onsite would be maintained.

5.3.2 Alternative 2—Soil Cover

Alternative 2 consists of installing a soil cover over landfill contents at Site 4. Figure 5-1 shows the conceptual design of Alternative 2. The major components of this alternative, in addition to the common elements discussed in Section 5.1, are as follows:

- Cover materials will be placed over the upland and slope areas (approximately 8.2 acres)
- Cover material will be certified clean (Virginia requires a TPH of less than 50 mg/kg and total BTEX less than 10 mg/kg. Other analytical tests may also be considered).
- Cover materials will consist of the following layers (listed from top to bottom):
  - **Topsoil Layer.** The performance standards require the upper 6 inches of the final cover system to consist of topsoil or similar materials capable of sustaining vegetation. Acceptable topsoil is defined as native or amended soil with an organic content of at least 1.5 percent by weight, a pH in the range of 6.0 to 7.0, and a soluble salt concentration less than 500 parts per million (ppm).
  - **Vegetative Support Layer.** The vegetative support layer will consist of a minimum of clean soil fill with a maximum particle size of 3 inches. Since there are no onsite borrow sources for this material, it is expected that the vegetative support layer will be constructed of imported soil materials. These materials will be trucked to the site, spread, and compacted to at least 90 percent relative compaction per ASTM D698 (Standard Proctor) to provide a stable base for the overlying topsoil layer. Below this layer will be the compacted soil base layer, as required, to establish proper slopes for drainage and stability.
  - **Leveling Layer.** A layer of approximately 6 in. of soil will be placed to protect the overlying layers from landfill contents and to build up the appropriate grades specified in the design basis. The leveling layer will be compacted to serve as a proper sub-base for the overlying layers.

A typical soil cover section is displayed in Figure 5-2.

- A stand of vegetation will be established on top of the final cover. Temperature- and drought-resistant vegetation indigenous to the area will be planted. The vegetation will have a root system that does not extend past the vegetative support layer, will require minimal maintenance, can survive in low-nutrient soil, and has sufficient density to control the rate of erosion to recommended levels (less than 2 tons/acre/year).
- Land use restrictions will be incorporated into the Navy's planning documents to prevent future disturbance of the landfill contents beneath the soil cover.
- Groundwater monitoring and five-year site reviews must be conducted. A groundwater monitoring plan will be created during the design phase and should imply a 30-year project life.
- An O&M plan will be implemented at Site 4. O&M will consist primarily of maintaining cover vegetation and stormwater drainage ditches, and preventing erosion.

5.3.3 Alternative 3—RCRA Subtitle D Cap

Alternative 3 consists of installing a RCRA Subtitle D Cap over landfill contents at Site 4. Based on the dates of disposal and the type of materials disposed of at Site 4, a RCRA Subtitle D Cap is not required but is evaluated for comparison only. Figure 5-3 shows the conceptual design of Alternative 3. This alternative's major components, in addition to the common elements discussed in Section 5.1, are:

Alternative 3 consists of installing a cap that incorporates the minimum landfill cover requirements specified by RCRA Subtitle D (40 CFR Part 258). Per those requirements, the low permeability soil layer will be a minimum of 18 in. and the permeability of the soil will be 1×10^{-5} centimeters per second or less. The overall goals of landfill closure under the Subtitle D regulations are to minimize the infiltration of water into the landfill and to maintain the integrity of the cover during the post-closure period by minimizing cover erosion. Subtitle D cap and closure requirements are expanded upon in the seminar publication *Design, Operation, and Closure of Municipal Solid Waste Landfills* (USEPA, 1994).

In addition to the common elements among alternatives (discussed in Section 5.1), the major components of Alternative 3 are as follows:

- Cover materials will be placed over the upland and slope areas (approximately 8.2 acres)
- Cover materials will consist of the following layers (listed from top to bottom):
  - **Topsoil Layer.** The topsoil layer will comprise a 6-in. thickness of soil and consist of imported topsoil and/or a native soil and compost composite. The topsoil layer will be spread by low-ground-pressure equipment and will be compacted only as required for access and stability. The uppermost 2 in. of topsoil will be scarified to provide a good base for seeding.
  - **Vegetative Support Layer.** The vegetative support layer consists of an 18-in.-thick layer of native soil that stores moisture and supports overlying vegetation. It will also acts as a protective layer for the underlying drainage and barrier layers.
  - **Drainage Layer.** RCRA Subtitle D does not require a drainage layer in landfill cover systems. However, previous design experience has shown that a drainage layer is desirable to maintain slope stability and to promote the growth of a healthy stand of vegetation on the cap surface. The drainage layer will consist of a geocomposite drainage net (CDN). The drainage layer is designed to direct water away from the barrier layer and, hence, to decrease the potential for the water to reach the waste. Water that filters through the overlying layers will be intercepted and rapidly moved to an exit drain. Water allowed to accumulate in the cap layers can generate excess pore water pressure above the barrier layer and cause the overlying layers to slide off. During the design phase, the CDN will be designed to provide adequate flow capacity to handle the water infiltrating through the overlying layers.
  - **Barrier Layer.** The barrier layer consists of an 18-in.-thick compacted soil layer that has a maximum hydraulic conductivity of 1×10^{-5} centimeters per second. The barrier layer will be thoroughly compacted to reduce its permeability and to serve as an adequate sub-base for the overlying layers. The material will be imported from an offsite borrow source.

- **Leveling Layer.** A layer of approximately 6 in. of soil will be placed to protect the overlying layers from landfill contents and build up the appropriate grades specified in the design basis. The leveling layer will be compacted to serve as a proper sub-base for the overlying layers.

A typical soil cover section is displayed in Figure 5-4.

- A stand of vegetation will be established on top of the final cover. Indigenous temperature- and drought-resistant vegetation will be planted. The vegetation will have a root system that does not extend past the vegetative support layer, will require minimal maintenance, can survive in low-nutrient soil, and has sufficient density to control the rate of erosion to recommended levels (less than 2 tons / acre / year).
- A passive landfill gas-venting system will not be included with the cap system.
- Land use restrictions will be incorporated into the Navy's planning documents to prevent future disturbance of the landfill contents beneath the soil cover.
- RCRA Subtitle D requires that post-closure care and monitoring be performed for at least 30 years. As part of landfill closure, the owner will prepare a written post-closure care plan and a monitoring plan. The plans will include a maintenance program, an end-use plan, groundwater monitoring, and other monitoring procedures as appropriate for the site.
- Groundwater monitoring and five-year site reviews must be conducted, as required by the NCP. A groundwater monitoring plan will be created during the design phase and should imply a 30-year project life.

5.3.4 Alternative 4—Excavation and Offsite Disposal of Landfill Materials

Alternative 4 consists of excavating soil from the landfill and disposing of the excavated material in an appropriately licensed and permitted disposal facility. A conceptual design for Alternative 4 is displayed in Figure 5-5. The major components of this alternative, in addition to the common elements discussed in Section 5.1, are as follows:

- Soil and landfill contents will be excavated to a depth of 8 ft in the upland area (3.4 acres), 5 ft in the slope area (4.8 acres), and 3 ft in the wetland area (1.9 acres). These quantities were selected based on available site data. It is assumed that these disposal depths will be sufficient to remove landfill contents.
- Installation of well points for dewatering of the excavation. Groundwater will be tested and properly managed to comply with regulatory requirements.
- Excavated soil and landfill contents will be classified as either hazardous or nonhazardous waste based on the results of waste characterization testing.
- Following characterization, the excavated materials will be properly manifested and transported to a landfill facility located within 50 mi. of Site 4.
- The excavated area will be backfilled and graded to allow for surface drainage southward into the wetland area north of Blows Creek.

Figure 5-6 provides a cross-section illustrating the excavation limits proposed under Alternative 4.

5.4 NCP Criteria Evaluation of Remedial Alternatives

The following section evaluates each of the potential remedial alternatives against the NCP criteria that must be satisfied.

Although Site 4 groundwater results from the RI (CH2M HILL, 2003b) indicated MCL and tap water RBC exceedances of inorganics and SVOCs, the SJCA Tier I Partnering Team risk managed constituents found in the groundwater based on the concentrations of compounds as compared to background and screening values, the low risks identified with the SVOC compounds, and the nature of the groundwater flow conditions. Therefore, in the evaluations of alternatives for Site 4, only risks and contamination related to soil, waste, and sediment and the potential for future risk associated with contaminants leaching into groundwater are considered.

5.4.1 Protection of Human Health and the Environment

5.4.1.1 Alternative 1—No Action

Alternative 1 does not achieve chemical-, action-, or location-specific ARARs. Direct contact of human and ecological receptors with impacted soil and with surface debris in the wetland area would not be prevented. In addition, exposure to human and ecological receptors from sediment in the eastern drainage ditch would remain. Surface water run-on, surface water runoff, and erosion would not be minimized within the Site 4 landfill boundaries and the existing wetlands would not be protected. The potential for contaminants leaching into the groundwater would also remain.

5.4.1.2 Alternative 2—Soil Cover

Alternative 2 is considered protective because it reduces the potential of direct human or ecological contact with impacted landfill soil, the landfill materials, and drainage ditch sediment. The cap would also reduce the infiltration of precipitation and the subsequent leaching of contaminants to the groundwater. However, because no system would be constructed within the cover to capture and divert moisture away from the landfill cell, some precipitation would be able to infiltrate the cover and migrate through the landfill materials to the groundwater.

5.4.1.3 Alternative 3—RCRA Subtitle D Cap

Alternative 3 is considered protective because it reduces the potential of direct human or ecological contact with the landfill, the landfill materials, and drainage ditch sediment. The cap would also minimize the penetration of precipitation and the subsequent leaching of contaminants to the Columbia and Yorktown Aquifers. Unlike Alternative 2, a RCRA Subtitle D cap is designed, at a minimum, to meet regulatory solid-waste disposal requirements. A RCRA Subtitle D cap is constructed with a barrier layer and often includes a drainage layer to more effectively divert infiltration water away from the landfill cell. This would reduce the potential of water penetrating the landfill materials and leaching contaminants to the groundwater.

5.4.1.4 Alternative 4—Excavation and Offsite Disposal of Landfill Materials

Alternative 4 is considered protective because it involves the removal of the landfill materials, thereby eliminating the potential for direct human or ecological contact with the landfill contents. Removal also eliminates any future potential risk associated with contaminants leaching into the groundwater.

5.4.2 Compliance with ARARs

5.4.2.1 Alternative 1—No Action

Alternative 1 does not achieve compliance with chemical -specific ARARs. Action- and location-specific ARARs do not apply. Impacted soil, landfill materials, and sediment would remain in place. Surface water run-on, surface water runoff, and erosion would not be minimized within the Site 4 landfill boundaries and the existing wetlands would not be protected. Additionally, the potential for contaminants leaching into groundwater would remain.

5.4.2.2 Alternative 2—Soil Cover

Alternative 2 would achieve compliance with chemical-, action-, and location-specific ARARs. Although impacted soil and landfill materials would remain in place, they are not considered hazardous waste and only require a soil cover. The soil cover would minimize surface water run-on, surface water runoff, and erosion; protect the existing wetlands; prevent exposure to soil and landfill contents; and reduce infiltration through contaminated soil and landfill contents, thereby reducing the potential contribution to groundwater. Impacted drainage ditch sediment would also be addressed. Because no system would be constructed within the cap to capture and divert moisture away from the landfill cell, some precipitation would be able to infiltrate the cap and migrate through the landfill materials to the aquifers.

5.4.2.3 Alternative 3—RCRA Subtitle D Cap

Alternative 2 would achieve compliance with chemical-, action-, and location-specific ARARs. Unlike Alternative 2, a RCRA Subtitle D cap is designed, at a minimum, to meet regulatory solid-waste disposal requirements. A RCRA Subtitle D cap is constructed with a barrier layer and often includes a drainage layer to more effectively divert infiltration water away from the landfill cell. This would reduce the potential of water penetrating the landfill materials and leaching contaminants to the groundwater. Impacted drainage ditch sediment would also be addressed.

5.4.2.4 Alternative 4—Excavation and Offsite Disposal of Landfill Materials

Alternative 4 would achieve compliance with chemical-, action-, and location-specific ARARs for Site 4. By removing the landfill materials, the risk associated with impacted soil, the landfill materials, and sediment would be eliminated. In addition, removal eliminates any future potential risk associated with contaminants leaching into the groundwater.

5.4.3 Long-Term Effectiveness and Permanence

5.4.3.1 Alternative 1—No Action

Alternative 1 does not provide long-term effectiveness and permanence. The risks associated with soil and sediment would not be reduced through this alternative.

5.4.3.2 Alternative 2—Soil Cover

Alternative 2 would eliminate the risk posed by impacted sediment by removing this material from the site. Alternative 2 would minimize the risk associated with surface and subsurface soil by preventing direct contact with the Site 4 landfill contents. Land use restrictions would reduce residual risk by preventing future disturbances of covered media. Covering the landfill with soil, however, will not remove impacted soil or debris from the site.

With a thorough O&M program, the useful life of a soil cover can easily surpass 30 years. The level of effectiveness of this alternative would remain virtually the same over that period. The soil cover would have to be maintained to prevent degradation. The soil cover is expected to be effective and reliable over the long-term if properly designed and maintained.

5.4.3.3 Alternative 3—RCRA Subtitle D Cap

Alternative 3 is identical to Alternative 2 except that a RCRA Subtitle D Cap, rather than a soil cover, would be installed over the upland and slope areas of Site 4. Because of the cap design, Alternative 3 would be more effective in preventing infiltration of surface runoff through the landfill contents and, ultimately, into the Columbia and Yorktown Aquifers.

Similar to Alternative 2, the long-term effectiveness of Alternative 3 hinges on an effective thorough O&M program. The RCRA Subtitle D cap would have to be maintained to prevent degradation. With sufficient O&M, the useful life of a RCRA Subtitle D cap can surpass 30 years.

5.4.3.4 Alternative 4—Excavation and Offsite Disposal of Landfill Materials

Alternative 4 would eliminate risks associated with impacted soil, the landfill materials, and sediment by removing these materials from Site 4. This alternative has a higher degree of permanence than Alternatives 2 and 3 because O&M activities would not be required to prevent exposure to the site.

5.4.4 Reduction of Toxicity, Mobility, and Volume

5.4.4.1 Alternative 1—No Action

Alternative 1 would not provide any reduction of toxicity, mobility, and volume and does not meet the statutory preference for treatment.

5.4.4.2 Alternative 2—Soil Cover

Alternative 2 would reduce contaminant volume by removing impacted sediment from the eastern drainage ditch. Impacted soil and debris in the landfill would remain, but the mobility of these contaminants would be reduced by installing a soil cover that would

reduce the infiltration of surface runoff through the landfill contents. Alternative 2 does not include a treatment component that would reduce the toxicity of contaminants that would remain onsite.

5.4.4.3 Alternative 3—RCRA Subtitle D Cap

Alternative 3 would reduce contaminant volume by removing impacted sediment from the eastern drainage ditch. Similar to Alternative 2, this alternative would reduce the mobility of contamination present in soil and landfill debris through the construction of a RCRA Subtitle D cap. Because the cap will provide a greater degree of protection from infiltrating stormwater than the soil cover prescribed under Alternative 2, Alternative 3 provides a greater reduction in contaminant mobility than Alternative 2. Alternative 3 does not include a treatment component that would reduce the toxicity of contaminants that would remain onsite.

5.4.4.4 Alternative 4—Excavation and Offsite Disposal of Landfill Materials

Alternative 4 will reduce the volume and mobility of contaminants by excavating and removing impacted materials from Site 4 and placing them in an appropriately permitted and licensed landfill facility. Alternative 4 does not include a treatment component that would reduce the toxicity of contaminants transported offsite.

5.4.5 Short-Term Effectiveness

5.4.5.1 Alternative 1—No Action

Implementation of this alternative would result in no short-term change in the level of risk posed by impacted soil and sediment at Site 4.

5.4.5.2 Alternative 2—Soil Cover

Implementation of Alternative 2 will require typical construction activities, such as excavation, placement of fill, and grading. Construction activities would likely take several months. These activities would potentially expose workers to contaminated materials and debris. Workers would be required to receive training and use personal protective equipment (PPE). Implementation of this alternative would result in minimal increased risk to the surrounding community and ecosystems over current conditions because landfill contents will remain in place.

5.4.5.3 Alternative 3—RCRA Subtitle D Cap

The short-term effectiveness of Alternative 3 would be identical to that of Alternative 2, described above.

5.4.5.4 Alternative 4—Excavation and Offsite Disposal of Landfill Materials

Alternative 4 would require similar construction activities (e.g., excavation, grading) to those associated with Alternatives 2 and 3. Because all of the landfill soil and debris would be excavated and hauled offsite under Alternative 4, a greater volume of offsite truck traffic would occur under this Alternative than under Alternatives 2 and 3. This increased traffic poses a slightly higher risk of exposure to communities surrounding Site 4, as compared to Alternatives 2 and 3.

5.4.6 Implementability

5.4.6.1 Alternative 1—No Action

There are no implementability issues associated with Alternative 1.

5.4.6.2 Alternative 2—Soil Cover

Installation of soil cover is a well-established technology. Placement of soil cover material can be done with conventional equipment in a relatively short time. Waste handling, hauling, and disposal are routine operations for waste management contractors. Construction and improvements of drainage ditches are implementable using standard construction methods. To minimize wetland disturbance, low-pressure equipment and/or logging mats would be required to remove debris from the wetlands area of Site 4.

Periodic maintenance would be required to maintain the soil cover's integrity. Landfill contents would remain onsite under this alternative and would require incorporation of land use restrictions in the Navy's planning documents and administrative resources to conduct the 5-year site reviews. Maintenance of the soil cover would also require an annual expenditure of administrative resources. The implementation of land use restrictions would need to be coordinated with the Navy.

5.4.6.3 Alternative 3—RCRA Subtitle D Cap

Although the design of a RCRA Subtitle D cap is more sophisticated than the soil cover prescribed under Alternative 2, capping is a proven technology that could be constructed with conventional equipment in a relatively short timeframe using conventional construction equipment and methods. As noted above, drainage ditch construction and improvements are implementable using standard construction methods. Based on field observations, no technical difficulties are anticipated in implementing this alternative, although low-pressure equipment and/or logging mats would be required to remove debris from the wetlands area of Site 4.

Periodic maintenance will be required to maintain the integrity of the RCRA Subtitle D cap. Landfill contents would remain onsite under this alternative and would require incorporation of land use restrictions in the Navy's planning documents and administrative resources to conduct the 5-year site reviews. Maintenance of the soil cover would also require an annual expenditure of administrative resources. The implementation of land use restrictions would need to be coordinated with the Navy.

5.4.6.4 Alternative 4—Excavation and Offsite Disposal of Landfill Materials

Implementation of this alternative would be the most difficult of the four alternatives. In the upland and slope areas, soil excavation and offsite disposal can be performed using conventional construction equipment and methods. However, the soil removal will be difficult to implement because UXO would be required during construction. Dewatering operations, that also include testing of discharge water, would also be required for this alternative. Low-pressure equipment and/or logging mats would be required to remove debris from the wetlands area of Site 4. Drainage ditch construction and improvements are implementable using standard construction methods.

5.4.7 Cost

5.4.7.1 Alternative 1—No Action

There would be no costs associated with Alternative 1.

5.4.7.2 Alternative 2—Soil Cover

Alternative 2 would have both capital and annual O&M costs. The capital cost associated with constructing the soil cover is estimated to total $1,396,000. O&M costs would include inspection of cover material and drainage ditches, groundwater monitoring and reporting, mowing, and minor repairs to the cover material and ditches. The total O&M cost for the soil cover would be approximately $650,000 (for 30 years). The present worth, based on a 7-percent discount rate, is $1,825,000. Appendix B contains detailed cost data used to prepare the cost estimate.

5.4.7.3 Alternative 3—RCRA Subtitle D Cap

Similar to Alternative 2, both capital and O&M costs are associated with implementing Alternative 3. The capital cost for Alternative 3 is estimated at $2,358,000. O&M activities, which include inspection, groundwater monitoring and reporting, mowing, and minor repairs of erosion-related damage to the cap and drainage ditches, are estimated to cost approximately $650,000 (30 years). The present worth, based on a 7 percent discount rate, is $2,787,000. Appendix B contains detailed cost data used to prepare the cost estimate.

5.4.7.4 Alternative 4—Excavation and Offsite Disposal of Landfill Materials

The capital cost of excavation and offsite disposal of landfill materials is estimated at $10,791,000. There would be no annual O&M activities associated with Alternative 4. Therefore, the present worth of Alternative 4 is $10,791,000. Appendix B contains detailed cost data used to prepare the cost estimate.

5.5 Comparative Analysis of Remedial Alternatives

A comparative analysis of each of the alternative evaluated for Site 4 was completed using a ranking system (1 to 5, with 5 being the highest score) for each of the following seven NCP criteria described earlier in Section 5:

- Protection of human health and the environment
- Compliance with ARARs
- Long-term effective and permanence
- Reduction of toxicity, mobility, and volume
- Short-term effectiveness
- Implementability
- Cost

The PRAP and ROD will address two additional criteria, state and community acceptance.

Table 5-2 summarizes the comparative analysis of remedial alternatives. Based on this analysis, Alternative 2—Soil Cover is the recommended remedial alternative for Site 4.

Table 5-1
Detailed Analyses of Alternatives for Site 4
St. Juliens Creek Annex
Chesapeake, Virginia

Evaluation Criteria	Alternative No. 1 No Action	Alternative No. 2 Soil Cover	Alternative No. 3 RCRA Subtitle D Cap*	Alternative No. 4 Excavation and Offsite Disposal of Landfill Materials
Compliance with ARARs				
Chemical-Specific ARARs	Does not meet Chemical-Specific ARARs. Impacted soil, landfill contents, and sediment would remain in place. Additionally, the potential for contaminants leaching into groundwater would remain.	Meets Chemical-Specific ARARs. Although impacted soil and landfill materials would remain in place, they are not considered hazardous waste and only require a soil cover. The soil cover would minimize surface water run-on, surface water runoff, and erosion; protect the existing wetlands; prevent exposure to soil and landfill contents; and reduce infiltration through contaminated soil and landfill contents, thereby reducing the potential contribution to groundwater. Impacted drainage ditch sediment would also be addressed.	Meets Chemical-Specific ARARs. Impacted soil and landfill materials would remain in place. Unlike Alternative 2, a RCRA Subtitle D cap is designed, at a minimum, to meet regulatory solid-waste disposal requirements. A RCRA Subtitle D cap is constructed with a barrier layer and often includes a drainage layer to more effectively divert infiltration water away from the landfill cell. This would reduce the potential of water penetrating the landfill materials and leaching contaminants to the groundwater. Impacted drainage ditch sediment would also be addressed.	Meets Chemical-Specific ARARs. By removing the landfill materials, the risk associated with impacted soil, the landfill materials, and sediment would be eliminated. In addition, removal eliminates any future potential risk associated with contaminants leaching into the groundwater.
Action-Specific ARARs	Not applicable.	Meets Action-Specific ARARs.	Meets Action-Specific ARARs.	Meets Action-Specific ARARs.
Location-Specific ARARs	Not applicable.	Meets Location-Specific ARARs.	Meets Location-Specific ARARs.	Meets Location-Specific ARARs.
Need for Five Year Review	Impacted soil, landfill materials, and sediment remain on site. Therefore, a five-year review would be required.	Impacted soil, landfill materials, and sediment remain on site. Therefore, a five-year review would be required.	Impacted soil, landfill materials, and sediment remain on site. Therefore, a five-year review would be required.	Not required.

Table 5-1
Detailed Analyses of Alternatives for Site 4
St. Juliens Creek Annex
Chesapeake, Virginia

Evaluation Criteria	Alternative No. 1 No Action	Alternative No. 2 Soil Cover	Alternative No. 3 RCRA Subtitle D Cap*	Alternative No. 4 Excavation and Offsite Disposal of Landfill Materials
Reduction of Toxicity, Mobility, or Volume				
Groundwater	Not Applicable.	Not Applicable.	Not Applicable.	Not Applicable.
Soil/Sediment	Impacted soil and sediment would remain onsite.	Impacted sediment would be removed from the site. Although impacted soil and landfill materials would remain in place, they are not considered hazardous waste and only require a soil cover. The soil cover would minimize surface water run-on, surface water runoff, and erosion; protect the existing wetlands; prevent exposure to soil and landfill contents; and reduce infiltration through contaminated soil and landfill contents, thereby reducing the potential contribution to groundwater.	Impacted sediment would be removed from the site. Impacted soil and landfill materials would remain in place. Unlike Alternative 2, a RCRA Subtitle D cap is designed, at a minimum, to meet regulatory solid-waste disposal requirements. A RCRA Subtitle D cap is constructed with a barrier layer and often includes a drainage layer to more effectively divert infiltration water away from the landfill cell. This would reduce the potential of water penetrating the landfill materials and leaching contaminants to the groundwater.	Impacted soil, landfill materials, and sediment would be removed.
Type and Quantity of Residuals Remaining After Remediation	Impacted soil and sediment would remain onsite.	Impacted soil would remain onsite.	Impacted soil would remain onsite.	Not Applicable.
Time Until Action is Complete	Not Applicable.	The exposure pathways (and therefore risks) associated with impacted soil and landfill materials would be eliminated immediately after construction of soil cover. Risks posed by sediment would be eliminated immediately after impacted sediment is removed and disposed offsite.	The exposure pathways (and therefore risks) associated with impacted soil and landfill materials would be eliminated immediately after construction of the RCRA Subtitle D cap. Risks posed by sediment would be eliminated immediately after impacted sediment is removed and disposed offsite.	Risks posed by impacted soil and sediment would be eliminated immediately after removal and offsite disposal.

Table 5-1
Detailed Analyses of Alternatives for Site 4
St. Juliens Creek Annex
Chesapeake, Virginia

Evaluation Criteria	Alternative No. 1 No Action	Alternative No. 2 Soil Cover	Alternative No. 3 RCRA Subtitle D Cap*	Alternative No. 4 Excavation and Offsite Disposal of Landfill Materials
Implementability				
Ability to Construct and Operate	Not Applicable.	Installation of soil cover is a well-established technology. Placement of soil cover material can be done with conventional equipment in a relatively short time. Waste handling, hauling, and disposal are routine operations for waste management contractors. Construction and improvements of drainage ditches are implementable using standard construction methods. To minimize wetland disturbance, low-pressure equipment and/or logging mats would be required to remove debris from the wetlands area of Site 4.	Although the design of a RCRA Subtitle D cap is more sophisticated than the soil cover prescribed under Alternative 2, capping is a proven technology that could be constructed with conventional equipment in a relatively short timeframe using conventional construction equipment and methods.	Implementation of this alternative would be the most difficult of the four alternatives. In the upland and slope areas, soil excavation and offsite disposal can be performed using conventional construction equipment and methods. However, the soil removal will be difficult to implement because UXO would be required during construction. Dewatering operations, that also include testing of discharge water, would also be required for this alternative. Low-pressure equipment and/or logging mats would be required to remove debris from the wetlands area of Site 4. Drainage ditch construction and improvements are implementable using standard construction methods.
Ease of Implementing Additional Action if needed	Very Easy	Easy	Moderate	Difficult
Ability to Monitor Effectiveness	Not Applicable.	Effectiveness can be monitored through annual inspections of soil cover.	Effectiveness can be monitored through annual inspections of RCRA Subtitle D cap.	Not Applicable.
Cost				
Capital Cost	$0	$1,396,000	$2,358,000	$10,791,000
O&M Cost	$0	$650,000	$650,000	$0
Present-Worth	**$0**	**$1,825,000**	**$2,787,000**	**$10,791,000**

*A RCRA Subtitle D Cap is not required but included for comparison.

Table 5-2
Summary of Detailed Alternatives Analysis for Site 4
St. Juliens Creek Annex
Chesapeake, Virginia

NCP Criteria	Site 4 Remedial Alternatives			
	Alternative 1 No Action	**Alternative 2 Soil Cover**	**Alternative 3 RCRA Subtitle D Cap***	**Alternative 4 Excavation and Offsite Disposal of Landfill Materials**
Protection of Human Health and the Environment	1	4	4	4
Compliance with ARARs	1	5	5	5
Long-Term Effectiveness and Permanence	1	3	3	4
Reduction in Toxicity, Mobility, or Volume	1	4	4	5
Short-Term Effectiveness	1	3	3	2
Implementability	5	4	3	1
Cost	5	4	3	1
TOTAL SCORE	**15**	**27**	**25**	**22**

Notes:

For each NCP criterion, alternatives were scored from 1 (worst) to 5 (best). The alternative with the highest total score (Alternative 2) was selected as the recommended alternative for Site 4.

*A RCRA Subtitle D Cap is not required but included for comparison.

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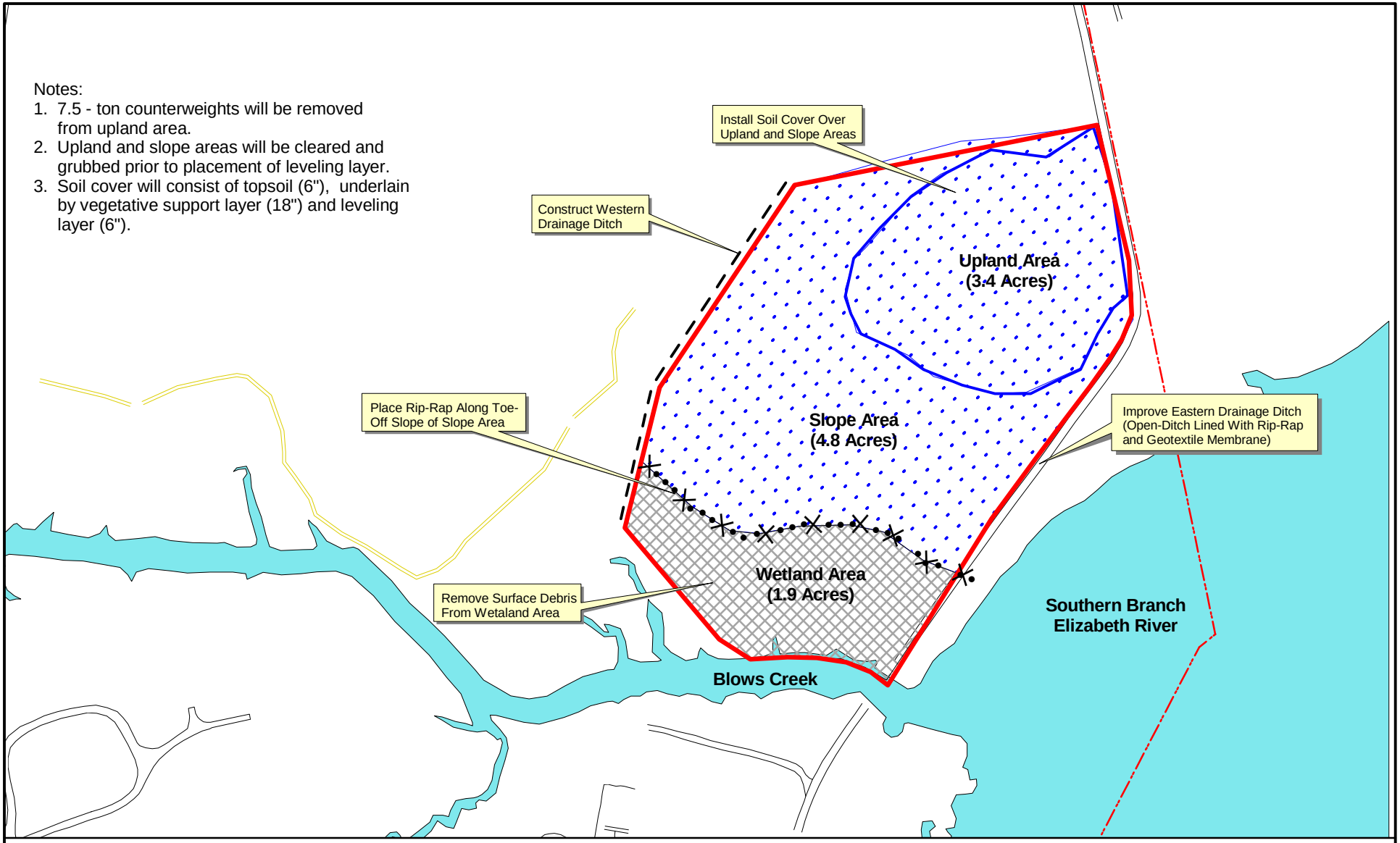

Figure 5-1
Conceptual Design For Alternative 2 - Soil Cover
St. Juliens Creek Annex
Chesapeake, Virginia

CH2MHILL

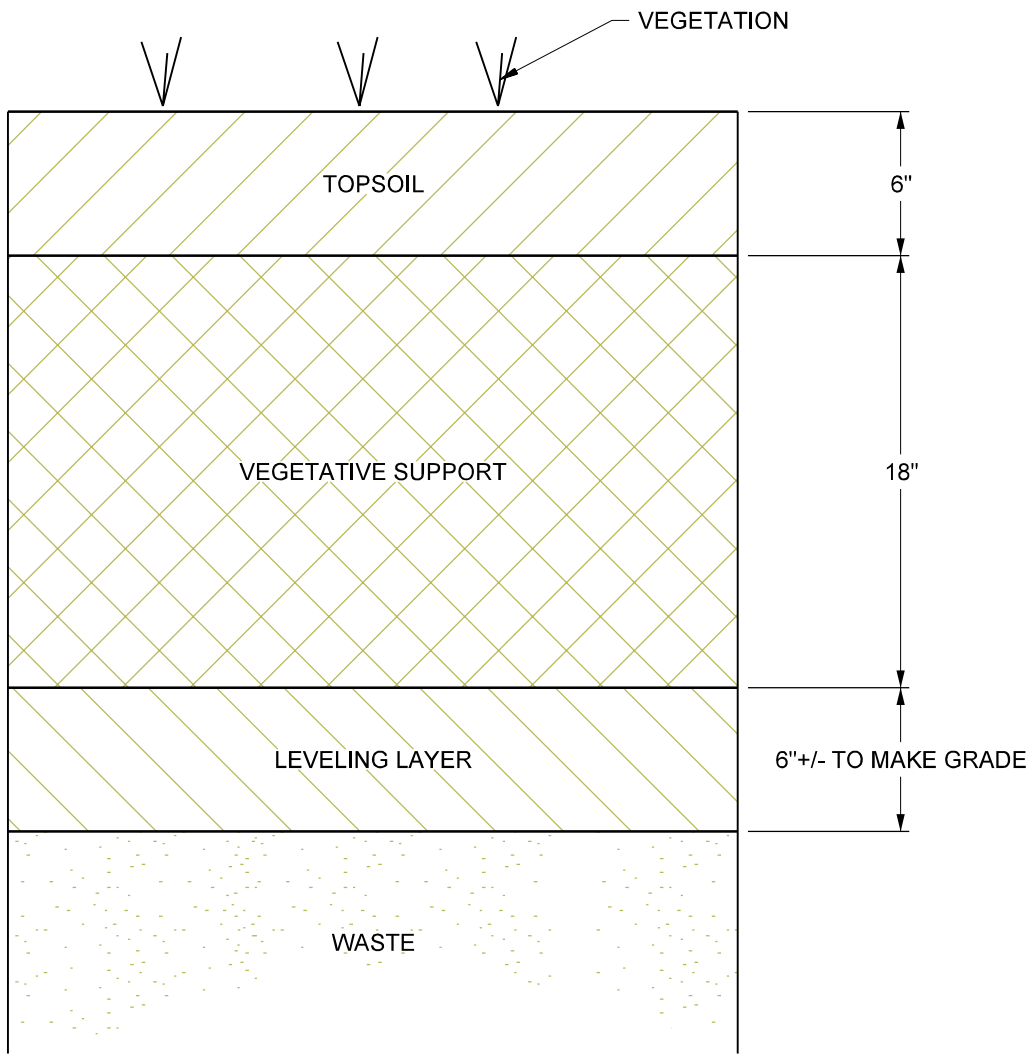

FIGURE 5-2
ALTERNATIVE 2
SOIL COVER - TYPICAL SECTION
SITE 4
ST. JULIENS CREEK ANNEX, CHESAPEAKE, VA

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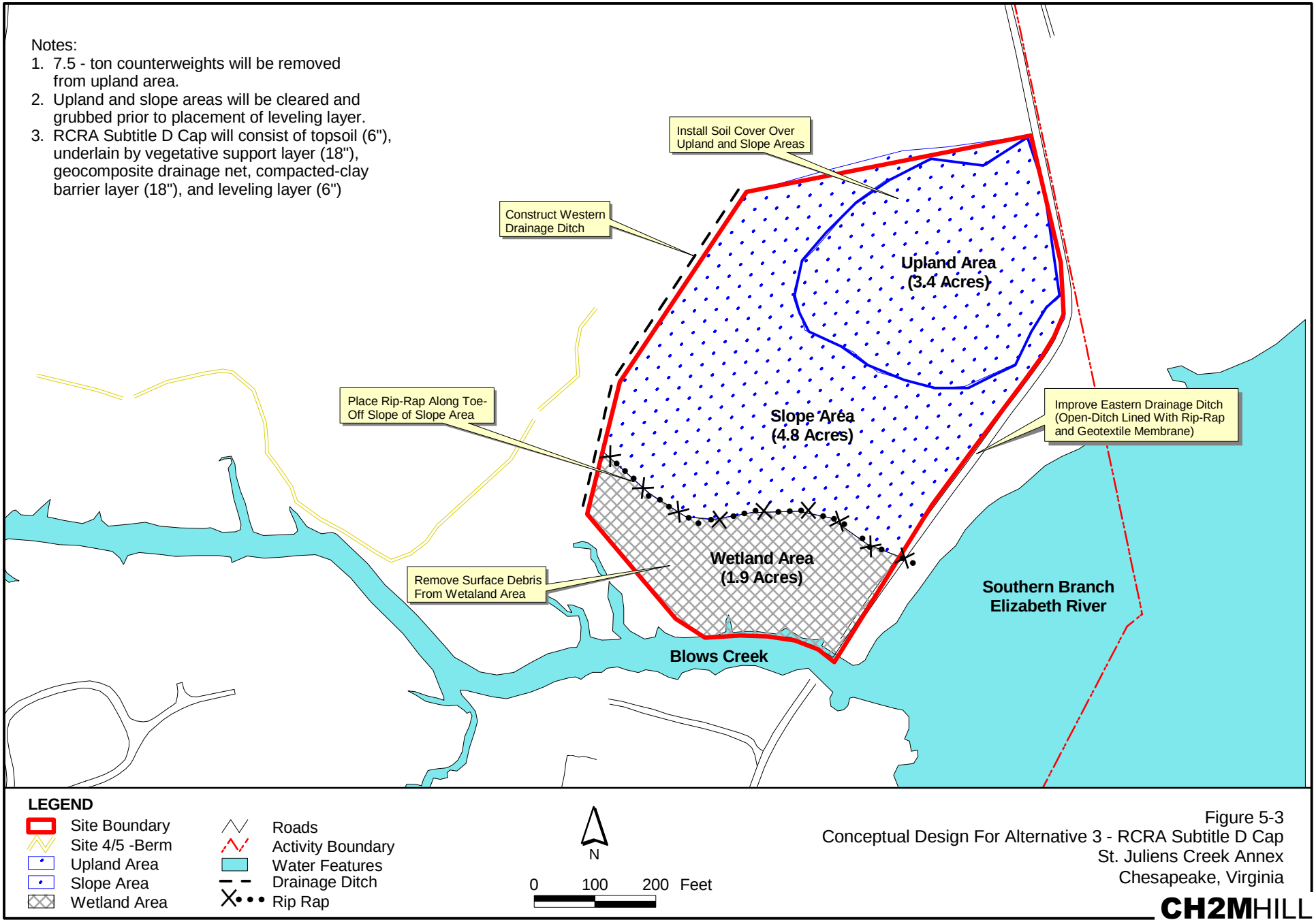

Figure 5-3
Conceptual Design For Alternative 3 - RCRA Subtitle D Cap
St. Juliens Creek Annex
Chesapeake, Virginia

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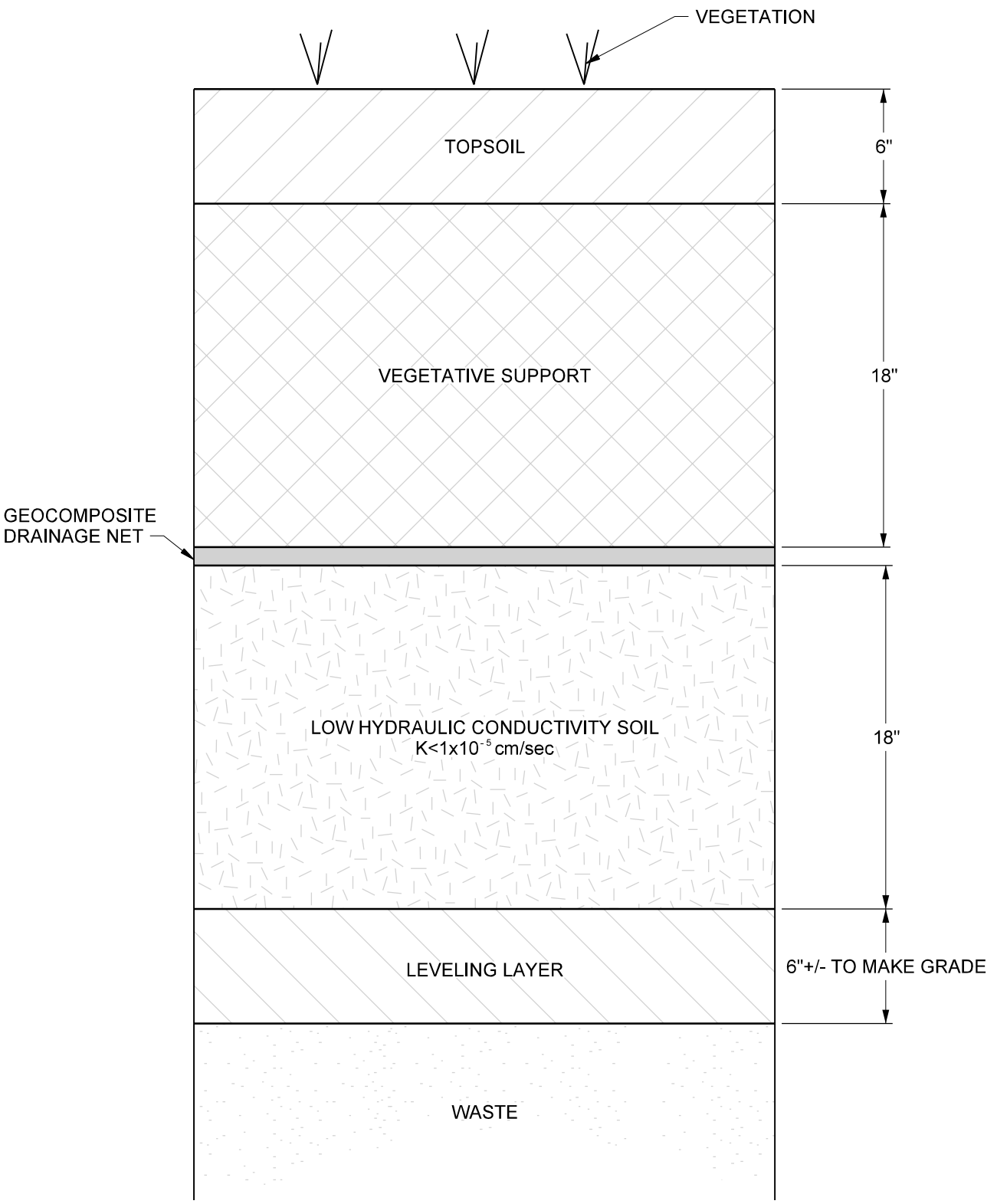

FIGURE 5-4
ALTERNATIVE 3
RCRA SUBTITLE D CAP - TYPICAL SECTION
SITE 4
ST. JULIENS CREEK ANNEX, CHESAPEAKE, VA

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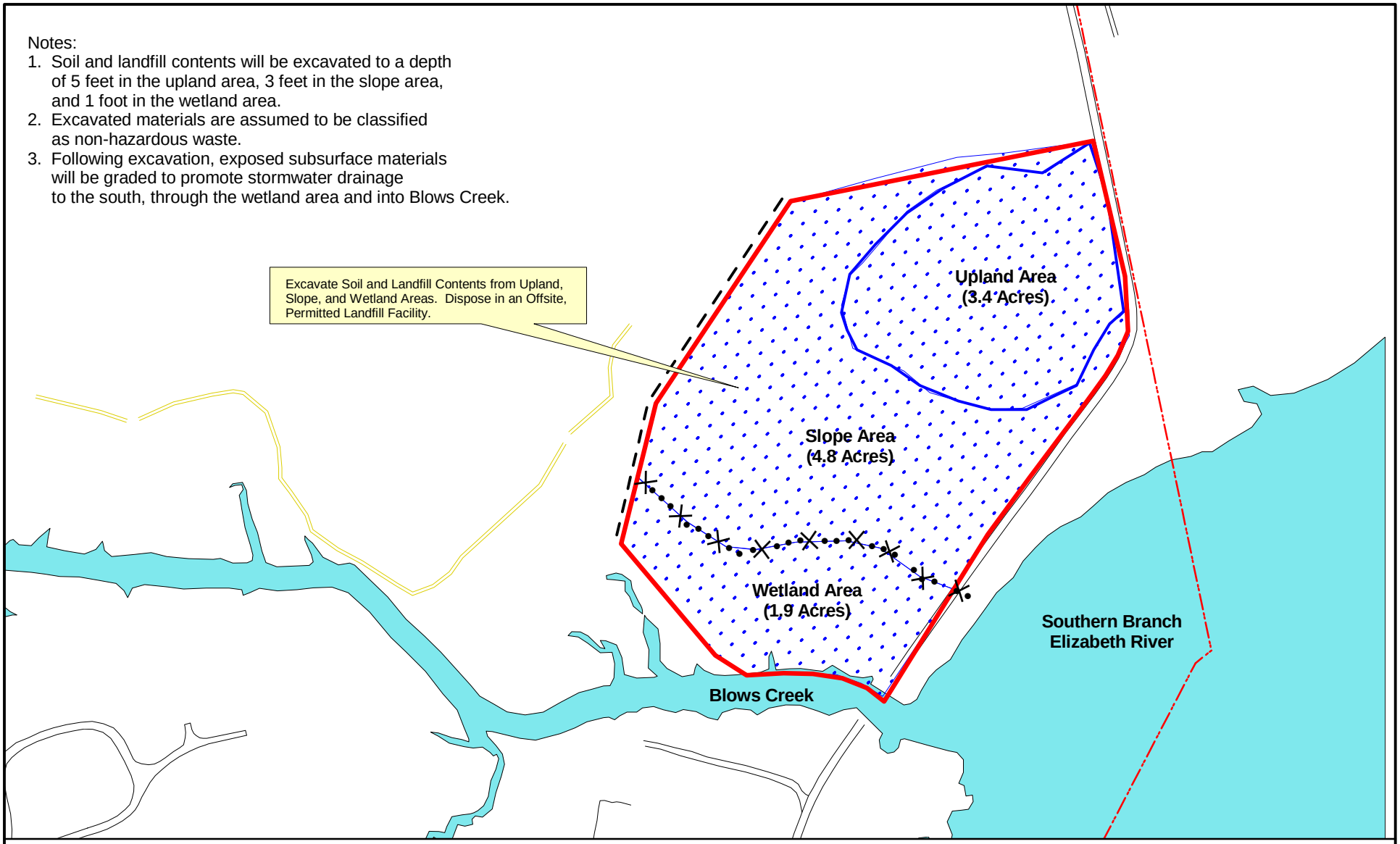
Notes:
1. Soil and landfill contents will be excavated to a depth of 5 feet in the upland area, 3 feet in the slope area, and 1 foot in the wetland area.
2. Excavated materials are assumed to be classified as non-hazardous waste.
3. Following excavation, exposed subsurface materials will be graded to promote stormwater drainage to the south, through the wetland area and into Blows Creek.



LEGEND

- Site Boundary
- Site 4/5 -Berm
- Upland Area
- Slope Area
- Wetland Area
- Roads
- Activity Boundary
- Water Features
- Drainage Ditch
- Rip Rap

N

0 100 200 Feet

Figure 5-5
Conceptual Design For Alternative 4 -
Excavation and Offsite Disposal of Landfill Materials
St. Juliens Creek Annex
Chesapeake, Virginia

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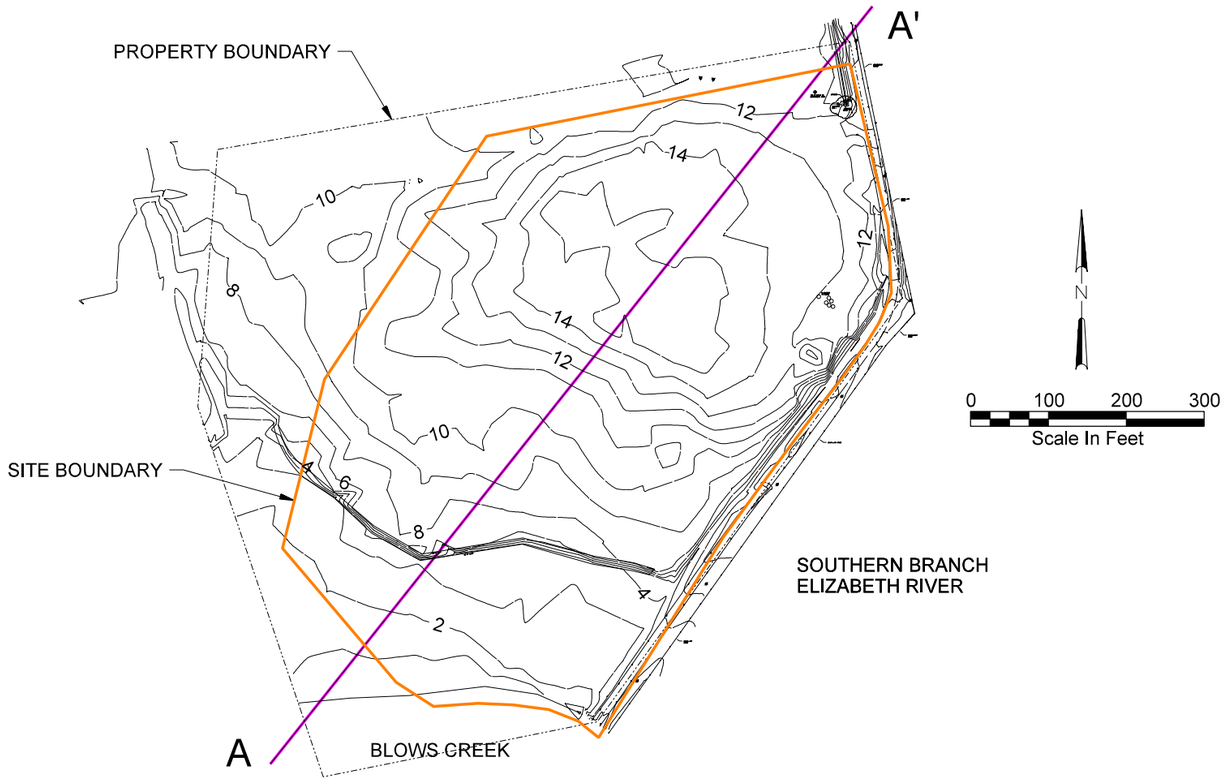

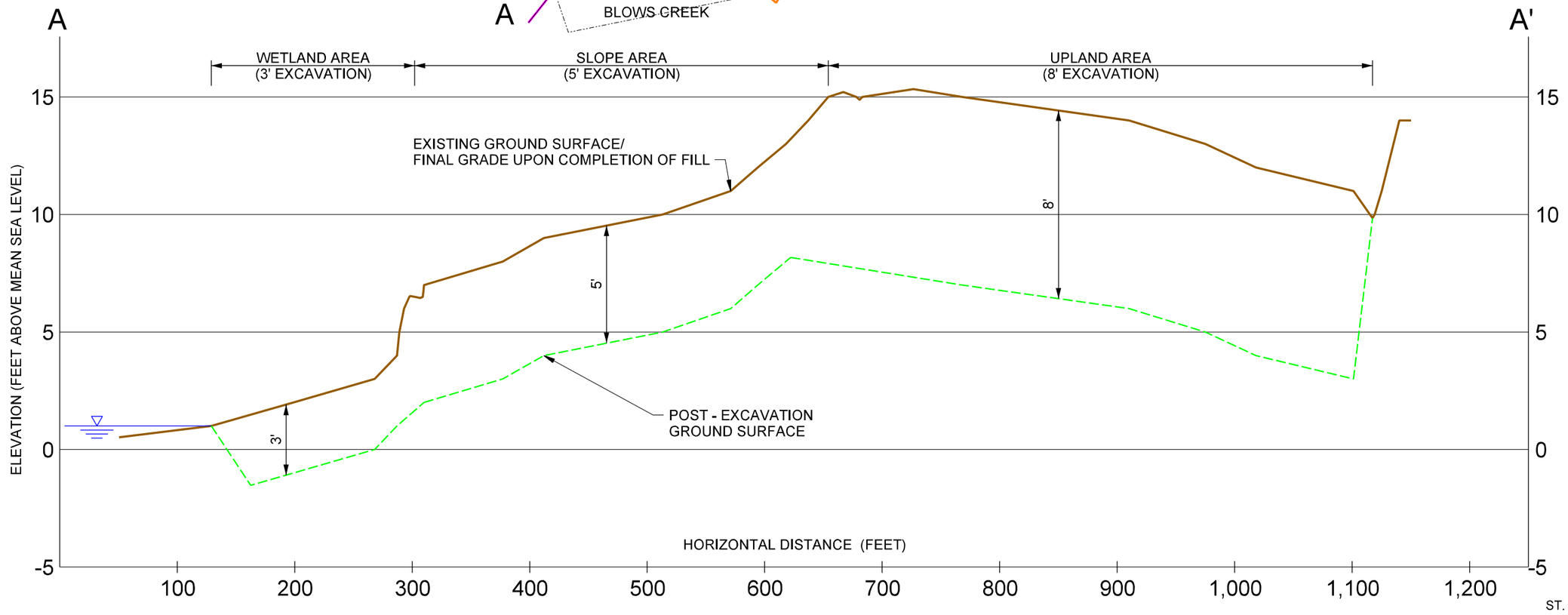

FIGURE 5-6
EXCAVATION CROSS SECTION
ALTERNATIVE 4
SITE 4
ST. JULIENS CREEK ANNEX, CHESAPEAKE, VA

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SECTION 6

Summary and Conclusions

A Feasibility Study was performed on Site 4, Landfill D, at SJCA in Chesapeake, Virginia. Remedial alternatives for Site 4 were developed based the results of previous investigations, including an RI for SJCA Sites 3, 4, 5, and 6 (CH2M HILL, 2003b). The RI provided an understanding of the nature and extent of contamination, as well as potential risks to human health and the environment, posed by contaminants at Site 4.

By considering containment as a presumptive remedy for Site 4, the following remedial alternatives were developed during the FS:

- Alternative 1—No Action
- Alternative 2—Soil Cover
- Alternative 3—RCRA Subtitle D Cap
- Alternative 4—Excavation and Offsite Disposal of Landfill Materials

With the exception of the No Action alternative, each of the remedial alternatives shared the following common components:

- Clearing and grubbing of the upland and slope areas
- Removal or consolidation of 7.5-ton counterweights from the upland area, depending on alternative selected
- Debris removal from the wetland area
- Installation of rip-rap upgradient of wetlands
- Sediment removal from the eastern drainage ditch
- Improvements to the eastern drainage ditch
- Construction of a new drainage ditch along the western site boundary (Alternatives 2 and 3 only)

A comparative analysis of each remedial alternative was completed by evaluating the alternatives against the following seven NCP criteria:

- Protection of human health and the environment
- Compliance with ARARs
- Long-term effective and permanence
- Reduction of toxicity, mobility, and volume
- Short-term effectiveness
- Implementability
- Cost

Two additional criteria, state acceptance and community acceptance, will be addressed in the PRAP and the ROD.

Based on the comparative analysis, Alternative 2—Soil Cover was selected as the recommended remedial alternative for Site 4. This alternative would protect human health and the environment by removing contaminated sediment and preventing direct exposure to contaminated soil and landfill contents. Further, the alternative would reduce any future potential risk associated with contaminants leaching into the Columbia and Yorktown aquifers. Alternative 2 complies with chemical-, location-, and action-specific ARARs. With an appropriate O&M plan, Alternative 2 would have a high degree of long-term effectiveness and permanence. Alternative 2 would also be effective in the short-term and it is implementable using standard construction methods and equipment. Other than No Action, Alternative 2 is the most cost-effective of all the alternatives considered for Site 4.

SECTION 7

References

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Appendix A
ARAR Tables

Contents

Tables

A-1 Federal Chemical-Specific ARARs

A-2 Virginia Chemical Specific ARARs

A-3 Federal Location-Specific ARARs

A-4 Virginia Location-Specific ARARs

A-5 Federal Action-Specific ARARs

A-6 Virginia Action-Specific ARARs

Table A-1
Federal Chemical-Specific ARARs
St. Juliens Creek Annex, Chesapeake, Virginia

Requirement	Prerequisite	Citation	ARAR Determination	Comment
Soil				
Toxicity Characteristic Leaching Procedure (TCLP) regulatory levels	Hazardous waste treatment, storage, or disposal	40 CFR, Section 261.24	Relevant and Appropriate	The remedial action at Site 4 will not require disposal of hazardous wastes. Further sampling will determine waste categorization.
Definition of RCRA Hazardous Waste	Waste soil	40 CFR Sections 261.21, 261.22(a)(1); 261.23; 261.24(a)(1); and 261.100	Applicable	Applicable for determining whether waste is hazardous. See Table A-2, Virginia Chemical Specific-ARARs, as Virginia has lead RCRA Regulatory Authority under the VHWMRs.
Chemical-specific risk-based concentration (RBC) screening levels	CERCLA site	EPA Region III RBC Tables	TBC	RBCs to screen against site concentrations as a preliminary indicator of the presence of risk.
Groundwater				
Safe Drinking Water Act (SDWA), 42 USC 300*				
National primary drinking water standards are health-based standards for public water systems (maximum contaminant levels [MCLs]).	Public water system	40 CFR Part 141 Subparts B & G	Not Applicable	Although Site 4 groundwater results from the RI (CH2M HILL, 2003b) indicated slight MCL exceedances in 1997 data only, the SJCA Tier I Partnering Team risk managed constituents found in the groundwater. Groundwater will only be encountered as nuisance water in any excavation below site groundwater levels.
Maximum contaminant level goals [MCLGs] pertain to known or anticipated adverse health effects (also known as recommended maximum contaminant levels).	Public water system	40 CFR Part 141, Subpart F	Not Applicable	Although Site 4 groundwater results from the RI (CH2M HILL, 2003b) indicated MCLG exceedances, the SJCA Tier I Partnering Team risk managed constituents found in the groundwater. Groundwater will only be encountered as nuisance water in any excavation below site groundwater levels.

Table A-1
Federal Chemical-Specific ARARs
St. Juliens Creek Annex, Chesapeake, Virginia

Requirement	Prerequisite	Citation	ARAR Determination	Comment
National secondary drinking water regulations are standards for the aesthetic qualities of public water systems (secondary MCLs [SMCLs]).	Public water system	40 CFR Part 143, excluding 143.5(b)	Not Applicable	Although Site 4 groundwater results from the RI (CH2M HILL, 2003b) indicated SMCL exceedances, the SJCA Tier I Partnering Team risk managed constituents found in the groundwater. Groundwater will only be encountered as nuisance water in any excavation below site groundwater levels.
Risk Based Concentrations (RBCs)	Public water system	EPA Region III RBC Tables	Not Applicable	Although Site 4 groundwater results from the RI (CH2M HILL, 2003b) indicated tap water RBC exceedances, the SJCA Tier I Partnering Team risk managed constituents found in the groundwater. Groundwater will only be encountered as nuisance water in any excavation below site groundwater levels.

* Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate that DON accepts the entire statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading; only substantive requirements of the specific citations are considered potential ARARs.

ARARs - Applicable or relevant and appropriate requirements

CFR - Code of Federal Regulations

TBC - To Be Considered

VHWMRs - Virginia Hazardous Waste Management Regulations

Table A-2
Virginia Chemical-Specific ARARs
St. Juliens Creek Annex, Chesapeake, Virginia

Requirement	Prerequisite	Citation	ARAR Determination	Comment
Soil				
Virginia Hazardous Waste Management Regulations (VHWMRs)				
Definition of RCRA Hazardous Waste	Waste soil	9 VAC 20-60 et al	Applicable	Applicable for determining whether waste is hazardous. Virginia has lead RCRA Regulatory Authority.
Virginia Solid Waste Management Regulations (VSWMRs)				
Specific regulations for the handling of “Special Wastes"	Waste must meet the determination of a Virginia “special waste”	9 VAC 20-80 et al	Applicable	Materials to be removed will be evaluated for classification as “special waste” per VSWMR.
Groundwater				
Virginia Drinking Water Standards*				
Primary drinking water standards are health-based standards for public water supplies (primary maximum contaminant levels [PMCLs]).	Public water system.	12 VAC 5-590-10	Not Applicable	Virginia PMCLs are similar to federal MCLs. Although Site 4 groundwater results from the RI (CH2M HILL, 2003b) indicated PMCL exceedances, the SJCA Tier I Partnering Team risk managed constituents found in the groundwater. Groundwater will only be encountered as nuisance water in any excavation below site groundwater levels.
Secondary drinking water regulations are chemical based standards for qualities of public water supplies (secondary MCLs [SMCLs]).	Public water system.	12 VAC 5-590-390	Not Applicable	Virginia SMCLs are similar to federal SMCLs. Although Site 4 groundwater results from the RI (CH2M HILL, 2003b) indicated SMCL exceedances, the SJCA Tier I Partnering Team risk managed constituents found in the groundwater. Groundwater will only be encountered as nuisance water in any excavation below site groundwater levels.

Table A-2
Virginia Chemical-Specific ARARs
St. Juliens Creek Annex, Chesapeake, Virginia

Requirement	Prerequisite	Citation	ARAR Determination	Comment
Virginia Groundwater Standards (VGWS)*				
Establishes groundwater standards for State Antidegradation Policy.	Standards are used when no MCL is available.	9 VAC 25-260-190 to 220	Not Applicable	VGWS are used when MCLs are not available. Although Site 4 groundwater results from the RI (CH2M HILL, 2003b) indicated VGWS exceedances, the SJCA Tier I Partnering Team risk managed constituents found in the groundwater. Groundwater will only be encountered as nuisance water in any excavation below site groundwater levels.

*Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate that Navy accepts the entire statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading; only substantive requirements of the specific citations are considered potential ARARs.

ARARs - Applicable or relevant and appropriate requirements

CFR - Code of Federal Regulations

TBC - To be considered

VAC - Virginia Administrative Code

Table A-3
Federal Location-Specific ARARs
St. Juliens Creek Annex, Chesapeake, Virginia

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comment
Executive Order 11988, Protection of Floodplain*					
Within floodplain	Actions taken should avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values.	Action that will occur in a floodplain, i.e., lowlands, and relatively flat areas adjoining inland and coastal waters and other flood-prone areas.	40 CFR Part 6, Appendix A; excluding Sections 6(a)(2), 6(a)(4), 6(a)(6); 40 CFR 6.302	Applicable	Removal activities may require compliance with this order. Measures required may include erosion control.
Executive Order 11990, Protection of Wetlands*					
Wetland	Action to minimize the destruction, loss, or degradation of wetlands.	Wetland as defined by Executive Order 11990 Section 7.	40 CFR 6, Appendix A; excluding Sections 6(a)(2), 6(a)(4), 6(a)(6); 40 CFR 6.302	Relevant and Appropriate	Federal or State regulated wetlands are present at the site. Nationwide Permit No. 38 allows for activities in wetlands to contain, stabilize, or remove hazardous or toxic materials. "Notification" is required to the District Engineer and the wetlands on the site should be delineated. Activities undertaken entirely on a CERCLA site by authority of CERCLA as approved or required by EPA, are not required to obtain permits under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act. NWP 38 notification will put in place coordination with natural resource and historic resource trustees regarding the potential to adversely affect threatened and endangered species and sites protected under the National Historic Preservation Act.

Table A-3
Federal Location-Specific ARARs
St. Juliens Creek Annex, Chesapeake, Virginia

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comment
Clean Water Act, Section 404*					
Wetland	Action to prohibit discharge of dredged or fill material into wetland without permit.	Wetland as defined by Executive Order 11990 Section 7.	40 CFR 230.10; 40 CFR 231 (231.1, 231.2, 231.7, 231.8)	Relevant and Appropriate	Remedial action at Site 4 will include removal of surface debris from the wetland area. Activities undertaken entirely on a CERCLA site by authority of CERCLA as approved or required by EPA, are not required to obtain permits under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act.
Endangered Species Act of 1978*					
Endanger-ed species	Action to ensure that any action is not likely to jeopardize the continued existence of endangered or threatened species or adversely affect its critical habitat.	Applies to actions that affect endangered or threatened species or their habitat.	16 USC 1531 50 CFR Part 402	Relevant and Appropriate	Except for the occasional transient individuals, no federally listed or proposed endangered species are known to exist at Site 4. Therefore, the requirements of the Endangered Species Act of 1973 (16 USC 1536(a)) will not be applicable to removal action.
Federal Fish and Wildlife Conservation Act					
Fish and Wildlife	Requires that activities avoid, minimize, or compensate for impacts to fish and wildlife and their habitats.	Applies to actions that affect fish and wildlife and their habitat.	16 USC §662 et seq.	Relevant and Appropriate	Blows Creek and the tidally influenced wetland area of Site 4 adjacent to Blows Creek will provide habitat for fish and wildlife species.
Coastal Zone and Management Act					
Coastal Zone	Requires that activities conducted within a coastal zone be consistent with an approved state management program.	Applies to sites located within a coastal zone.	16 USC §1451 et seq.	Relevant and Appropriate	Site 4 and surrounding vicinity is located within the coastal zone. Activities will be conducted in accordance with an approved state management program.

Table A-3
Federal Location-Specific ARARs
St. Juliens Creek Annex, Chesapeake, Virginia

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comment
National Historical Preservation Act of 1966 (NHPA) and Archaeological Resources Protection Act of 1979					
Historical Locations and Archaeolo-gical Artifacts	Provides for the recovery and preservation of historical and archaeological significant artifacts. Implementing regulations for NHPA (36 CFR Part 65) establish the National Register of Historic Places and provide for preservation of historic properties and minimization of damage to historic landmarks.	Applies to historical properties and landmarks, and archaeological artifacts.	NHPA: 16 USC §470; 36 CFR Part 65. Archaeological Resources Protection Act.	Relevant and Appropriate	Based upon the known industrial use and filling activities that were conducted in the vicinity, it is not likely that historical landmarks or artifacts exist at Site 4 and surrounding vicinity.

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ARARs - Applicable or relevant and appropriate requirements

CFR - Code of Federal Regulations

NWP - Nationwide Permit

USC - United States Code

Table A-4
Virginia Location-Specific ARARs
St. Juliens Creek Annex, Chesapeake, Virginia

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comment
Virginia State Water Control Laws and Virginia Wetlands Regulations*					
Wetland	Action to minimize the destruction, loss, or degradation of wetlands.	Wetland as defined by Virginia statutory provision.	General Provisions Relating to Marine Resources Commission, Va. Code Ann. ?28.2-1300 to 1320 (1998); Wetlands Mitigation Compensation Policy, 4 VAC 20-390-10 to 50.	Applicable	Federal and/or state regulated wetlands are present at the site which could be impacted by the remedial action at the site. The process of excavating in wetlands is marginally regulated at this time. Virginia's draft regulation, Virginia Administrative Code, 9 VAC 25-210 et seq establishes excavation and related activities as a regulated activity. Although CERCLA actions do not require permits in wetlands, the VDEQ (along with the USACE as the lead agency in CWA Section 404 actions) work with project proponents to meet the intent of the law, including compensatory mitigation.
Chesapeake Bay Preservation Act and Chesapeake Bay Preservation Area Designation and Management Regulations*					
Chesapeake Bay areas	Under these requirements, certain locally designated tidal and nontidal wetlands, as well as other sensitive land areas, may be subject to limitations regarding land-disturbing activities, removal of vegetation, use of impervious cover, erosion and sediment control, stormwater management, and other aspects of land use that may have effects on water quality.	Federally owned area designated as a Chesapeake Bay Preservation area.	Chesapeake Bay Preservation Act, Va. Code Ann. ? 10.1-2100 to 2116; Chesapeake Bay Preservation Area Designation and Management Regulations, 9 VAC 10-20-10 to 280	TBC	This requirement is not an ARAR since the area affected by the removal action is federally owned and the City of Chesapeake does not have jurisdiction over St. Juliens Creek Annex.
Coastal Zone Management Act; NOAA Regulations of Federal Consistency with approved State Coastal Zone Management Programs					
Within coastal zone	Conduct activities within a coastal Management Zone in a manner consistent with local requirements.	Activities affecting the coastal zone including lands thereunder and adjacent shore land.	Section 307(c) of 16 USC 1456(c); also see 15 CFR 930 and 923.45	TBC	This requirement is not an ARAR since the Commonwealth of Virginia does not have jurisdiction over the federally owned St. Juliens Creek Annex.

Table A-4
Virginia Location-Specific ARARs
St. Juliens Creek Annex, Chesapeake, Virginia

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comment
Virginia Endangered Species					
Critical habitat upon which endangered species or threatened species depend.	Action to conserve endangered species or threatened species, including consultation with the Virginia Board of Game and Inland Fisheries.	Determination of effect upon endangered or threatened species or its habitat.	Virginia Code Ann. §§ 29.1-563 to 570 (1998) *Definitions and Miscellaneous in General*, 4 VAC 15-20-130 to 140 Endangered Plant and Insect Species Act, Va. Code Ann. 3.1-1020 to 1030 (1998)	Relevant and Appropriate	Except for occasional transient individuals, no federally listed or proposed endangered species are known to exist at Site 4. Therefore, the requirements of the Endangered Species Act of 1973 (16 USC 1536(a)) will not be applicable to removal action.
Virginia Natural Areas Preserves Act*					
Natural preserves area	Action to conserve natural preserve areas and restrict certain activities in these areas	Applicable to sites that meet natural preserve area criteria as determined by the Virginia Department of Conservation and Recreation	Code of Virginia Sections 10.1-209 through 217	Relevant and Appropriate	Site 4 is not a natural preserve area.
Virginia Endangered Plant and Insect Species Act; Virginia Board of Game and Inland Fisheries*					
Endangered plant and insect species	Action to conserve endangered or protected plant and insect species	Applies to actions that affect endangered or protected plant and insect species.	Code of Virginia Sections 29.1-100 and 29.1-565 2 VAC 5-320-10	Relevant and Appropriate	No rare plant or insect species are known to occur in the vicinity of Site 4.

Table A-4
Virginia Location-Specific ARARs
St. Juliens Creek Annex, Chesapeake, Virginia

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comment

* Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate that Navy accepts the entire statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading; only substantive requirements of the specific citations are considered potential ARARs.

ARARs - Applicable or relevant and appropriate requirements

CFR - Code of Federal Regulations

CWA - Clean Water Act

NOAA - National Oceanic and Atmospheric Administration

TBC - To Be Considered

USACE - United States Army Corps of Engineers

VAC - Virginia Administrative Code

VDEQ - Virginia Department of Environmental Quality

Table A-5
Federal Action-Specific ARARs
St. Juliens Creek Annex, Chesapeake, Virginia

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comment
Clean Air Act (CAA) 40 USC 7401 et seq.*					
Discharge to air	National Primary and Secondary Ambient Air Quality Standards (NAAQS) - standards for ambient air quality to protect public health and welfare (including standards for particulate matter and lead).	Contamination of air affecting public health and welfare	40 CFR Sections 50.4 - 50.12	Not Applicable	Not an ARAR; Federal NAAQS are non-enforceable standards. May be a TBC for site remediation activities.

* Statutes and policies, and their citations are provided as headings to identify general categories of ARARs. Specific potential ARARs are addressed in the table below each general heading.

ARARs - Applicable or relevant and appropriate requirements

CFR - Code of Federal Regulations

TBC - To Be Considered

Table A-6
Virginia Action-Specific ARARs
St. Juliens Creek Annex, Chesapeake, Virginia

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comment
Virginia Pollutant Discharge Elimination System (VPDES) Permit Regulations*					
Discharge of Treated Water to Surface Waters, and certain storm water discharges	Regulated point-source discharges through VPDES permitting program. Permit requirements include compliance with corresponding water quality standards, establishment of a discharge monitoring system, and completion of regular discharge monitoring records.	Applicable to discharge of treated water to surface water, and to storm water dis-charges from certain facilities, including landfills.	9 VAC 25-31-10 to 940	Applicable	The base has several VPDES permits, but none are immediately present in the vicinity of Site 4. Construction activities will conform to 9 VAC 25-180-10 et seq for stormwater discharges from construction activities.
Virginia Hazardous Waste Management Regulations (VHWMRs)					
Hazardous Waste Staging Transport, and Disposal	These regulations and laws define the requirements for the management of hazardous wastes. Any disposal facility must be properly permitted and in compliance with all operational and monitoring requirements of the permit and regulations.	Wastes must meet definition of hazardous waste.	9 VAC 20-60-420 to 500	Applicable	Extracted groundwater will be adequately characterized for potential hazardous classification prior to disposal.
Virginia Solid Waste Management Regulations (VSWMRs)					
Solid Waste Staging Transport, and Disposal	These regulations and laws define the requirements for the management of solid wastes. Any disposal facility must be properly permitted and in compliance with all operational and monitoring requirements of the permit and regulations.	Wastes must meet definition of solid waste.	9 VAC 20-80 et al	Applicable	Applicable to management and staging, transportation, and off-site disposal of any debris classified as a solid waste.
Off-site Disposal	Provides criteria for determining if solid waste disposal facility poses an adverse effect on human health or environment.	Permitted solid waste landfill.	9 VAC 20-80 et al	TBC	TBC for determining suitable off-site disposal facilities for stabilized, non-hazardous waste. Applicable for on-site determination of disposal. Off-site disposal is not an ARAR.

Table A-6
Virginia Action-Specific ARARs
St. Juliens Creek Annex, Chesapeake, Virginia

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comment
Off-site Disposal	Provides criteria for determining if municipal solid waste disposal facility poses an adverse effect on human health or environment.	Permitted municipal solid waste landfill.	9 VAC 20-80 et al	TBC	TBC for determining suitable off-site disposal facilities. Off-site disposal is not an ARAR.
Virginia Air Pollution Control Regulations*					
Discharge to air	Virginia Ambient Air Quality Standards - standards for ambient air quality to protect public health and welfare (including standards for particulate matter and lead).	Contamination of air affecting public health and welfare.	9 VAC 5-30-10 to 180	Applicable	Applicable for all site remediation activities that may generate air discharges. No discharges to air are anticipated other than fugitive dust.
Discharge of visible emissions and fugitive dust	Fugitive dust/emissions may not be discharged to the atmosphere at amounts in excess of standards.	Any source of fugitive dust/ emissions.	9 VAC 5-50-60 to 120	Applicable	Applicable for any site remediation activities that generate fugitive dust.
Discharge of toxic pollutants	Toxic pollutants may not be discharged to the atmosphere at amounts in excess of standards.	Any emission from the disturbance of soil, or treatment of soil or water, that do not qualify for the exemptions under Rule 4-3.	9 VAC 5-50-160 to 230	Applicable	Applicable for any site remediation activities that generate toxic air pollutants. No toxic air pollutants are anticipated as part of this NTCRA.

Table A-6
Virginia Action-Specific ARARs
St. Juliens Creek Annex, Chesapeake, Virginia

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comment
Virginia Stormwater Management Regulations and Virginia Erosion and Sediment Control Regulations					
Stormwater Management	Regulates stormwater management and erosion/ sedimentation control practice.	Land disturbing activities.	*Stormwater Management Act*, VA Code Ann. §§ 10.1-603.1 to 603.15 (1998); *Stormwater Management Regulations*, 4 VAC 3-20-10 to 251 Erosion and Sediment Control Law, Va. Code Ann .§§ 10.1-560 to 571 (1998); Erosion and Sediment Control Regulations, 4 VAC 50-30-10 to 110	Applicable	Applicable for any site remediation activities involving surface water runoff, nuisance groundwater infiltration, and erosion. The NTCRA will include erosion and sediment control for storm water; and, storage, treatment, and discharge of nuisance groundwater infiltration.

* Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs. Specific ARARs are addressed in the table below each general heading.

ARAR - Applicable or relevant and appropriate requirement

CFR - Code of Federal Regulations

NTCRA - Non-time critical removal action

TBC - To Be Considered

VAC - Virginia Administrative Code

Appendix B
Cost Estimates

Alternative 2
SOIL COVER

Site: Site 4
Location: St. Juliens Creek Annex, Chesapeake, Virginia
Phase: Feasibility Study
Date: 10-Sep-03

Description: Installation of soil cover over landfill contents at Site 4. Also consists of surface debris removal from wetlands area, installing rip-rap upgradient of wetland area, improving the stormwater drainage ditches surrounding the landfill, and long term groundwater monitoring.

CALCULATIONS

Lanfill Cap Placement
Upland Area = 149,100 sq. ft
Slope Area = 207,490 sq. ft
Upland and Slope Area = 356,590 sq. ft
Cap thickness in upland and slope areas = 2.0 ft

Cap volume = 713,180 cu ft (26,414 cu yd)
Assumed soil weight = 1.5 tons/cu yd

Total Cap Material Required = 39,621 tons

Sediment Removal from Wetland Area
Wetland Area - 81,303 sq. ft
Sediment removal depth in wetland area = 3.0 ft

Removal volume = 243,909 cu ft (9,034 cu yd)
Assumed soil weight = 1.5 tons/cu yd

Sediment Removed from Wetland Area = 13,551 tons

Soil Removal During Excavation of Drainage Ditch
Slope length = 5 ft
Floor width = 5 ft
Length of ditch = 1,000 ft

Removal volume = 15,000 cu ft (555 cu yd)
Assumed soil weight = 1.5 tons/cu yd

Soil Removed for Drainage Ditch = 832 tons

ASSUMPTIONS

1) Clearing and Grubbing
   * Area w/ trees < 40 yrs old: 3.6 acres
   * Area w/ trees > 40 yrs old: 1.2 acres
   * No trees/brush will be removed from wetland area
   * All brush/trees will be hauled at no cost by logging/mulching company
2) Landfill Cap
   * 2 ft of clay compacted by weight of heavy equipment only (no tamping)
   * Clay installed in 6-inch lifts
   * No nuclear density testing
   * Clay fill source located within 20 mile radius of Site 4
   * Assume 20 trucks/day @ 10 cu yds/truck x 2 trips to fill source = 400 cu yd/day (600 tons/day)
3) UXO Support
   * 2 UXO technicians will be present during the removal of wetland sediment and site preparation
   * Assume $53/hr per UXO technician
   * Assume $76/day for UXO equipment/materials
4) Drainage Ditch
   * Existing piping on east side of landfill will be removed and ditch will be excavated
   * Dimensions: 5 ft floor width; 5 ft vertical height; 15 ft distance across ditch at ground surface; 1,000 ft length; 3:1 slope
   * Ditch lined with geotextile membrane and 1 ft of rip-rap
   * Excavated soil/sediment will be disposed at a landfill as non-hazardous waste
5) Wetland Protection
   * Rip-rap placed at toe of slope area to protect slope from erosion
   * Dimensions: 10 ft wide, 0.5 ft thick, 600 ft long
   * Wetland will be allowed to naturally restore itself, no enhancement
6) Groundwater Sampling
   * Assume 2 field technicians at $55/hr
   * Assume 2 hours per well, 4 hours mob/demob
   * Assume cost for total/dissolved TAL metals at $135/sample
   * Assume 8 groundwater samples including QA/QC samples
   * QA/QC samples include 1 equipment blank, 1 field duplicate, 1 MS/MSD
7) Cap Maintenance
   * Assume that cap and ditch vegetation will be mowed on a monthly basis from May through September. No mowing October through April.
   * Assume annual cost for potential cap repairs

Alternative 2
SOIL COVER

Site: Site 4
Location: St. Juliens Creek Annex, Chesapeake, Virginia
Phase: Feasibility Study
Date: 10-Sep-03

Description: Installation of soil cover over landfill contents at Site 4. Also consists of surface debris removal from wetlands area, installing rip-rap upgradient of wetland area, improving the stormwater drainage ditches surrounding the landfill, and long term groundwater monitoring.

CAPITAL COSTS

Description	Qty	Unit	Unit Cost	Total Cost	Notes
Clearing and Grubbing					
Removal of brush, trees, stumps, w/in landfill area	3.6	ACRE	$2,514.00	$9,050	RS Means 02230-200-0160
Removal of larger trees and stumps w/in landfill area and on slopes	1.2	ACRE	$2,115.00	$2,538	RS Means 02230-200-0200
SUBTOTAL				$11,588	
Site Preparation					
Surface preparation for cap placement	39,621	SY	$0.29	$11,490	RS Means 02310-440-0100
SUBTOTAL				$11,490	
Sediment Excavation					
Excavate and load sediment material	13,551	TON	$10.00	$135,510	Subcontractor Estimate
SUBTOTAL				$135,510	
Landfill Cap Construction					
Cap material (includes haul, spread, compact)	26,414	CY	$25.00	$660,350	Subcontractor Estimate
Stone on south slope for wetland erosion control	112	CY	$27.45	$3,074	RS Means 02370-300-0100
Seeding	357	MSF	$34.44	$12,295	RS Means 02920-510-4600
SUBTOTAL				$675,719	
Clearing/Grading/Excavation Support					
UXO Technician II/III for UXO scanning (2 UXO technicians)	15	DAYS	$848.00	$12,720	Engineer's Estimate
UXO Equipment/Materials	15	DAYS	$76.00	$1,140	Engineer's Estimate
Per Diem (2 UXO technicians)	15	DAYS	$302.00	$4,530	Engineer's Estimate
SUBTOTAL				$18,390	
Drainage Construction					
Excavate/load soil/sediment from stormwater ditch NE/SE of landfill area	832	TONS	$10.00	$8,320	Subcontractor Estimate
Transportation and disposal of non-hazardous waste (local)	832	TONS	$35.00	$29,120	Subcontractor Estimate
Placement of geotextile membrane along floor/slopes of ditch	555	SY	$1.22	$677	RS Means 02620-400-0100
Placement of stone for erosion control	700	CY	$22.55	$15,785	RS Means 02370-300-0100
SUBTOTAL				$53,902	
Disposal Characterization					
TCLP Analysis	1	UNIT	$700.00	$700	Engineer's Estimate
SUBTOTAL				$700	
Long Term Groundwater Monitoring					
Monitoring well construction	4	WELLS	$1,500.00	$6,000	Engineer's estimate
SUBTOTAL				$6,000	
Institutional Controls					
Establish institutional controls (fencing, signs, deed restrictions)	1	UNIT	$10,000.00	$10,000	Engineer's estimate
SUBTOTAL				$10,000	
SUBTOTAL				$923,300	
Contingency	20%			$184,660	Engineer's estimate
SUBTOTAL				$1,107,960	
Project Management	6%			$66,478	Source: A Guide to Developing and
Remedial Design	12%			$132,955	Documenting Cost Estimates During the
Construction Management	8%			$88,637	Feasibility Study - USEPA/USACE, July 2000
TOTAL CAPITAL COST				**$1,396,030**	

Alternative 2
SOIL COVER

Site: Site 4
Location: St. Juliens Creek Annex, Chesapeake, Virginia
Phase: Feasibility Study
Date: 10-Sep-03

Description: Installation of soil cover over landfill contents at Site 4. Also consists of surface debris removal from wetlands area, installing rip-rap upgradient of wetland area, improving the stormwater drainage ditches surrounding the landfill, and long term groundwater monitoring.

OPERATION AND MAINTENANCE COSTS (Year 1)

Long Term Groundwater Monitoring					
Groundwater sampling (labor/equipment/materials)	4	EVENT	$1,600.00	$6,400	Engineer's estimate, 4 MW's, quarterly
Laboratory analysis (Total/dissovled TAL metals), includes QA/QC	4	EVENT	$1,080.00	$4,320	Engineer's estimate
Annual Report	1	UNIT	$2,500.00	$2,500	Engineer's estimate
SUBTOTAL				$13,220	
Cap Monitoring					
Mowing cap and ditch vegetation	5	MONTH	$1,000.00	$5,000	Engineer's Estimate
Erosion repair to cap	1	UNIT	$2,000.00	$2,000	Engineer's Estimate
Annual cap inspection and report	1	UNIT	$2,000.00	$2,000	Engineer's Estimate
SUBTOTAL				$9,000	
SUBTOTAL				$22,220	
Contingency	20%			$4,444	
SUBTOTAL				$26,664	
Project Management	6%			$1,600	
TOTAL ANNUAL OPERATION AND MAINTENANCE COST (Year 1)				$28,264	

OPERATION AND MAINTENANCE COSTS (Years 2-30)

Long Term Groundwater Monitoring					
Groundwater sampling/data validation	2	EVENT	$1,600.00	$3,200	Engineer's estimate, 4 MW's, semiannual
Laboratory analysis (Total/dissovled TAL metals), includes QA/QC	2	EVENT	$1,080.00	$2,160	Engineer's estimate, 4 MW's, semiannual
Annual Report	1	UNIT	$2,500.00	$2,500	Engineer's estimate
SUBTOTAL				$7,860	
Cap Monitoring					
Mowing cap and ditch vegetation	5	MONTH	$1,000.00	$5,000	Engineer's Estimate
Erosion repair to cap	1	UNIT	$2,000.00	$2,000	Engineer's Estimate
Annual cap inspection and report	1	UNIT	$2,000.00	$2,000	Engineer's estimate
SUBTOTAL				$9,000	
SUBTOTAL				$16,860	
Contingency	20%			$3,372	Engineer's estimate
SUBTOTAL				$20,232	
Project Management	6%			$1,213.92	
TOTAL ANNUAL OPERATION AND MAINTENANCE COST (Years 2-30)				$21,446	

PRESENT VALUE ANALYSIS

i = 0.032
t = 1
t = 29

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (7%)	Present Value
Capital	0	$1,396,030	$1,396,030	1.000	$1,396,030
O&M	1	$28,264	$28,264	0.969	$27,387
O&M	2-30	$621,932	$21,446	18.715	$401,351
		$2,046,225			$1,824,769
TOTAL PRESENT VALUE OF ALTERNATIVE					**$1,825,000**

*Discount factor established per "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis", OSWER Directive No. 9355.3-20, June 25, 1993.

Dewatering Cost

Well Point Installation	
Upgradient perimeter of Site 3 (upland area only), ft	600
Assumed well point spacing (ft)	5
Required number of well points	120

	Unit	Quantity	Cost/Unit	Total Cost	Adjusted Cost[2]
Complete Installation, operation, equipment rental, fuel & removal of system with 2" well points 5' on center[*, a]	L.F.	600			
Cost per linear foot of header, first month	L.F.		175	$105,000	$112,350
Cost per linear foot of header, each add'l month	L.F.		100	$240,000	$256,800
Construction Duration, working days	Day	104			
Construction Duration, months (22 days per month)	Month	5			
				Total Cost	$369,150

[*] cost includes pumping 168 hours per week and include pump operator and one stand-by pump

[2] Adjusted 7% to account for 3.5% inflation over each of 2 years

Direct Pumping from Excavation Areas	Unit	Quantity	Cost/Unit	Total Cost	Adjusted Cost[2]
4" diaphragm pump[b]	Day	104	610	$63,440	$67,881
				Total Cost	$67,881

Water Treatment Prior to Discharge	Unit	Quantity	Cost/Unit	Total Cost	Adjusted Cost[3]
20,000 gallon storage tanks in series Sand filter to reduce turbidy	Lump Sum	1	$125,000	$125,000	$125,000
Carbon filtration, as necessary	Lump Sum	1	$125,000	$125,000	$125,000
				Total Cost	$125,000

Total Dewatering Cost	**$562,031**

SOURCES:

[1] RS Means Heavy Construction Cost Data, 2001

[a] 02240 900 1300/1700

[b] 02240 500 1000

[3] Engineer's Estimate

Alternative 3
RCRA Subtitle D Cap

Site: Site 4
Location: St. Juliens Creek Annex, Chesapeake, Virginia
Phase: Feasibility Study
Date: 10-Sep-03

Description: Installation of a RCRA Subtitle D cap over landfill contents at Site 4. Also consists of surface debris removal from wetlands area, installing rip-rap upgradient of wetland area, and improving the stormwater drainage ditches surrounding the landfill.

CALCULATIONS

Lanfill Cap Placement
Upland Area = 149,100 sq. ft
Slope Area = 207,490 sq. ft
Upland and Slope Area = 356,590 sq. ft
Cap thickness in upland and slope areas = 4.0 ft

Cap volume = 1,426,360 cu ft (52,828 cu yd)
Assumed soil weight = 1.5 tons/cu yd

Total Cap Material Required = 79,242 tons

Sediment Removal from Wetland Area
Wetland Area - 81,303 sq. ft
Sediment removal depth in wetland area = 3.0 ft

Removal volume = 243,909 cu ft (9,034 cu yd)
Assumed soil weight = 1.5 tons/cu yd

Sediment Removed from Wetland Area = 13,551 tons

Soil Removal During Excavation of Drainage Ditch
Slope length = 5 ft
Floor width = 5 ft
Length of ditch = 1,000 ft

Removal volume = 15,000 cu ft (555 cu yd)
Assumed soil weight = 1.5 tons/cu yd

Soil Removed for Drainage Ditch = 832 tons

ASSUMPTIONS

1) Clearing and Grubbing
* Area w/ trees < 40 yrs old: 3.6 acres
* Area w/ trees > 40 yrs old: 1.2 acres
* No trees/brush will be removed from wetland area
* All brush/trees will be hauled at no cost by logging/mulching company

2) Subtitle D Landfill Cap Design (from bottom to top)
* 6 in. grading/leveling layer, compacted
* 18 in. low permeability soil layer (K<10E-05 cm/sec), imported from borrow source, compacted
* Geocomposite drainage net
* 18 in. vegetative support layer, consists of native soil, compacted
* 6 in. topsoil layer, imported or native soil, compacted, hydroseeded

3) UXO Support
* 2 UXO technicians will be present during the removal of wetland sediment and site preparation
* Assume $53/hr per UXO technician
* Assume $76/day for UXO equipment/materials

4) Drainage Ditch
* Existing piping on east side of landfill will be removed and ditch will be excavated
* Dimensions: 5 ft floor width; 5 ft vertical height; 15 ft distance across ditch at ground surface; 1,000 ft length; 3:1 slope
* Ditch lined with geotextile membrane and 1 ft of rip-rap
* Excavated soil/sediment will be disposed at a landfill as non-hazardous waste

5) Wetland Protection
* Rip-rap placed at toe of slope area to protect slope from erosion
* Dimensions: 10 ft wide, 0.5 ft thick, 600 ft long
* Wetland will be allowed to naturally restore itself, no enhancement

6) Groundwater Sampling
* Assume 2 field technicians at $55/hr
* Assume 2 hours per well, 4 hours mob/demob
* Assume cost for total/dissolved TAL metals at $135/sample
* Assume 8 groundwater samples including QA/QC samples
* QA/QC samples include 1 equipment blank, 1 field duplicate, 1 MS/MSD

7) Cap Maintenance
* Assume that cap and ditch vegetation will be mowed on a monthly basis from May through September. No mowing October through April.
* Assume annual cost for potential cap repairs

Alternative 3
RCRA Subtitle D Cap

Site: Site 4
Location: St. Juliens Creek Annex, Chesapeake, Virginia
Phase: Feasibility Study
Date: 10-Sep-03

Description: Installation of a RCRA Subtitle D cap over landfill contents at Site 4. Also consists of surface debris removal from wetlands area, installing rip-rap upgradient of wetland area, and improving the stormwater drainage ditches surrounding the landfill.

OPERATION AND MAINTENANCE COSTS (Year 1)

Long Term Groundwater Monitoring					
Groundwater sampling (labor/equipment/materials)	4	EVENT	$1,600.00	$6,400	Engineer's estimate, 4 MW's, quarterly
Laboratory analysis (Total/dissovled TAL metals), includes QA/QC	4	EVENT	$1,080.00	$4,320	Engineer's estimate, 4 MW's, quarterly
Annual Report	1	UNIT	$2,500.00	$2,500	Engineer's estimate
SUBTOTAL				$13,220	
Cap Monitoring					
Mowing cap and ditch vegetation	5	MONTH	$1,000.00	$5,000	Engineer's Estimate
Erosion repair to cap	1	UNIT	$2,000.00	$2,000	Engineer's Estimate
Annual cap inspection and report	1	UNIT	$2,000.00	$2,000	Engineer's estimate
SUBTOTAL				$9,000	
SUBTOTAL				$22,220	
Contingency	20%			$4,444	
SUBTOTAL				$26,664	
Project Management	6%			$1,600	
TOTAL ANNUAL OPERATION AND MAINTENANCE COST (Year 1)				$28,264	

OPERATION AND MAINTENANCE COSTS (Years 2-30)

Long Term Groundwater Monitoring					
Groundwater sampling/data validation	2	EVENT	$1,600.00	$3,200	Engineer's estimate, 4 MW's, semiannual
Laboratory analysis (Total/dissovled TAL metals), includes QA/QC	2	EVENT	$1,080.00	$2,160	Engineer's estimate, 4 MW's, semiannual
Annual Report	1	UNIT	$2,500.00	$2,500	Engineer's estimate
SUBTOTAL				$7,860	
Cap Monitoring					
Mowing cap and ditch vegetation	5	MONTH	$1,000.00	$5,000	Engineer's Estimate
Erosion repair to cap	1	UNIT	$2,000.00	$2,000	Engineer's Estimate
Annual cap inspection and report	1	UNIT	$2,000.00	$2,000	Engineer's estimate
SUBTOTAL				$9,000	
SUBTOTAL				$16,860	
Contingency	20%			$3,372	Engineer's estimate
SUBTOTAL				$20,232	
Project Management	6%			$1,214	
TOTAL ANNUAL OPERATION AND MAINTENANCE COST (Years 2-30)				$21,446	

PRESENT VALUE ANALYSIS

i = 0.032
t = 1
t = 29

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (7%)	Present Value
Capital	0	$2,358,111	2,358,111	1.000	$2,358,111
O&M	1	$28,264	28,264	0.969	$27,387
O&M	2-30	$621,932	21,446	18.715	$401,351
		$3,008,306			$2,786,849
TOTAL PRESENT VALUE OF ALTERNATIVE					**$2,787,000**

*Discount factor established per "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis", OSWER Directive No. 9355.3-20, June 25, 1993.

Alternative 4
Excavation and Offsite Disposal of Landfill Materials

Site: Site 4
Location: St. Juliens Creek Annex, Chesapeake, Virginia
Phase: Feasibility Study
Date: 10-Sep-03

Description: Excavation of soil from the landfill and disposing of the excavated material at an appropriate disposal facility. Also consists of surface debris removal from wetlands area, installing rip-rap upgradient of wetland area, and improving the stormwater drainage ditches surrounding the landfill.

CALCULATIONS

Soil/Waste Removal from Landfill
Upland Area = 149,100 sq. ft
Slope Area = 207,490 sq. ft
Soil/waste depth in upland area = 8 ft
Soil/waste depth in slope area = 5 ft

Soil/waste volume = 2,230,250 cu ft (82,602 cu yd)

Assumed soil weight = 1.5 tons/cu yd

Total Soil/Waste Material to be Excavated = 123,903 tons

Sediment Removal from Wetland Area
Wetland Area - 81,303 sq. ft
Sediment removal depth in wetland area = 3.0 ft

Removal volume = 243,909 cu ft (9,034 cu yd)
Assumed soil weight = 1.5 tons/cu yd

Sediment Removed from Wetland Area = 13,551 tons

Soil Removal During Excavation of Drainage Ditch
Slope length = 5 ft
Floor width = 5 ft
Length of ditch = 1,000 ft

Removal volume = 15,000 cu ft (555 cu yd)
Assumed soil weight = 1.5 tons/cu yd

Soil Removed for Drainage Ditch = 832 tons

Fill Material
Upland Area = 149,100 sq. ft
Slope Area = 207,490 sq. ft
Fill depth in upland area = 8 ft
Fill depth in slope area = 5 ft

Fill volume = 2,230,250 cu ft (82,602 cu yd)
Assumed soil weight = 1.5 tons/cu yd

Fill Material = 123,903 tons

ASSUMPTIONS

1) Clearing and Grubbing
* Area w/ trees < 40 yrs old: 3.6 acres
* Area w/ trees > 40 yrs old: 1.2 acres
* No trees/brush will be removed from wetland area
* All brush/trees will be hauled at no cost by logging/mulching company

2) Excavation of Soil/Waste Material
* Assume 8 ft of material will be excavated from upland area
* Assume 5 ft of material will be excavated from slope area
* Excavated materials disposed at offsite landfill as non-hazardous waste
* Landfill located within 50 miles of site
* Assume: 20 trucks/day @ 10 cu yds/truck x 2 trips to fill source = 400 cu yds/day (600 tons/day)

3) Excavation Dewatering
* 120 Well points allong northern perimeter.

4) UXO Support
* 2 UXO technicians will be present during the removal of wetland sediment and landfill soil and waste materials
* Assume $53/hr per UXO technician
* Assume $76/day for UXO equipment/materials

5) Drainage Ditch
* Existing piping on east side of landfill will be removed and ditch will be excavated
* Dimensions: 5 ft floor width; 5 ft vertical height; 15 ft distance across ditch at ground surface; 1,000 ft length; 3:1 slope
* Ditch lined with geotextile membrane and 1 ft of rip-rap
* Excavated soil/sediment will be disposed at a landfill as non-hazardous waste

6) Wetland Protection
* Rip-rap placed at toe of slope area to protect slope from erosion
* Dimensions: 10 ft wide, 0.5 ft thick, 600 ft long
* Wetland will be allowed to naturally restore itself, no enhancement

7) Fill Material
* Backfill material will come from an offsite borrow source
* Assume complete backfill of material removed, restoring original grade

8) Confirmation Sampling
* Assume 4 confirmation composite soil samples collected per acre
* Actual number of confirmation soil samples will be negotiated with agency
* Samples analyzed for SVOCs and metals
* Assume $125/sample for metals
* Assume $250/sample for SVOCs
* Assume 32 confirmation samples, does not include QA/QC samples

Dewatering Cost

Well Point Installation	
Upgradient perimeter of Site 3 (upland area only), ft	600
Assumed well point spacing (ft)	5
Required number of well points	120

	Unit	Quantity	Cost/Unit	Total Cost	Adjusted Cost[2]
Complete Installation, operation, equipment rental, fuel & removal of system with 2" well points 5' on center[*, a]	L.F.	600			
Cost per linear foot of header, first month	L.F.		175	$105,000	$112,350
Cost per linear foot of header, each add'l month	L.F.		100	$240,000	$256,800
Construction Duration, working days	Day	104			
Construction Duration, months (22 days per month)	Month	5			
				Total Cost	$369,150

[*] cost includes pumping 168 hours per week and include pump operator and one stand-by pump

[2] Adjusted 7% to account for 3.5% inflation over each of 2 years

Direct Pumping from Excavation Areas	Unit	Quantity	Cost/Unit	Total Cost	Adjusted Cost[2]
4" diaphragm pump[b]	Day	104	610	$63,440	$67,881
				Total Cost	$67,881

Water Treatment Prior to Discharge	Unit	Quantity	Cost/Unit	Total Cost	Adjusted Cost[3]
20,000 gallon storage tanks in series					
Sand filter to reduce turbidy	Lump Sum	1	$125,000	$125,000	$125,000
Carbon filtration, as necessary	Lump Sum	1	$125,000	$125,000	$125,000
				Total Cost	$125,000

Total Dewatering Cost	**$562,031**

SOURCES:

[1] RS Means Heavy Construction Cost Data, 2001

[a] 02240 900 1300/1700

[b] 02240 500 1000

[3] Engineer's Estimate