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FINAL

PROPOSED REMEDIAL ACTION PLAN

CAMP ALLEN LANDFILL
NAVAL BASE NORFOLK, VIRGINIA

CONTRACT TASK ORDER 0084

MARCH 2, 1995

Prepared For:

DEPARTMENT OF THE NAVY
ATLANTIC DIVISION
NAVAL FACILITIES
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ACRONYMS AND ABBREVIATIONS

ARARs	applicable or relevant and appropriate requirements
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COPCs	contaminants of potential concern
DoN	Department of the Navy
DPVE	dual phase vacuum extraction
EE/CA	Engineering Evaluation/Cost Analysis
FS	Feasibility Study
gpm	gallons per minute
HI	hazard index
HRSD	Hampton Roads Sanitation District
ICR	incremental cancer risk
MCLs	maximum contaminant levels
NPW	net present worth
O&M	operation and maintenance
PRAP	Proposed Remedial Action Plan
RA	Risk Assessment
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial Design/Remedial Action
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SVOCs	semivolatile organic compounds
TBC	to be considered
TMV	toxicity, mobility, and volume
USEPA	United States Environmental Protection Agency
USMC	United States Marine Corps
VADEQ	Virginia Department of Environmental Quality
VOCs	volatile organic compounds

SECTION 1

1.0 INTRODUCTION

This Proposed Remedial Action Plan (PRAP) is issued to describe the Department of the Navy's (DoN's) preferred remedial actions for the Camp Allen Landfill at the Naval Base, Norfolk, Virginia. The Camp Allen Landfill is located approximately one mile east of Hampton Boulevard and one mile south of Willoughby Bay. As shown in Figure 1-1, the Camp Allen Landfill is divided into Area A (approximately 45 acres) and Area B (approximately 3 acres). In addition, source areas identified within Area A are designated as Area A1 and Area A2, as shown in Figure 1-1. The location of the Camp Allen Landfill Site within Naval Base Norfolk is illustrated in Figure 1-2.

The DoN is issuing this PRAP in fulfillment of the public participation responsibility established under Section 117(a) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The DoN, with the assistance of United States Environmental Protection Agency (USEPA) Region III and the Virginia Department of Environmental Quality (VADEQ), will select a final remedy for the Camp Allen Landfill after the public comment period has ended and the information submitted during this time has been reviewed and considered. The Final Decision Document may recommend different remedial actions than are presented in this plan, depending upon new information or public comments.

This PRAP presents a brief summary of information that can be found in greater detail in the administrative record file, which includes the Camp Allen Landfill Remedial Investigation (RI) Report, Risk Assessment (RA) Report, Feasibility Study (FS) Report, and other documents referenced in these reports. The administrative record file, which contains information on which the selection of the remedial action will be based, is available for public review at the Kirn Memorial Branch at the Norfolk Public Library in Norfolk, Virginia. The DoN encourages the public to review these documents in order to gain a more comprehensive understanding of the site and the proposed remedial action. The public also is invited to comment on the administrative record and this PRAP. Section 8.0 provides information on community participation in the decision-making process including information regarding the public comment period, public meetings, information repositories, and a mailing list of DoN and/or agency contact people to whom public comments may be sent.

The remedial alternatives evaluated for the various contaminated media within Areas A and B at the Camp Allen Landfill are listed below, and the preferred alternatives are noted. Descriptions and evaluations of these alternatives are presented in Sections 5.0 and 6.0 of this PRAP. The preferred alternatives and the rationale for their preference are presented in Section 7.0.

Area A Soil Remedial Alternatives

- A-SO1 - No Action
- A-SO2 - Institutional Controls
- A-SO3 - Asphalt/Geosynthetic Cap Over Brig Area with Institutional Controls
- A-SO4 - Composite Cap Over Hot Spot Areas with Institutional Controls
- A-SO5 - In Situ Treatment of Hot Spot Area Soils and Shallow Groundwater Using Dual Phase Vacuum Extraction with Institutional Controls
- A-SO6 - Thermal Treatment of Hot Spot Area Soils with Institutional Controls
- A-SO7 - Disposal of Hot Spot Area Soils in Off-site Hazardous Waste Landfill with Institutional Controls

The preferred alternative for Area A1 soil is A-SO5 - In Situ Treatment of Hot Spot Area Soils and Shallow Groundwater Using Dual Phase Vacuum Extraction with Institutional Controls. The dual phase vacuum extraction (DPVE) system offers an in situ alternative capable of extracting contaminants from both soil and shallow groundwater using a single system. Results of a DPVE pilot test performed in Area A1 (OHM, 1994) indicate that this technology is well-suited for this area and is capable of extracting contaminants from both soil and groundwater. In addition, the DPVE wells removed significantly more groundwater from the water table aquifer (shallow groundwater) in Area A1 than did conventional submersible pumps. During previous investigations, conventional submersible pumps pumped the wells dry and proved impractical for groundwater remediation.

The preferred alternative for Area A2 soil is A-SO2 - Institutional Controls. Institutional controls would include maintenance of the existing fencing in Area A and deed restrictions to limit the area to non-residential land uses. In contrast to Area A1, the DPVE pilot test performed in Area A2 yielded no identifiable contaminants in either the extracted groundwater or soil vapors, indicating that the extent of soil contamination in Area A2 is very limited. The test results also showed that the DPVE technology is not well-suited for the shallow groundwater in Area A2, and that conventional submersible pumps are more appropriate for the water table aquifer in this area. Shallow groundwater remediation is addressed under the Area A2 groundwater remedial alternatives.

Area B Soil Remedial Alternatives

- B-SO1 - No Action
- B-SO2 - Institutional Controls

A removal action for Area B soil was completed in late 1994 (see Section 2.4). Since it is expected that this removal action has permanently removed the primary sources of contamination in Area B, the preferred alternative for Area B soil is B-SO2 - Institutional Controls. Institutional controls would include maintenance of the existing fencing in Area B and deed restrictions to limit the area to non-residential land use.

Area A and B Surface Water/Sediment Remedial Alternatives

- SD1- No Action
- SD2 - Institutional Controls with Monitoring

The preferred alternative for Area A and B surface water/sediment is SD-2 - Institutional Controls with Monitoring. Institutional controls would include maintenance of the existing Areas A and B fencing and deed restrictions to limit the area to non-residential land use. The proposed remediation of the soil and groundwater in the Camp Allen Landfill Area is expected to result in a decrease in contaminant levels in surface water/sediment over time. Therefore, a post-remediation surface water/sediment monitoring program is proposed to track contaminant trends in these media. Additional sampling/analysis of surface water/sediment is planned in the immediate future to determine the full extent of ecological impacts and to establish baseline conditions of surface water/sediment in the vicinity of the Camp Allen Site.

Area A1 Groundwater Remedial Alternatives

- A1-GW1 - No Action with Monitoring
- A1-GW2 - Institutional Controls with Monitoring
- A1-GW3 - Protection of the Yorktown Aquifer for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring

The preferred alternative for Area A1 groundwater is A1-GW3 - Protection of the Yorktown Aquifer for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring. The water table aquifer in Area A1 will be addressed by the DPVE system that is proposed for Area A1 soils. Although there are no downgradient residential receptors for groundwater in this area, extraction and treatment of groundwater in the Yorktown Aquifer is recommended in Area A1 since the contaminant plume could migrate from Navy property in this area.

Area A2 Groundwater Remedial Alternatives

- A2-GW1 - No Action with Monitoring
- A2-GW2 - Institutional Controls with Monitoring
- A2-GW3 - Protection of the Yorktown Aquifer for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring
- A2-GW4 - Protection of the Water Table Aquifer for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring

The preferred alternative for the water table aquifer in Area A2 is A2-GW4 - Protection of the Water Table Aquifer for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring. This alternative was not included in the Feasibility Study because shallow groundwater remediation was addressed by the DPVE alternative developed for Area A2 soils. However, Alternative A-GW4 has been added to this PRAP since results of the DPVE pilot test indicate that the DPVE technology is not well-suited for extraction of groundwater from the water table aquifer in Area A2, and that conventional submersible pumps are more appropriate for the water table aquifer in this area. Alternative A2-GW4 is recommended to contain shallow groundwater contamination in Area A2, which could migrate horizontally, or vertically to the Yorktown Aquifer.

At this time, the preferred alternative for the Yorktown Aquifer in Area A2 is A2-GW2 -- Institutional Controls with Monitoring. Institutional controls for the Yorktown Aquifer would include deed restrictions limiting the area to non-residential land use and, possibly, aquifer use restrictions. Since there are no receptors for groundwater immediately downgradient of Area A2, and the contaminant plume is not expected to migrate off of Navy property in this area, extraction and treatment of groundwater in the Yorktown Aquifer is not recommended in Area A2.

Area B Groundwater Remedial Alternatives

- B-GW1 - No Action with Monitoring
- B-GW2 - Institutional Controls with Monitoring
- B-GW3 - Protection of the Water Table and Yorktown Aquifers for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring

The preferred alternative for Area B groundwater is B-GW3 - Protection of the Water Table and Yorktown Aquifers for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring. Extraction and treatment of both aquifers in Area B is recommended because, in general, the levels of contaminants in Area B groundwater are higher than in Areas A1 and A2. Although there are no groundwater users downgradient of Area B, extraction and treatment of groundwater in both aquifers is recommended in this area to contain the contaminant plume.

SECTION 1.0 FIGURES

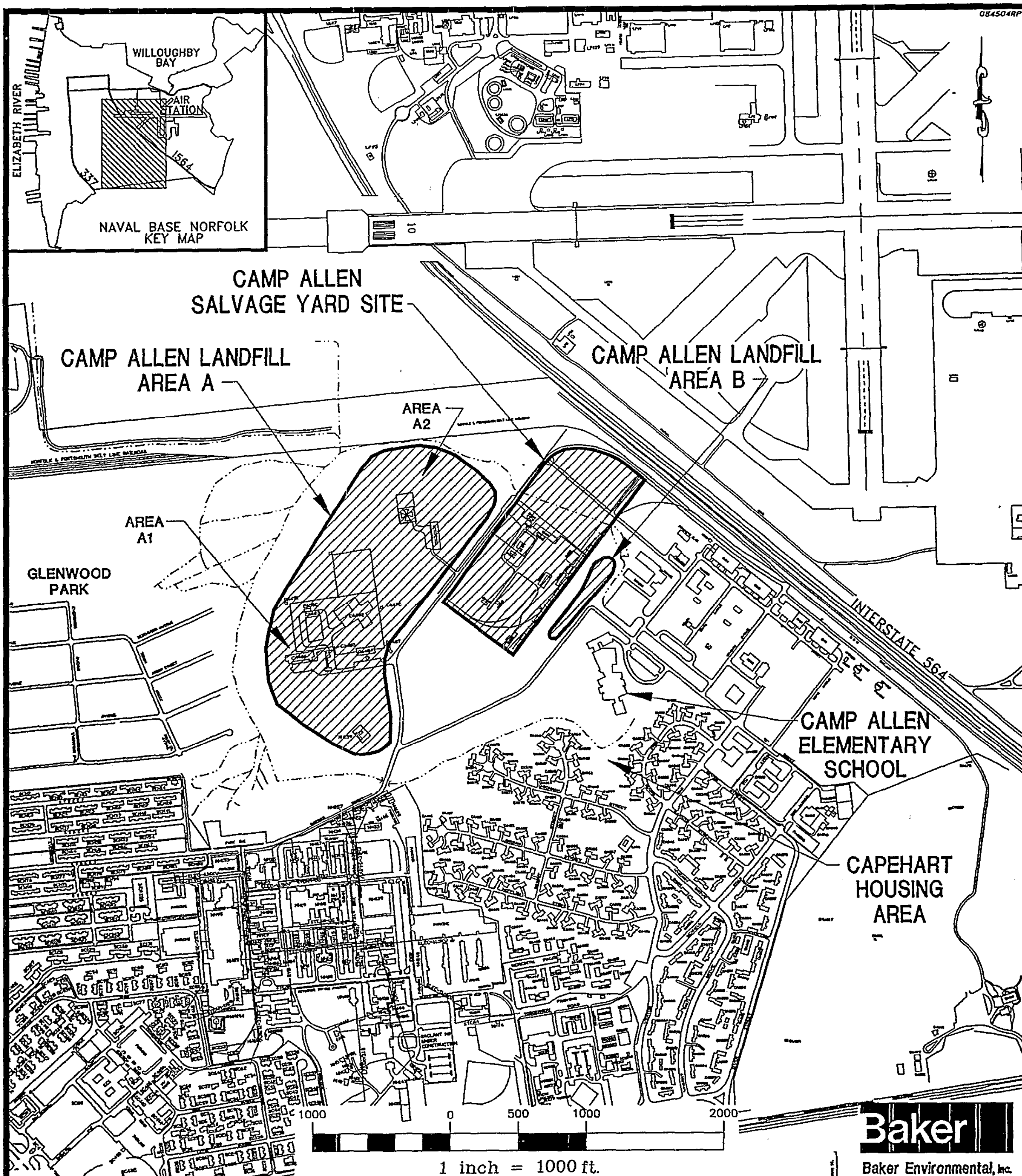


FIGURE 1-1
SITE MAP
CAMP ALLEN LANDFILL

NAVAL BASE NORFOLK
NORFOLK, VIRGINIA

SOURCE: LANTDIV, OCTOBER 1991

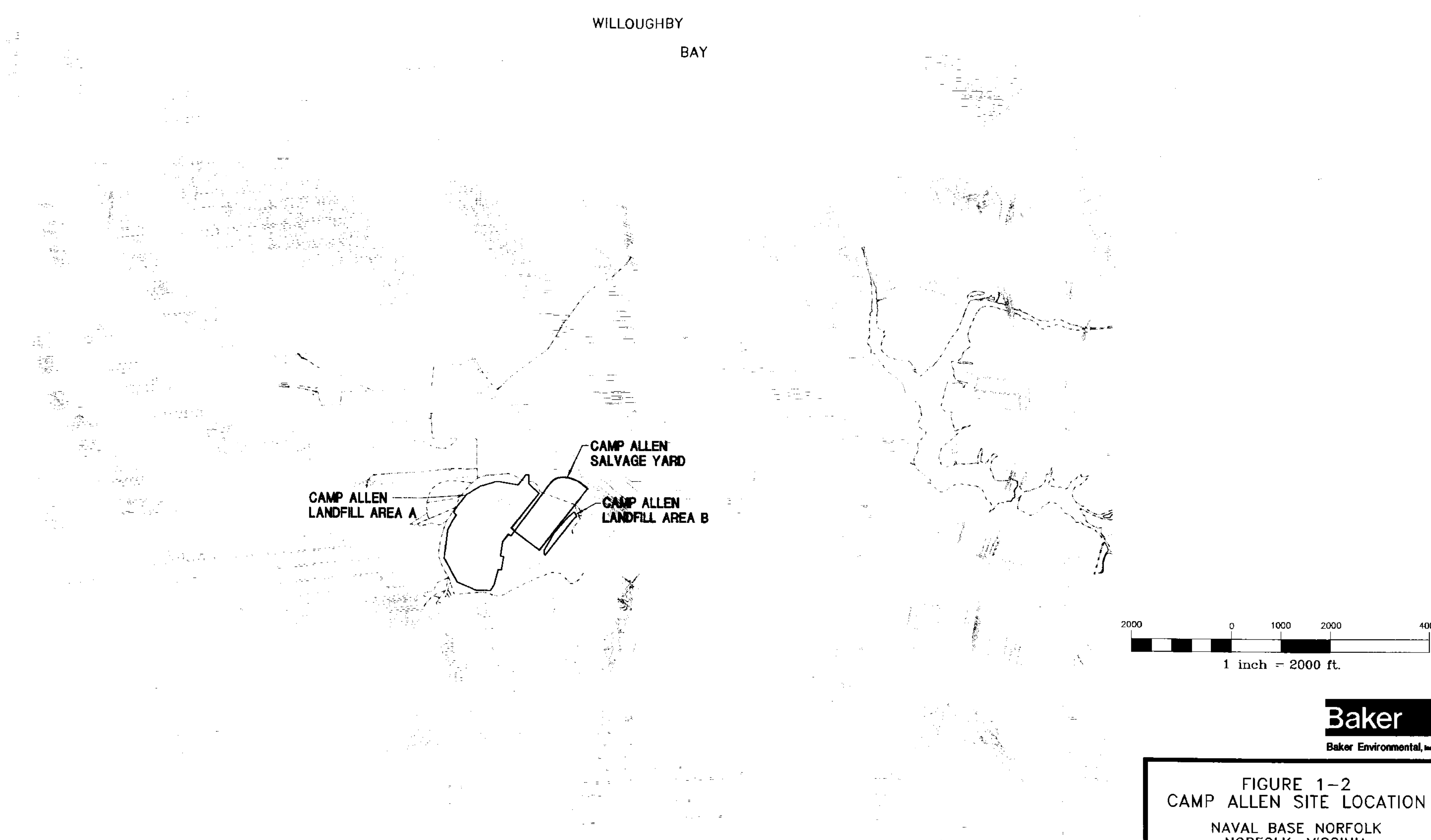


FIGURE 1-2
CAMP ALLEN SITE LOCATION

NAVAL BASE NORFOLK
NORFOLK, VIRGINIA

SECTION 2

2.0 SITE BACKGROUND

2.1 Site History

Prior to 1940, the Camp Allen area was characterized by a low-lying tidal environment dominated by surface water features related to Bousch Creek, which flowed north into Willoughby Bay. Development of residential, commercial, and military related structures was limited to adjacent, topographically high areas during this time period. In the late 1930s, these high portions of the Camp Allen area reportedly were used as soil borrow areas for development of low-lying areas of Naval Base Norfolk.

During the early 1940s, landfill operations commenced in the Camp Allen area (Camp Allen Landfill) and continued until about 1974. The Camp Allen Landfill site today is comprised of two distinct areas (Area A and Area B), as shown in Figure 1-1.

Area A of the Camp Allen Landfill is a 45-acre site that was used for the disposal of a variety of wastes. Unknown quantities of municipal, solid, and hazardous wastes were disposed in Area A including general refuse, demolition debris, sludges from metal plating processes, parts cleaning and paint stripping wastes, overage chemicals, various chlorinated organic solvents, acids, caustics, paints and paint thinners, pesticides, and asbestos. In the mid-1940s, an incinerator was constructed in the southern portion of Area A to burn combustible wastes. The incinerator operated until the mid-1960s. Materials too bulky for the incinerator were burned in Area A of the Camp Allen Landfill. Ash from the incinerator, as well as fly and bottom ash from the base power plant, were landfilled in Area A.

The Camp Allen Salvage Yard, which is still in operation, is located between Camp Allen Landfill Areas A and B (see Figure 1-2). The salvage yard stores and recycles scrap such as wood, metal, appliances, abandoned cars, drums of various materials and other types of surplus material. The residue and debris resulting from a 1971 salvage yard fire were buried in Area B.

At present, most of Area A and Area B are soil covered and vegetated to minimize surface erosion. The area is surrounded by drainage ditches, which convey surface water runoff to Willoughby Bay. These drainage ditches are remnants of Bousch Creek, the main channel of which was completely filled and replaced by a network of ditches and channels during the development of Naval Base Norfolk.

The Camp Allen Landfill site is located in mixed-use, urban land. Military facilities are located atop and/or adjacent to the landfill areas. Area A incorporates the Navy Brig facility and a heliport, which was built over a portion of the landfill during the mid-1970s. Glenwood Park (an off-base residential area) is located to the west of Area A. The Camp Allen Elementary School is located to the south of Area B, and the Capehart Military Housing Area is located south of the Camp Allen Elementary School. Various military activities, including USMC Camp Elmore operations, are conducted throughout the Camp Allen area.

2.2 Previous Investigations

Previous investigations of various hazardous waste sites at Naval Base Norfolk (including the Camp Allen Landfill) were conducted and documented in an Initial Assessment Study. In addition, a Site Suitability Assessment, Confirmation Study, Interim Remedial Investigation Report, and an Interim Remedial Investigation have been conducted specifically for the Camp Allen Landfill site. These investigations are briefly described below:

1) Initial Assessment Study (February 1983): Based on review of historical records and general site reconnaissance, the Camp Allen Landfill was among the sites at the Naval Base Norfolk recommended for further study.

2) Site Suitability Assessment (June 1984): Assessment activities were conducted for a proposed Brig Expansion. Magnetometer data indicated extensive areas of buried metallic objects throughout the middle and southern portions of Area A. Shallow groundwater samples identified the area west of the Brig Facility as having organic pollutants (i.e., trichloroethylene, benzene, and toluene) and certain metals (i.e., arsenic, cadmium, lead, and zinc) in concentrations that exceeded USEPA water quality criteria.

3) Confirmation Study (June 1983): Analysis of organic compounds in water table aquifer groundwater samples from two general locations (Area A [west of Brig] -

3 wells; Area B [northeast portion] - 3 wells) identified elevated concentrations (exceeding applicable water quality criteria/standards) of several volatile organics, including vinyl chloride, trichloroethylene, toluene. No organic compounds were detected in the Yorktown Aquifer groundwater in limited sampling. Leaching of organic compounds (i.e., vinyl chloride, trichloroethylene) into the drainage and ponded surface waters directly east of Area B was confirmed. Cadmium, chromium, lead, and zinc exceeded applicable water quality criteria in unfiltered groundwater and surface water samples.

4) Interim Remedial Investigation Report (March 1988): This interim report summarized Confirmation Study results for the Camp Allen Landfill. Additional field activities were not performed.

5) Interim Remedial Investigation (1990-1991): This investigation noted the following:

- The confining clay unit which separates the shallow (water table) aquifer and the Yorktown Aquifer appeared to be absent in various locations, allowing for potential downward migration of contaminants from the landfill.

- Samples from shallow wells at Areas A and B confirmed the presence of organic compounds exceeding applicable water quality criteria/standards in the water table aquifer, downgradient of Area A - west of Brig Facility, and southeast of Area B.

- Samples from deep wells at Areas A and B confirmed the presence of the same organic compounds in the deep (Yorktown Aquifer) groundwater samples.

- Leaching of organic compounds into the ponded surface waters directly east of Area B was confirmed.

- Inorganic compounds were detected in sediments north of Area A.

- Volatile organic compounds (VOCs) did not appear to be migrating west from Area A beyond the perimeter drainage ditch, since VOCs were absent in 55 residential (nonpotable) shallow wells in Glenwood Park.

In part, these results guided the scoping of the Remedial Investigation, summarized in Section 2.3 of this document, and have been incorporated into this study's interpretations, as appropriate.

2.3 Remedial Investigation Findings

A remedial investigation (RI) of the Camp Allen Landfill site was performed by Baker Environmental, Inc., in 1992/1993. Detailed information regarding the findings of the investigation can be found in the Camp Allen Landfill RI Report. A summary of pertinent findings is presented below.

2.3.1 Geology/Hydrogeology

Site lithology of the Camp Allen area consists of three primary strata: (1) silts, clays, and sands of the Columbia Group ranging from 0 to 27 feet below ground surface (bgs) or deeper; (2) a confining clay layer at the base of the Columbia Group (absent in some areas) ranging from 25 to approximately 40 feet bgs; and/or, (3) a silt/sand/shell hash unit (Yorktown Formation) ranging from about 40 to 130 feet bgs, where it abruptly contacts the St. Mary's "blue bed" of the Calvert Formation.

Two aquifer systems are impacted by the Camp Allen Landfill: the water table aquifer (Columbia Group) and the underlying Yorktown Aquifer (Yorktown Formation). The water table aquifer (shallow groundwater) is unconfined. A breach and/or ineffective (poorly developed) leaky portion of the confining clay unit allows downward migration of constituents from the water table aquifer to the Yorktown Aquifer. Figure 2-1 presents generalized groundwater flow patterns for both the water table and Yorktown aquifer systems.

2.3.2 Nature and Extent of Contamination

Contamination from prior disposal practices at Areas A and B of the Camp Allen Landfill has been detected in subsurface soils, surface soils, sediment, surface water, and groundwater (water table and Yorktown aquifer systems). Table 2-1 lists primary areas of detected contamination by media and area. Highlights include source areas of VOCs in subsurface soils identified at or near the top of the water table aquifer in Area A and Area B. In isolated locations, wastes were identified beneath the water table. Although various organic and inorganic contaminants were detected in site media, the primary constituents of concern at the site are volatile organic compounds (VOCs). Summaries of contaminants of potential concern (COPCs) by environmental media for various areas of the site are presented in Tables 2-2, 2-3, and 2-4. Following is a summary of the nature and extent of contamination at the Camp Allen Landfill.

<u>Area A</u>

- Subsurface soil: VOCs were the predominant contaminants detected in the subsurface soils at Area A. In general, two primary source locations were indicated. The first area appears to be located in the western portion of the Brig Facility. The second area appears to be located in the northern/northeastern region of Area A (north of the Brig Facility, near the helipad).

- Surface soil: Analytical results indicate surficial soil to be nominally impacted by disposal activities.

- Surface water: Results indicate isolated areas of VOCs and various inorganic constituent concentrations exceeding applicable standards/criteria.

- Sediment: Results indicate isolated areas of elevated levels of organic and inorganic constituent concentrations in small, sporadic areas of the drainage ditches surrounding the area.

- Groundwater: Two primary areas of VOC contamination were identified at Area A. The first area is located in the western portion of the Brig Facility and the second area is located along the north portion of the site near the helipad area. Both shallow and deep groundwater contamination is present within these areas. Identified contaminants (primarily VOCs) appear to correspond to source areas mentioned above.

- Residential well groundwater sampling: Analytical results indicate that site-related contaminants have not impacted the shallow (water table) groundwater in the Glenwood Park area. Shallow groundwater contamination appears to be limited to the western side of the Brig Facility (located east of Glenwood Park).

- Air sampling: No significant site-specific volatile air contaminants were detected.

Area B

- Subsurface soil: VOCs were the predominant contaminants detected in the subsurface soils at Area B. In general, the primary source area is located in the middle portion of the site within the landfill.

- Surface soil: Analytical results indicate surficial soil to be nominally impacted by disposal activities.

- Surface water: Results indicate areas of VOCs and various inorganic constituent concentrations exceeding applicable standards/criteria primarily in the eastern and northern portion of the ponded area.

- Sediment: Results indicate isolated areas of elevated levels of organic and inorganic constituent concentrations, primarily in the ponded area northeast of the site.

- Groundwater: The primary area of VOC contamination is located south/southeast of Area B. Both shallow and deep groundwater contamination is present within this area. Identified contaminants (primarily VOCs) correspond to the source area within the Area B landfill mentioned above.

- Residential wells: No residential wells reportedly are located in the vicinity of Area B.

- Air sampling: No significant site-specific volatile air contaminants were detected.

2.4 Area B Removal Action

Based on the RI findings, an Engineering Evaluation/Cost Analysis (EE/CA) for a non-time-critical removal action in Area B was performed to develop and evaluate alternatives for removal and disposal of contaminated subsurface soil and debris identified in former waste burial trenches at this location. The selected removal action alternative included:

- Collection of extracted groundwater, pre-treatment of the water to comply with applicable state and local pretreatment standards, and discharge to the Hampton Roads Sanitation District (HRSD) wastewater treatment facility for treatment and disposal;

- Excavation of the soil, debris, and buried drums from the trenches plus over-excavation of visibly-contaminated soil from the side walls and floor of the excavation;

- Confirmation soil sampling and analysis, and additional excavation of material contaminated in excess of the removal action cleanup levels;

- Transportation to and disposal of excavated soil and debris at a RCRA-permitted hazardous waste management facility.

The Area B removal action was initiated in the summer of 1994 and has been completed. The objective of the removal action was to remove the sources of groundwater contamination within the Area B Landfill so that no further remedial actions would be required for the soils and debris associated with the Area B Landfill. Confirmation soil sampling and analysis, as outlined in the Remedial Action Closeout Report (OHM, March 1995), verified that the soil cleanup levels (established in the Final EE/CA Report) were met. Therefore, the primary sources of contamination at Area B have been eliminated.

2.5 Pre-Design Investigation

In October 1993, Baker initiated a pre-design investigation. One of the goals of the pre-design investigation was to further delineate areas of groundwater and soil contamination to facilitate remedial design for site soil and groundwater. Related pre-design activities included: in situ groundwater sampling (hydraulic drive points) and analysis of shallow groundwater in suspected source areas within Area A; temporary well installation (shallow and deep) and groundwater sampling/analysis in Areas A and B; and, test pits in suspected source areas within Area A. The contaminants detected in groundwater and soil were similar to those found during the RI. Detailed information on the pre-design investigation can be found in the Remedial Design Work Plan. A summary of pre-design investigation conclusions are presented below.

Based on results of the in situ groundwater sampling and the temporary well sampling/analysis, the estimated downgradient edges of groundwater contamination in the water table aquifer in Area B and the deep (Yorktown) aquifer in Areas A1, A2 and B were revised as shown in Figure 2-2.

Based on the test pit investigation results and the soil cleanup goals (see Section 4.3), two primary source areas were delineated in Area A for purposes of remedial alternative development in the Feasibility Study. The assumed source areas were designated Areas A1 and A2, as shown in Figures 2-3 and 2-4, respectively. For cost estimating purposes, the volume of contaminated soil was estimated to be 12,800 cubic yards in the Feasibility Study.

2.6 Remedial Design/Remedial Actions

In order to expedite the cleanup of contaminated soil and groundwater at the Camp Allen Landfill site, the DoN has proceeded with preliminary remedial design/remedial action (RD/RA) activities. Remedial design activities were initiated in the spring of 1994 and are expected to be completed in early 1995. The basis for the remedial design (groundwater and soil remediation) is summarized in the Final Basis of Design Report (Baker, 1994). In addition, limited remedial action activities have been initiated at the site, including installation of groundwater extraction wells and performance of DPVE pilot tests in Areas A1 and A2 (OHM, 1994).

Initially, DPVE was recommended for Areas A1 and A2 to provide source control in these "hot spot" areas of the Area A Landfill. As discussed in this PRAP, DPVE technology is no longer recommended for use in Area A2 based on the results of the DPVE pilot study. An alternative remediation approach, using submersible pumps to extract shallow groundwater, is recommended for Area A2. This approach, which was not initially proposed as an alternative in the FS, is now being recommended as the preferred alternative for Area A2 groundwater. Therefore, an additional alternative (A2-GW4) has been added, as discussed in this PRAP.

The purpose of this PRAP is to provide information and to solicit public comments on the selected remedial action. Although RD/RA activities have been initiated at this site, revisions or additions to the remedial activities may still be made after consideration of comments received during the public comment period on this PRAP.

SECTION 2.0 TABLES

TABLE 2-1

SUMMARY OF RI FINDINGS

Media	Area A	Area B
Subsurface Soil	VOCs • West of Brig Facility • North of Brig Facility	VOCs • Middle portion of Area B
Surface Soil	Nominal findings	Nominal findings
Sediment	VOCs • Northwest drainage ditch (Area B related)	VOCs • Ponded area
	Metals • Northeast drainage ditch (Area B related) (various constituents) • Northern drainage ditch (various constituents) • Northwestern drainage ditch (mercury plus others)	Metals • Ponded area (mercury plus others)
Surface Water	VOCs • Northwest drainage ditch (Area B related)	VOCs • Ponded area
	Metals • Throughout Area A (various constituents)	Metals • Ponded area • Throughout drainage ditches
Shallow Groundwater	VOCs • West of Brig Facility • North of Brig Facility	VOCs • South/southeast of Area B
Deep Groundwater	VOCs • West of Brig Facility • North of Brig Facility	VOCs • Underneath Area B

TABLE 2-2 (Continued)

SUMMARY OF COPCs BY ENVIRONMENTAL MEDIUM AND MAXIMUM DETECTED CONCENTRATIONS(1)
AREA A LANDFILL
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

COPCs	Surface Soil (µg/kg)	Subsurface Soil (µg/kg)	Shallow Groundwater (µg/L)	Deep Groundwater (µg/L)	Surface Water (µg/L)	Shallow Sediment (µg/kg)	Deep Sediment (µg/kg)
Volatile Organic Compounds (Continued): Tetrachloroethene	--	--	620	4	6J	--	--
Toluene	--	3,000,000	5,400	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--
Trichloroethene	--	--	1,800	100	20	--	--
1,2,4-Trimethylbenzene	--	--	--	--	--	--	--
1,3,5-Trimethylbenzene	--	--	--	--	--	--	--
Benzyl chloride	--	--	--	--	--	--	--
Vinyl chloride	--	--	3,300	100	6J	--	--
Total Xylenes	--	--	--	--	3J	--	--
Semivolatile Organic Compounds: Hexachlorobutadiene	--	--	--	--	--	--	--

TABLE 2-2 (Continued)

SUMMARY OF COPCs BY ENVIRONMENTAL MEDIUM AND MAXIMUM DETECTED CONCENTRATIONS[1]
AREA A LANDFILL
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

COPCs	Surface Soil (µg/kg)	Subsurface Soil (µg/kg)	Shallow Groundwater (µg/L)	Deep Groundwater (µg/L)	Surface Water (µg/L)	Shallow Sediment (µg/kg)	Deep Sediment (µg/kg)
Semivolatile Organic Compounds: (Continued) 2-Methylphenol	--	--	1,800J	--	--	--	--
2,4-Dimethylphenol	--	--	1,400J	--	--	--	--
4-Methylphenol	--	--	21,000	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	13	--	3J	--	--
Bis(2-chloroethyl)ether	--	--	--	2J	--	--	--
Acenaphthene	--	--	--	--	--	--	4,100
Pesticides: Aldrin	--	--	0.026J	--	--	--	--
alpha-Chlordane	--	--	--	--	0.015J	--	--
delta-BHC	--	--	--	--	0.025J	--	--
gamma-BHC (Lindane)	--	--	--	--	--	--	--

TABLE 2-2 (Continued)

SUMMARY OF COPCs BY ENVIRONMENTAL MEDIUM AND MAXIMUM DETECTED CONCENTRATIONS[1] AREA A LANDFILL CAMP ALLEN LANDFILL NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

COPCs	Surface Soil (µg/kg)	Subsurface Soil (µg/kg)	Shallow Groundwater (µg/L)	Deep Groundwater (µg/L)	Surface Water (µg/L)	Shallow Sediment (µg/kg)	Deep Sediment (µg/kg)
Pesticides (Continued): 4,4'-DDD	--	--	--	--	0.26L	--	--
4,4'-DDE	--	--	--	--	0.069J	110	85
4,4'-DDT	--	--	--	--	--	73L	--
Dieldrin	--	89K	--	--	0.027J	--	62
gamma-Chlordane	--	--	--	--	0.024J	--	--
Heptachlor epoxide	--	--	0.14L	0.0065J	0.006J	--	--
Polychlorinated Biphenyls: Aroclor-1254	--	1,600	--	--	0.44J	--	980
Aroclor-1260	420L	1,800	--	--	--	1,500	--
Metals (2): Aluminum	9,880	--	132,000 (-)	49,600 (-)	20,300J	--	--
Antimony	--	--	31 (-)	-- (-)	--	--	--

TABLE 2-2 (Continued)

SUMMARY OF COPCs BY ENVIRONMENTAL MEDIUM
AND MAXIMUM DETECTED CONCENTRATIONS[1]
AREA A LANDFILL
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

COPCs	Surface Soil (µg/kg)	Subsurface Soil (µg/kg)	Shallow Groundwater (µg/L)	Deep Groundwater (µg/L)	Surface Water (µg/L)	Shallow Sediment (µg/kg)	Deep Sediment (µg/kg)
Metals (Continued): Arsenic	70	--	309 (200L)	64.35L (4.9)	64.2	590	71
Barium	1,050J	--	7,270 (6,060)	(-)	409	--	--
Beryllium	--	--	10.6 (-)	-- (-)	--	--	--
Cadmium	88.9	--	45.9 (-)	6.5 (-)	--	160	180
Chromium	121	--	353 (-)	165.5 (-)	--	3,000	1,700
Copper	477	--	356 (-)	-- (-)	--	553J	--
Lead	683	--	381L (1.6)	44.2 (-)	800	1,000	540
Manganese	128	--	2,060J (2,630)	2,170 (284)	697	51.2	50.7
Mercury	--	--	(-)	(-)	3.9	3	1.1

TABLE 2-2 (Continued)

SUMMARY OF COPCs BY ENVIRONMENTAL MEDIUM
AND MAXIMUM DETECTED CONCENTRATIONS[1]
AREA A LANDFILL
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

COPCs	Surface Soil (μg/kg)	Subsurface Soil (μg/kg)	Shallow Groundwater (μg/L)	Deep Groundwater (μg/L)	Surface Water (μg/L)	Shallow Sediment (μg/kg)	Deep Sediment (μg/kg)
Nickel	--	--	352	-- (-)	--	--	--
Silver	--	--	-- (-)	-- (-)	12	110	49
Thallium	0.92	--	-- (-)	6L (-)	--	--	--
Vanadium	78.7	--	396 (-)	355.5 (-)	--	180	74
Zinc	--	--	-- (-)	-- (-)	1,860J	--	542K

Notes:

(1) Maximum detected concentrations are presented only for those constituents retained as COPCs in the Revised Final Human Health Risk Assessment.

(2) Maximum detected concentrations presented for metals in soils and sediments are in units of mg/kg.

-- Not retained as a COPC for the respective environmental medium in the Revised Final Human Health Risk Assessment.

() = Concentration or "--" in parentheses is for dissolved (filtered) constituent in groundwater.

TABLE 2-3

SUMMARY OF COPCs BY ENVIRONMENTAL MEDIUM
AND MAXIMUM DETECTED CONCENTRATIONS(1)
AREA B LANDFILL AND POND
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

COPCs	Surface Soil (µg/kg)	Subsurface Soil (µg/kg)	Shallow Groundwater (µg/L)	Deep Groundwater (µg/L)	Surface Water (µg/L)	Shallow Sediment (µg/kg)	Deep Sediment (µg/kg)
Volatile Organic Compounds: Benzene	--	--	410	12	12	--	--
Bromomethane	--	--	--	--	--	--	--
2-Butanone	--	--	48	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--
Chloroform	--	--	--	1J	24	--	--
Chloromethane	--	--	--	--	--	--	--
1,4-Dichlorobenzene	--	--	3J	--	--	--	--
1,2-Dichloroethane	--	--	180	450	8J	--	--
1,1-Dichloroethene	--	--	51	--	--	--	--
1,2-Dichloroethene	--	--	1,600	16	--	--	--
4-Methyl-2-pentanone	--	--	--	--	--	--	--
Methylene chloride	--	--	--	--	--	--	--

TABLE 2-3 (Continued)

SUMMARY OF COPCs BY ENVIRONMENTAL MEDIUM AND MAXIMUM DETECTED CONCENTRATIONS[1]
AREA B LANDFILL AND POND
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

COPCs	Surface Soil (µg/kg)	Subsurface Soil (µg/kg)	Shallow Groundwater (µg/L)	Deep Groundwater (µg/L)	Surface Water (µg/L)	Shallow Sediment (µg/kg)	Deep Sediment (µg/kg)
Volatile Organic Compounds (Continued): Tetrachloroethene	--	--	10J	--	--	--	--
Toluene	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--
Trichloroethene	--	3,100	520	35	45	--	--
1,2,4-Trimethylbenzene	--	--	--	--	--	--	--
1,3,5-Trimethylbenzene	--	--	--	--	--	--	--
Benzyl chloride	--	--	--	--	--	--	--
Vinyl chloride	--	16	940J	3	22	60	10J
Total Xylenes	--	--	--	--	--	--	--
Semivolatile Organic Compounds: Hexachlorobutadiene	--	--	--	--	--	--	--

TABLE 2-3 (Continued)

SUMMARY OF COPCs BY ENVIRONMENTAL MEDIUM
AND MAXIMUM DETECTED CONCENTRATIONS[1]
AREA B LANDFILL AND POND
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

COPCs	Surface Soil (µg/kg)	Subsurface Soil (µg/kg)	Shallow Groundwater (µg/L)	Deep Groundwater (µg/L)	Surface Water (µg/L)	Shallow Sediment (µg/kg)	Deep Sediment (µg/kg)
Semivolatile Organic Compounds: (Continued) 2-Methylphenol	--	--	--	--	--	--	--
2,4-Dimethylphenol	--	--	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	5J	--	9J	--	--
Bis(2-chloroethyl)ether	--	--	8J	--	--	--	--
Acenaphthene	--	--	--	--	--	--	--
Pesticides: Aldrin	--	--	--	--	--	--	--
alpha-Chlordane	--	--	--	--	--	--	--
delta-BHC	--	--	--	--	--	--	--
gamma-BHC (Lindane)	--	--	0.15	--	--	--	--

TABLE 2-3 (Continued)

SUMMARY OF COPCs BY ENVIRONMENTAL MEDIUM
AND MAXIMUM DETECTED CONCENTRATIONS(1)
AREA B LANDFILL AND POND
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

COPCs	Surface Soil (µg/kg)	Subsurface Soil (µg/kg)	Shallow Groundwater (µg/L)	Deep Groundwater (µg/L)	Surface Water (µg/L)	Shallow Sediment (µg/kg)	Deep Sediment (µg/kg)
Pesticides (Continued): 4,4'-DDD	--	3,800	--	--	--	4,200	--
4,4'-DDE	--	--	--	--	--	850	60L
4,4'-DDT	--	--	--	--	--	--	4,400
Dieldrin	--	1,500	0.043J	0.009J	--	86K	--
gamma-Chlordane	--	--	--	--	--	--	--
Heptachlor epoxide	--	--	0.006J	0.0105J	--	--	--
Polychlorinated Biphenyls: Aroclor-1254	--	9,500	--	--	--	7,600	--
Aroclor-1260	780L	--	--	--	--	--	--
Metals (2): Aluminum	--	15,500	192,000 (-)	146,000 (-)	690	--	--
Antimony	--	8L	28.7 (32.9)	25.2L (-)	--	16L	--

TABLE 2-3 (Continued)

SUMMARY OF COPCs BY ENVIRONMENTAL MEDIUM
AND MAXIMUM DETECTED CONCENTRATIONS[1]
AREA B LANDFILL AND POND
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

COPCs	Surface Soil (µg/kg)	Subsurface Soil (µg/kg)	Shallow Groundwater (µg/L)	Deep Groundwater (µg/L)	Surface Water (µg/L)	Shallow Sediment (µg/kg)	Deep Sediment (µg/kg)
Metals (Continued): Arsenic	11.6	60.5J	93.6 (16.4)	194L (1.3)	6.7	42.7	--
Barium	--	1,480	1,740 (-)	596 (-)	--	--	--
Beryllium	--	5.6	18.5 (-)	11.2 (-)	--	0.76	0.56
Cadmium	20.5	--	17.8 (-)	30.8 (-)	--	41.9	12
Chromium	44.3	--	774.5 (22.2)	542K (-)	--	--	--
Copper	--	--	380 (-)	225 (-)	--	298	--
Lead	--	--	1,020 (-)	183 (-)	15.8	497J	--
Manganese	102	63.5	4,880 (1,385)	4,740K (356)	272	246	69.6

TABLE 2-3 (Continued)

SUMMARY OF COPCs BY ENVIRONMENTAL MEDIUM
AND MAXIMUM DETECTED CONCENTRATIONS[1]
AREA B LANDFILL AND POND
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

COPCs	Surface Soil (µg/kg)	Subsurface Soil (µg/kg)	Shallow Groundwater (µg/L)	Deep Groundwater (µg/L)	Surface Water (µg/L)	Shallow Sediment (µg/kg)	Deep Sediment (µg/kg)
Mercury	--	--	3 (-)	-- (-)	--	0.35K	--
Nickel	--	--	433 (-)	203 (-)	--	--	--
Silver	--	--	-- (-)	-- (-)	--	14.7	--
Thallium	--	2	-- (-)	-- (-)	--	--	--
Vanadium	--	149	1,610 (29.9)	769K (-)	--	130	--
Zinc	--	--	1,550 (-)	-- (-)	202	1,020	--

Notes:

(1) Maximum detected concentrations are presented only for those constituents retained as COPCs in the Revised Final Human Health Risk Assessment.

(2) Maximum detected concentrations presented for metals in soils and sediments are in units of mg/kg.

-- Not retained as a COPC for the respective environmental medium in the Revised Final Human Health Risk Assessment.

() = Concentration or "--" in parentheses is for dissolved (filtered) constituent in groundwater.

TABLE 2-4

SUMMARY OF COPCs BY ENVIRONMENTAL MEDIUM AND MAXIMUM DETECTED CONCENTRATIONS[1]
AREA B - ELEMENTARY SCHOOL
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

COPCs	Surface Soil (µg/kg)	Subsurface Soil (µg/kg)	Shallow Groundwater (µg/L)	Deep Groundwater (µg/L)	Surface Water (µg/L)	Shallow Sediment (µg/kg)	Deep Sediment (µg/kg)
Volatile Organic Compounds: Benzene	--	--	410	12	--	--	--
Bromomethane	--	--	--	--	--	--	--
2-Butanone	--	--	48	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--
Chloroform	--	--	--	1J	--	--	--
Chloromethane	--	--	--	--	--	--	--
1,4-Dichlorobenzene	--	--	3J	--	--	--	--
1,2-Dichloroethane	--	--	180	450	--	--	--
1,1-Dichloroethene	--	--	51	--	--	--	--
1,2-Dichloroethene	--	--	1,600	16	--	--	--
4-Methyl-2-pentanone	--	--	--	--	--	--	--
Methylene chloride	--	--	--	--	--	--	--

TABLE 2-4 (Continued)

SUMMARY OF COPCs BY ENVIRONMENTAL MEDIUM
AND MAXIMUM DETECTED CONCENTRATIONS(1)
AREA B - ELEMENTARY SCHOOL
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

COPCs	Surface Soil (µg/kg)	Subsurface Soil (µg/kg)	Shallow Groundwater (µg/L)	Deep Groundwater (µg/L)	Surface Water (µg/L)	Shallow Sediment (µg/kg)	Deep Sediment (µg/kg)
Volatile Organic Compounds (Continued): Tetrachloroethene	--	--	10J	--	--	--	--
Toluene	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--
Trichloroethene	--	3,100	520	35	--	--	--
1,2,4-Trimethylbenzene	--	--	--	--	--	--	--
1,3,5-Trimethylbenzene	--	--	--	--	--	--	--
Benzyl chloride	--	--	--	--	--	--	--
Vinyl chloride	--	16	940J	3	--	--	--
Total Xylenes	--	--	--	--	--	--	--
Semivolatile Organic Compounds: Hexachlorobutadiene	--	--	--	--	--	--	--

TABLE 2-4 (Continued)

SUMMARY OF COPCs BY ENVIRONMENTAL MEDIUM
AND MAXIMUM DETECTED CONCENTRATIONS(1)
AREA B - ELEMENTARY SCHOOL
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

COPCs	Surface Soil (µg/kg)	Subsurface Soil (µg/kg)	Shallow Groundwater (µg/L)	Deep Groundwater (µg/L)	Surface Water (µg/L)	Shallow Sediment (µg/kg)	Deep Sediment (µg/kg)
Semivolatile Organic Compounds: (Continued) 2-Methylphenol	--	--	--	--	--	--	--
2,4-Dimethylphenol	--	--	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	5J	--	--	--	--
Bis(2-chloroethyl)ether	--	--	8J	--	--	--	--
Acenaphthene	--	--	--	--	--	--	--
Pesticides: Aldrin	--	--	--	--	--	--	--
alpha-Chlordane	--	--	--	--	--	--	--
delta-BHC	--	--	--	--	--	--	--
gamma-BHC (Lindane)	--	--	0.15	--	--	--	--

TABLE 2-4 (Continued)

SUMMARY OF COPCs BY ENVIRONMENTAL MEDIUM
AND MAXIMUM DETECTED CONCENTRATIONS[1]
AREA B - ELEMENTARY SCHOOL
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

COPCs	Surface Soil (µg/kg)	Subsurface Soil (µg/kg)	Shallow Groundwater (µg/L)	Deep Groundwater (µg/L)	Surface Water (µg/L)	Shallow Sediment (µg/kg)	Deep Sediment (µg/kg)
Pesticides (Continued): 4,4'-DDD	--	3,800	--	--	0.038J	--	--
4,4'-DDE	--	--	--	--	--	--	--
4,4'-DDT	--	--	--	--	--	--	--
Dieldrin	--	1,500	0.043J	0.009J	--	--	--
gamma-Chlordane	--	--	--	--	--	--	--
Heptachlor epoxide	--	--	0.006J	0.0105J	--	--	--
Polychlorinated Biphenyls: Aroclor-1254	--	9,500	--	--	--	--	--
Aroclor-1260	--	--	--	--	--	--	--
Metals (2): Aluminum	--	15,500	192,000 (-)	146,000 (-)	--	--	--
Antimony	7.8L	8L	28.7 (32.9)	25.2L (-)	--	--	--

TABLE 2-4 (Continued)

SUMMARY OF COPCs BY ENVIRONMENTAL MEDIUM
AND MAXIMUM DETECTED CONCENTRATIONS[1]
AREA B - ELEMENTARY SCHOOL
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

COPCs	Surface Soil (µg/kg)	Subsurface Soil (µg/kg)	Shallow Groundwater (µg/L)	Deep Groundwater (µg/L)	Surface Water (µg/L)	Shallow Sediment (µg/kg)	Deep Sediment (µg/kg)
Metals (Continued): Arsenic	25.1L	60.5J	93.6 (16.4)	194L (1.3)	11.5K	--	--
Barium	--	1,480	1,740 (-)	596 (-)	--	--	--
Beryllium	--	5.6	18.5 (-)	11.2 (-)	--	--	--
Cadmium	--	--	17.8 (-)	30.8 (-)	--	--	--
Chromium	869	--	774.5 (22.2)	542K (-)	--	--	--
Copper	--	--	380 (-)	225 (-)	--	--	--
Lead	--	--	1,020 (-)	183 (-)	53.6	--	310
Manganese	61.2	63.5	4,880 (1,385)	4,740K (1,356)	574	--	--

TABLE 2-4 (Continued)

SUMMARY OF COPCs BY ENVIRONMENTAL MEDIUM
AND MAXIMUM DETECTED CONCENTRATIONS[1]
AREA B - ELEMENTARY SCHOOL
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

COPCs	Surface Soil (μg/kg)	Subsurface Soil (μg/kg)	Shallow Groundwater (μg/L)	Deep Groundwater (μg/L)	Surface Water (μg/L)	Shallow Sediment (μg/kg)	Deep Sediment (μg/kg)
Mercury	--	--	3 (-)	-- (-)	--	--	0.8
Nickel	--	--	433 (-)	203 (-)	--	--	--
Silver	--	--	-- (-)	-- (-)	--	--	--
Thallium	--	2	-- (-)	-- (-)	--	--	--
Vanadium	128	149	1,610 (29.9)	769K (-)	--	--	--
Zinc	--	--	1,550 (-)	-- (-)	199J	--	--

Notes:

(1) Maximum detected concentrations are presented only for those constituents retained as COPCs in the Revised Final Human Health Risk Assessment.

(2) Maximum detected concentrations presented for metals in soils and sediments are in units of mg/kg.

-- Not retained as a COPC for the respective environmental medium in the Revised Final Human Health Risk Assessment.

() = Concentration or "--" in parentheses is for dissolved (filtered) constituent in groundwater.

SECTION 2.0 FIGURES

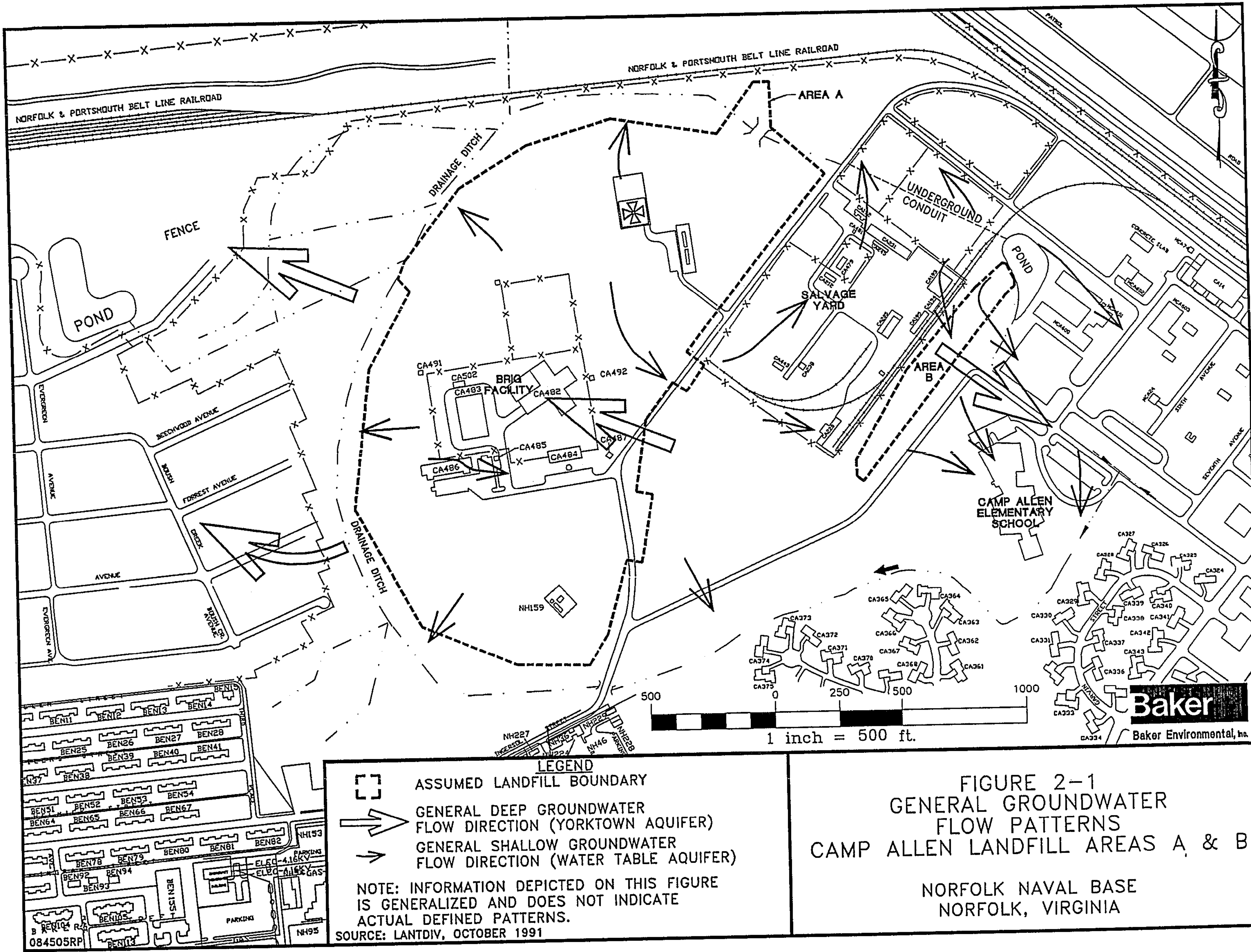


FIGURE 2-1
GENERAL GROUNDWATER FLOW PATTERNS
CAMP ALLEN LANDFILL AREAS A & B

NORFOLK NAVAL BASE
NORFOLK, VIRGINIA

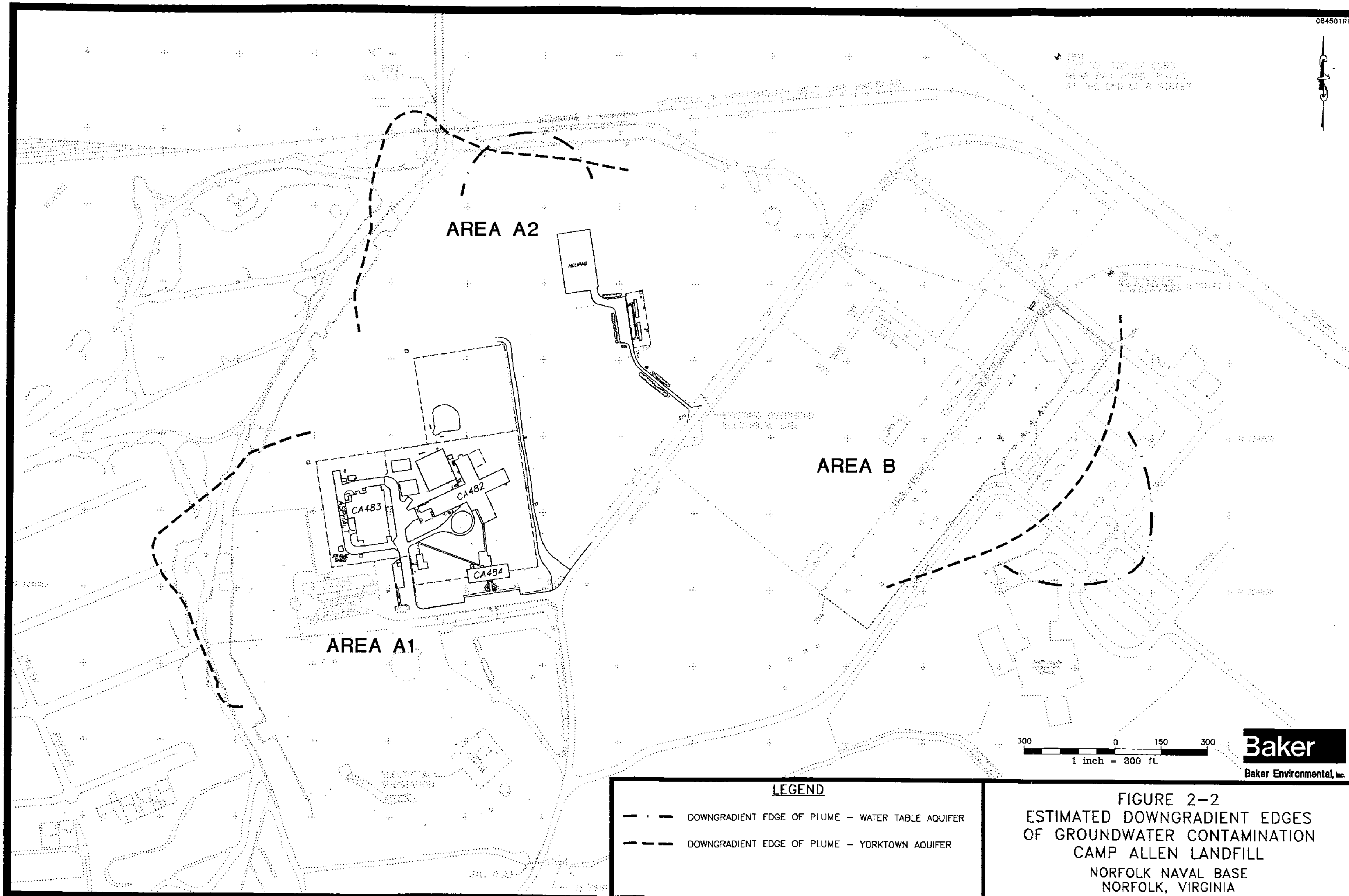
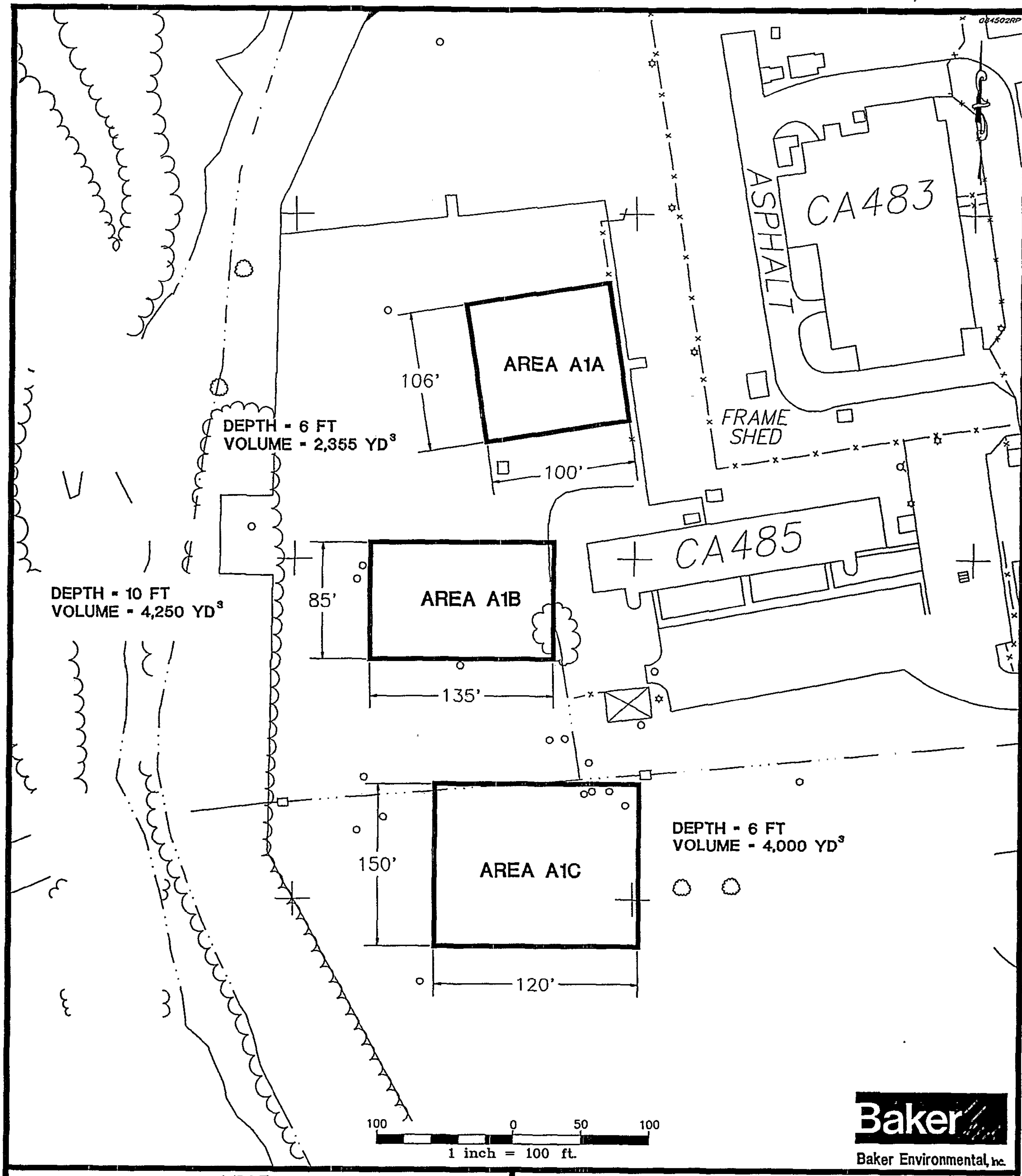


FIGURE 2-2
ESTIMATED DOWNGRADIENT EDGES OF GROUNDWATER CONTAMINATION
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE
NORFOLK, VIRGINIA

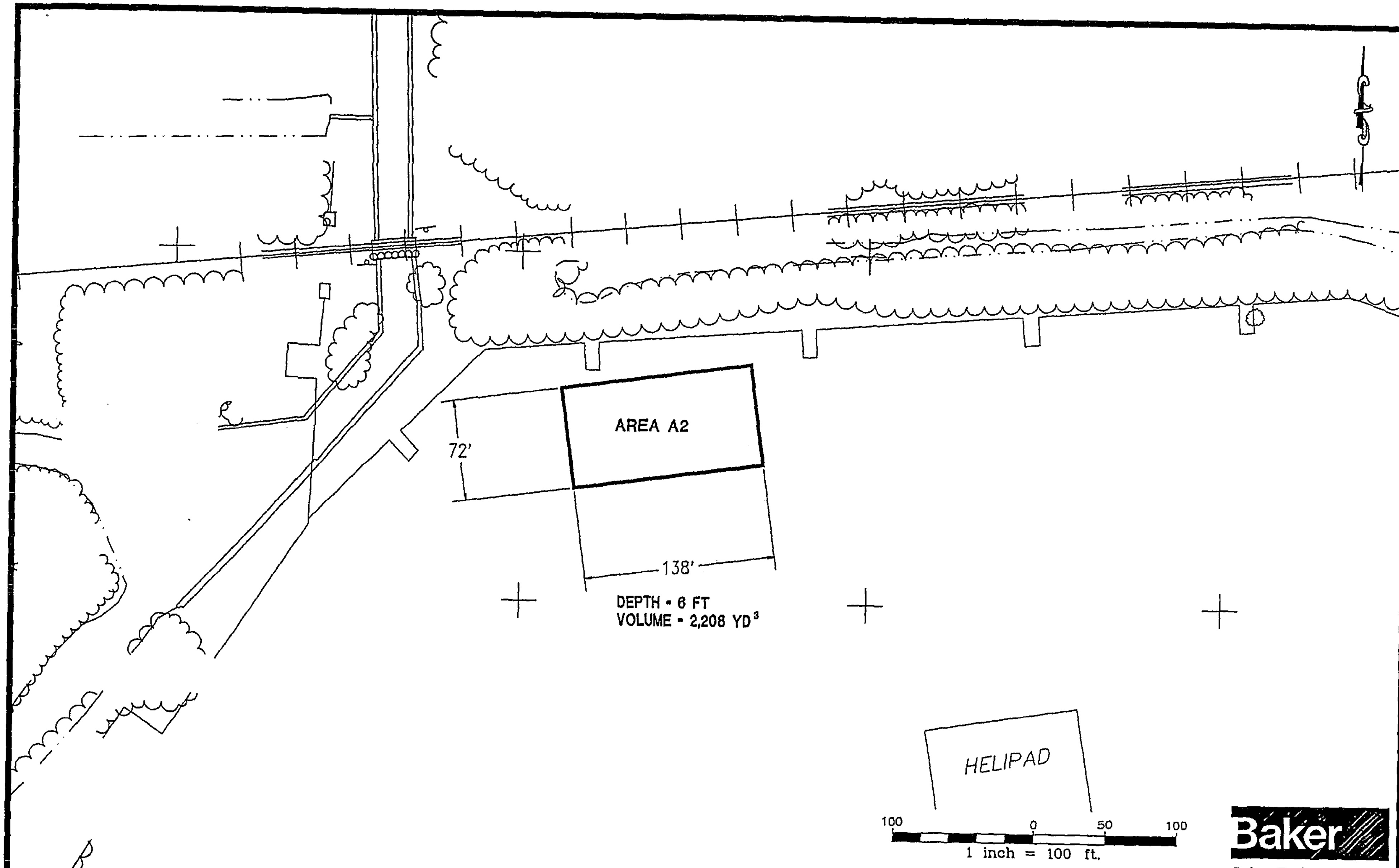


LEGEND

BOUNDARY OF SOIL REMEDIATION AREA

FIGURE 2-3
AREA A1
ESTIMATED SOIL CONTAMINATION AREAS
CAMP ALLEN LANDFILL

NORFOLK NAVAL BASE
NORFOLK, VIRGINIA



LEGEND

BOUNDARY OF SOIL REMEDIATION AREA

FIGURE 2-4
AREA A2
ESTIMATED SOIL CONTAMINATION AREAS
CAMP ALLEN LANDFILL
NORFOLK NAVAL BASE
NORFOLK, VIRGINIA

084503RP

SECTION 3

3.0 SCOPE AND ROLE OF RESPONSE ACTION

The proposed response actions identified in this Proposed Remedial Action Plan (PRAP) address all contaminated media of concern at the site and comprise the overall cleanup strategy for the site. Contaminated media addressed by the proposed response actions include contaminated soil, surface water/sediment, and groundwater in Areas A and B. The recommended response actions (or preferred alternatives) for the various media are identified and the rationale for their selection is described in Section 7.0.

The principal threat posed by conditions at the Camp Allen Landfill site is that contaminated soil in the Area A Landfill provides a continuing source of contamination, which threatens the underlying aquifers. Currently, potable water throughout Camp Allen and the surrounding area is supplied by the City of Norfolk. Residential wells in Glenwood Park, located west of Area A, supply water for nonpotable uses only. Although groundwater at the site currently is not used for any purpose, contaminated groundwater at the site could pose a human health risk if utilized as a drinking water source under a potential future residential use scenario.

The combination of proposed response actions for this site is expected to provide effective source control and substantially reduce the potential for migration of contamination, which will reduce potential human health and environmental risks.

The proposed response actions are expected to comply with applicable or relevant and appropriate requirements (ARARs) and to be considered (TBC) requirements, which are federal and state environmental statutes that are either directly applicable or are considered in the development and evaluation of remedial alternatives at a particular site. Summaries of ARARs and TBCs for the Camp Allen Landfill site are provided in Tables 3-1 and 3-2.

Additional sampling/analysis of surface water/sediment is planned in the immediate future to determine the full extent of ecological impacts to the area surrounding the Camp Allen Landfill.

SECTION 3.0 TABLES

TABLE 3-1

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

Citation	Requirement	ARAR Determination	Comments
FEDERAL/CONTAMINANT-SPECIFIC			
Safe Drinking Water Act (42 USC 300(f)) a. Maximum Contaminant Levels (MCLs) 40 CFR 141.11-141.16 b. Maximum Contaminant Level Goals (MCLGs) 40 CFR 141.50-141.51	Standards for protection of drinking water sources serving at least 25 persons. MCLs consider health factors, as well as economic and technical feasibility of removing a contaminant; MCLGs do not consider the technical feasibility of contaminant removal. For a given contaminant, the more stringent of MCLs or MCLGs is applicable unless the MCLG is zero, in which case the MCL applies.	Relevant and appropriate in developing cleanup goals for contaminated groundwater and surface water that may potentially be used as a potable water supply.	MCLs will be used in developing cleanup goals for the Yorktown Aquifer.
FEDERAL/LOCATION-SPECIFIC			
The Endangered Species Act of 1973 (16 USC 1531) (40 CFR Part 502)	Requires action to conserve endangered and threatened species and their critical habitats.	Applicable because peregrine falcons can be seen any time of year (Audet, 1989).	VADEQ has been notified of this project and the Navy requests the involvement of the Virginia Board of Game and Inland Fisheries for determination of endangered species or habitats.
Coastal Zone Management Act (16 USC 3501)	Conduct activities in a manner consistent with approved State management programs.	Relevant and appropriate to activities conducted within the Virginia coastal zone (Baker, 1988).	VADEQ has been notified of this project and the Navy requests that VADEQ provide requirements to comply with this ARAR.
National Historic Preservation Act (32 CFR Parts 229 and 229.4; 43 CFR Parts 107 and 171.1-5)	Develops procedures for the protection of archaeological resources.	Applicable to any excavation on site. If archaeological resources are encountered during soil excavation, they must be reviewed by Federal and State archaeologists.	Compliance can be met by submitting copies of work plans to the Virginia Department of Historic Resources (VDHR). The Navy requests that VDEQ provide coordination of this project with SHPO.
Executive Order 11988 (related to Floodplain Management)	Regulates activities located in a floodplain must comply with this Executive Order. Federal activities in floodplains must reduce the risk of flood loss, minimize the impact of floods on human safety, health and welfare, and preserve the natural and beneficial values served by floodplains.	Applicable for remedial actions involving activities with a floodplain.	Activities during construction will comply with requirements.

TABLE 3-1

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

Citation	Requirement	ARAR Determination	Comments
FEDERAL/ACTION-SPECIFIC			
DOT Rules for Hazardous Materials Transport (49 CFR Parts 107 and 171.1-500)	Regulates the transport of hazardous waste materials including packaging, shipping, and placarding.	Applicable for any action requiring off-site transportation of hazardous materials.	Remedial actions may include off-site treatment and disposal (e.g., off-site regeneration of activated carbon).
Resource Conservation and Recovery Act (RCRA) Subtitle C	Regulates the treatment, storage, and disposal of hazardous waste.	Applicable to remedial actions involving treatment, storage, or disposal of hazardous waste.	Remediation may involve treatment, storage, or disposal of hazardous waste.
Identification and Listing of Hazardous Waste (40 CFR Part 261)	Regulations concerning determination of whether or not a waste is hazardous based on characteristics or listing.	Applicable in determining waste classification.	Some site contaminants are considered listed wastes.
Treatment, Storage, and Disposal (TSD) of Hazardous Waste (40 CFR Parts 262-265, 266)	Regulates the treatment, storage, and disposal of hazardous waste.	Applicable in the event that wastes on site are classified as hazardous.	TSD activities related to hazardous waste will comply with regulations.
Manifest Systems, Recordkeeping, and Reporting (40 CFR Part 264, Subpart E)	Regulates manifest systems related to hazardous waste treatment, storage, and disposal.	Applicable to remedial actions where hazardous waste is generated or transported.	Remedial actions may include off-site disposal or treatment.
Releases from Solid Waste Management Unites (40 CFR Part 264, Subpart F)	Regulates releases from solid waste management units.	All solid waste management units on site shall comply with requirements.	Groundwater protection standards apply to solid waste management units.
Use and Management of Containers (40 CFR Part 264, Subpart I)	Regulates use and management of containers being stored at all hazardous waste facilities.	Applicable to containers stored on site.	Remedial actions may generate containerized waste. Investigation-derived waste (IDW) is containerized.
Resource Conservation and Recovery Act (RCRA) Subtitle D	Regulates the treatment, storage, and disposal of solid waste.	Applicable to remedial actions involving treatment, storage, or disposal of materials classified as solid waste.	Remediation may include treatment, storage, or disposal of solid waste.
National Emissions Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR Part 61)	Standards promulgated under the Clean Air Act for significant sources of hazardous pollutants, such as vinyl chloride, benzene, trichloroethylene, dichlorobenzene, asbestos, and other hazardous substances. Considered for any source that has the potential to emit 10 tons of any hazardous air pollutant or 25 tons of a combination of hazardous air pollutants per year.	Applicable to releases or potential releases of hazardous pollutants. Remedial actions (e.g., air stripping) may result in release of hazardous air pollutants. The treatment design would include air emissions control equipment as required to comply with NESHAPs.	To be used during remedial design to determine that air emissions from the treatment facility will not exceed air emission standards.

TABLE 3-1

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

Citation	Requirement	ARAR Determination	Comments
STATE/CONTAMINANT-SPECIFIC			
Virginia Water Quality Standards (VR 680-21-00)	Surface water quality standards based on water use and criteria class of surface water.	Applicable to remedial actions requiring discharge to surface water.	Will be used to determine the discharge limit from the treatment facility.
Virginia Groundwater Standard (VR 680-21-04.3)	Establishes groundwater standards for State Antidegradation policy.	Relevant and appropriate for contaminants for which no MCL exists.	MCLs available for all contaminants of concern.
Virginia Ambient Air Quality Standards (VAAQS) (VR 120-03-01)	Primary and secondary air quality standards for particulate matter, sulfur oxides, carbon monoxide, nitrogen dioxide, and lead.	Potentially applicable for remedial actions requiring discharge to the atmosphere.	Air emissions from the treatment facility will be monitored to comply with the substantive requirements of VAAQS provided by VADEQ.
Virginia Emission Standards for Toxic Pollutants (VR 120-01)	Establishes acceptable limits for toxic pollutants by applying a 1/40 correction factor to the occupational standard Threshold Limit Value-Ceiling (TLV-Ceiling).	These standards are applicable requirements for remedial actions requiring discharge to the atmosphere. Air calculations are provided in Appendix F that demonstrate compliance with standards.	To be used during remedial design to determine whether air emissions from the treatment facility will not exceed air emission standards.
Virginia Pollution Discharge Elimination System (VPDES) (VR 680-14-01) Regulation and Virginia Water Protection Permit Regulations (VR 680-15-01)	Regulated point-source discharges through the 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.	Substantive requirements of VPDES permit will be used to determine the discharge limits for the discharge of the treated water to surface water on site.
STATE/ACTION-SPECIFIC			
Virginia Solid Waste Management Regulations (VR 672-20-10)	Regulates the disposal of solid wastes.	Applicable for solid (nonhazardous) waste.	Remedial actions could include off-site disposal of nonhazardous waste.
Virginia Hazardous Waste Regulations (VR 72-30-1 and VR 672-10-1, Part VII)	Regulates the transport of hazardous waste materials including packaging, shipping, and placarding.	Applicable for any action requiring off-site transportation of hazardous materials.	Remedial actions may include off-site treatment and disposal (e.g., off-site regeneration of activated carbon).

TABLE 3-1

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

Citation	Requirement	ARAR Determination	Comments
STATE/ACTION-SPECIFIC			
Virginia Hazardous Waste Management Regulations (VR 672-10-1)	Regulates the treatment, storage, and disposal of hazardous waste.	Applicable to remedial actions involving treatment, storage, or disposal of hazardous waste.	Remediation may include treatment, storage, or disposal of hazardous waste.
Identification and Listing of Hazardous Waste (VR 672-10-1, Part III)	Regulations concerning determination of whether or not a waste is hazardous based on characteristics or listing.	Applicable in determining waste classification.	Some site contaminants are considered listed wastes.
Manifest Systems, Recordkeeping, and Reporting (VR 672-10-1, Part X, Section 10.4)	Regulates manifest systems related to hazardous waste treatment, storage, and disposal.	Applicable to remedial actions where hazardous waste is generated or transported.	Remedial actions may include off-site disposal or treatment.
Releases from Solid Waste Management Unites (VR 672-10, Part X, Section 10.5)	Regulates releases from solid waste management units.	All solid waste management units on site shall comply with requirements.	Groundwater protection standards apply to solid waste management units.
Use and Management of Containers (VR 672-10, Part X, Section 10.8)	Regulates use and management of containers being stored at all hazardous waste facilities.	Applicable to containers stored on site.	Remedial actions may generate containerized waste. Investigation-derived waste (IDW) is containerized.
Virginia Stormwater Management Regulations (VR 215-02-00) and Virginia Erosion and Sediment Control Regulations (VR 625-02-00)	Regulates stormwater management and erosion/ sedimentation control practices that must be followed during land disturbing activities.	Applicable for remedial actions involving land disturbing activities.	Activities during construction will comply with the Virginia Storm Water Management Program. A sediment and erosion control plan will be submitted to LANTDIV for approval.
Virginia Endangered Species Act (Code of Virginia 29.1-563)	Requires action to conserve endangered and threatened species and their critical habitats.	Applicable because peregrine falcons can be seen any time of year (Audet, 1989).	VADEQ has been notified of this project. The Navy requests determination of endangered species or habitats from VADEQ.
Virginia Wetlands Regulations (VR 450-01-0051)	Regulates activities that impact tidal wetlands.	Relevant and appropriate to activities that could impact site wetlands.	Activities that could impact wetlands will comply with regulations.
Chesapeake Bay Preservation Area Designation and Management Regulations (VR 173-02--01)	Sets limitations in certain tidal and wetland areas for land-disturbing activities, removal of vegetation, use of impervious cover, E&S control, stormwater management, etc.	Potentially relevant and appropriate if site is within jurisdiction.	If required, plans will be submitted to the appropriate agency for approval.
Coastal Management Plan City of Norfolk	Activities within a Coastal Management Zone must be in compliance with local requirements.	Relevant and appropriate.	Remedial activities will comply with local requirements.

TABLE 3-2

TO BE CONSIDERED (TBC) REQUIREMENTS
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

Citation	Requirement	TBC Determination	Comments
FEDERAL/CONTAMINANT-SPECIFIC			
Reference Doses (RfDs), EPA Office of Research and Development	Presents non-enforceable toxicity data for specific chemicals for use in public health assessments to characterize risks due to exposure to contaminants.	To be considered (TBC) requirement in the public health assessment.	Will be used in evaluating human health risks at the site.
Carcinogenic Potency Factors, EPA Environmental Criteria and Assessment Office; EPA Carcinogen Assessment Group	Presents non-enforceable toxicity data for specific chemicals for use in public health assessments to compute the individual incremental cancer risk resulting from exposure to carcinogens.	TBC requirement in the public health assessment.	Will be used in evaluating human health risks at the site.
Health Advisories, EPA Office of Drinking Water	Non-enforceable guidelines for chemicals that may intermittently be encountered in public water supply systems. Available for short- or long-term exposure for a child and/or adult.	TBC requirement in the public health assessment.	Will be used in evaluating human health risks at the site.
FEDERAL/LOCATION-SPECIFIC			
RCRA Subtitle C Landfills (40 CFR Part 264, Subpart N)	Regulates owners and operators of facilities that dispose hazardous wastes in landfills.	TBC to evaluate compliance of off-site landfills.	TBC for remedial actions that involve off-site landfill of hazardous waste (sludge or IDW).
Groundwater Protection Strategy	EPA policy to protect groundwater for its highest present or potential beneficial use. The strategy designates three categories of groundwater: Class 1 - Special Ground Waters Class 2 - Current and Potential Sources of Drinking Water and Waters Having Other Beneficial Uses Class 3 - Groundwater Not a Potential Source of Drinking Water and of Limited Beneficial Use	TBC requirement.	Groundwater in the Yorktown Aquifer is considered a Class 2 given its historical, current, and expected future use. Groundwater in the surficial (water table) aquifer is considered a Class 3.

TABLE 3-2

TO BE CONSIDERED (TBC) REQUIREMENTS
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

Citation	Requirement	TBC Determination	Comments
FEDERAL/ACTION-SPECIFIC			
National Ambient Air Quality Standards (NAAQS) (40 CFR 50)	Standards for the following six criteria pollutants: particulates matter; sulfur dioxide; carbon monoxide; ozone; nitrogen dioxide; and lead. The attainment and maintenance of these standards are required to protect the public health and welfare.	TBC requirements for remedial actions requiring discharge to the atmosphere. The treatment design would include air emissions control equipment as required to comply with NAAQS.	Air emissions from the treatment plant will be monitored to comply with the substantive requirements of NAAQS.
Control of Air Emissions from Superfund Air Strippers at Superfund Ground Water Sites (OSWER Directive 9355.0-28)	Guidance that establishes criteria as to whether air emission controls are necessary for air strippers. A maximum 3 lbs/hr or 15 lbs/day or 10 tons/yr of VOC emissions is allowable; air pollution controls are recommended for any emissions in excess of these quantities.	TBC requirement.	TBC as remedial action includes air stripping.
National Ambient Air Quality Standards (NAAQS) (40 CFR 50)	Standards for the following six criteria pollutants: particulates matter; sulfur dioxide; carbon monoxide; ozone; nitrogen dioxide; and lead. The attainment and maintenance of these standards are required to protect the public health and welfare.	TBC requirements for remedial actions requiring discharge to the atmosphere. The treatment design would include air emissions control equipment as required to comply with NAAQS.	Air emissions from the treatment plant will be monitored to comply with the substantive requirements of NAAQS.
STATE/LOCATION-SPECIFIC			
RCRA Subtitle C Landfills (VR 672-10, Part X, Section 10.13)	Regulates owners and operators of facilities that dispose hazardous wastes in landfills.	TBC to evaluate compliance of off-site landfills.	TBC for remedial actions that involve off-site landfill of hazardous waste (sludge or IDW).

SECTION 4

4.0 SUMMARY OF SITE RISKS/REMEDIATION GOALS

The public health risks associated with exposure to contaminated media within Areas A and B of the Camp Allen Landfill Site were evaluated in the baseline risk assessment. The baseline risk assessment evaluated and assessed the potential public health risks which might result under current and potential future land use scenarios. An ecological evaluation also was performed. The public health risks and ecological risks associated with the site are summarized below and are presented in detail in the Final Baseline Risk Assessment.

4.1 Summary of Human Health Risks

Incremental cancer risks (ICRs) and the potential to experience non-carcinogenic adverse effects (i.e., central nervous system effects, kidney effects, etc.), as measured by a hazard index (HI), were evaluated in this assessment. Estimated incremental cancer risks were compared to the target risk range of 10^{-4} to 10^{-6}, which the USEPA considers to be safe and protective of public health (USEPA, 1989). The calculated HI was compared to a threshold value of one; below this level, there is minimal potential to experience noncarcinogenic adverse health effects.

The risk assessment indicates that past practices at the Camp Allen Landfill Site have contaminated certain media to the extent that they pose a potential threat to human health only under certain potential future residential use scenarios. Although future residential use scenarios are unlikely at the site, they have been incorporated into the baseline comparisons. Table 4-1 summarizes potential health risk values associated with soil, surface water, and sediment under current use and potential future use (residential) scenarios. Table 4-2 summarizes potential health risk values associated with groundwater under current use (non-potable) and potential future use (potable) scenarios. Risk values presented for soil, sediment, surface water, shallow groundwater, and deep groundwater are considered to be "worst case," as they were derived by selecting those sampling locations with the most primary constituents of potential concern (COPCs). Sample locations were also selected so as to not underestimate the resulting potential human health risks.

A summary of human health risks for Areas A and B at the site, by media, is described below.

Area A - Soil

Results of the baseline risk assessment indicate that no unacceptable adverse human health effects would be expected from exposure (via ingestion, inhalation, and dermal contact) to the surface soil at Area A under the current land use of the area as a brig (for either prisoners or brig employees). Also, the risk assessment indicates that no unacceptable adverse human health effects would be expected from exposure to subsurface soils at Area A under a future use scenario for remedial construction workers. However, the HIs calculated for a child and an adult receptor under a future residential use scenario 6.4 and 1.3, respectively, which exceeds the acceptable HI of 1.0 under CERCLA. In addition, ICRs of 1.4 x 10^{-4} and 1.8 x 10^{-4} were estimated for a child and an adult receptor, respectively, under a future residential use scenario. These ICRs exceed USEPA's acceptable target risk range of 10^{-4} to 10^{-6}, which the USEPA considers to be safe and protective of public health (USEPA, 1989).

Area B - Soil

Results of the baseline risk assessment indicate that no unacceptable adverse human health effects would be expected from exposure (via ingestion, inhalation, and dermal contact) to the surface soil at Area B under the current land use in the area (i.e., for either employees or children at the Camp Allen Elementary School). Also, the risk assessment indicates that no unacceptable adverse human health effects would be expected from exposure of remedial construction workers to subsurface soils at the Area B Landfill/Pond/School under a remediation (removal action) scenario. The HIs calculated for a child receptor under a future residential use scenario ranged from 1.6 at the Area B Landfill/Pond to 4.5 in the school area, which exceed the acceptable HI of 1.0 under CERCLA; however, no unacceptable risks are indicated for an adult receptor under a future residential use scenario. Also, these risks were calculated at the Area B Landfill/Pond based on existing conditions prior to the removal action that has been implemented in this area. Therefore, the actual risks may be much lower in this area since the removal action has been successfully completed.

Area A - Surface Water/Sediment

Results of the baseline risk assessment indicate that, under the current land use of this area as a brig, no unacceptable adverse human health effects would be expected from exposure (via ingestion and dermal contact) to surface water or sediment in Area A. Under a future residential land use scenario, the HIs calculated for a child receptor ranged from 4.0 to 4.8 for exposure (via ingestion and dermal contact) to shallow and deep sediments, respectively, which exceed the acceptable HI of 1.0 under CERCLA. An ICR of 1.2×10^{-4} was estimated for a young child resident exposed to shallow sediments, which exceeds USEPA's target risk range of 10^{-4} to 10^{-6}. However, no unacceptable risks are indicated for an adult receptor for exposure to sediments under a future residential use scenario. Also, under a future residential land use scenario, the ICR for a child receptor associated with exposure (via ingestion and dermal contact) to surface water is $2.0 \text{ X } 10^{-4}$, which slightly exceeds the acceptable ICR of $1.0 \text{ X } 10^{-4}$ under CERCLA. Under a future residential land use scenario, the ICR for an adult receptor associated with exposure (via ingestion and dermal contact) to surface water is $1.2 \text{ X } 10^{-4}$, which also slightly exceeds the acceptable ICR of $1.0 \text{ X } 10^{-4}$ under CERCLA.

Area B - Surface Water/Sediment

Results of the baseline risk assessment indicate that, under the current land use of the Area B pond and school, no unacceptable human health effects would be expected from exposure (via ingestion and dermal contact) to the surface water and sediment in the vicinity of Area B. Under a future residential land use scenario, the HI calculated for a child receptor at the Area B Landfill and Pond, under a future residential scenario, was 2.0 for exposure (via ingestion and dermal contact) to shallow sediments. This exceeds the acceptable HI of 1.0 under CERCLA. However, no unacceptable risks are indicated for a child receptor for exposure to surface water, and no unacceptable risks are indicated for an adult receptor for exposure to surface water or sediments under a future residential use scenario.

Area A Groundwater

Results of the baseline risk assessment for Area A indicate that no unacceptable adverse human health effects would be expected from exposure (via incidental ingestion and dermal contact) to the shallow groundwater under the current land use in the area (i.e., nonpotable use of groundwater by

Glenwood Park residents). Groundwater currently is not used for any purpose at the brig facility in Area A.

Under a potential future residential use scenario, the baseline risk assessment indicates that unacceptable risks for both children and adult receptors would be expected from exposures to COPCs in both the shallow and deep aquifers via ingestion, dermal contact, and inhalation under a potable use scenario. A summary of maximum incremental cancer risks and hazard indices for shallow (water table aquifer) and deep (Yorktown Aquifer) groundwater under potential current and future use scenarios is presented in Table 4-2.

Area B Groundwater

Results of the baseline risk assessment for Area B indicate that no unacceptable adverse human health effects would be expected from exposure to either deep or shallow groundwater under the current land use in the area since groundwater currently is not used for any purpose at Area B.

Under a potential future residential use scenario (potable use of shallow or deep groundwater), the baseline risk assessment indicates that unacceptable risks for both children and adult receptors would be expected from exposure via ingestion, dermal contact, and inhalation . A summary of maximum incremental cancer risks and hazard indices for shallow and deep groundwater under potential current and future use scenarios is presented in Table 4-2.

4.2 Summary of Ecological Evaluation

The ecological evaluation focused upon three measures of environmental impact from the Camp Allen Landfill: exceedances of state and federal criteria for surface waters and sediments, the presence and distribution of benthic macroinvertebrates, and a qualitative assessment of terrestrial flora and fauna.

Surface water constituents exceeded federal criteria and/or Commonwealth of Virginia Standards at sampled locations throughout Areas A and B. National Oceanic and Atmospheric Administration (NOAA) sediment criteria were also exceeded at various locations. These exceedances represent the potential for environmental impacts.

The endpoint of the ecological evaluation used to assess the aquatic and terrestrial environment is decreased integrity of the aquatic and terrestrial community. Exceedances of surface water and sediment quality measurement endpoints indicate a low to moderate potential for risk to aquatic life. The benthic community is characteristic of an aquatic ecosystem that has potential impacts from both contaminant exposure and natural conditions. In addition, this benthic community exhibited spatial variations within the range of natural population variation in similar environments. Based on this finite ecological risk assessment, the aquatic community may be impacted by releases from the Camp Allen Landfill. However, remedial measures are being implemented that provide both source removal and source containment, as well as treatment to control further COPC migration into the drainage ditches. Therefore, post-remediation studies are warranted to evaluate the reduction of risks to the aquatic community as a result of site remediation activities.

The terrestrial qualitative evaluation did not produce any significant indicators of risk to terrestrial receptors based on observations of diversity and productivity of the fauna and flora. In addition, results of this evaluation suggest that significant potential effects on terrestrial receptors resulting from Area A and B were not observed at any location. For an urban area, the terrestrial habitats appear to be diverse and productive.

4.3 Site Remediation Goals

Based on RI findings and the results of the baseline risk assessment, three media of concern have been identified at the Camp Allen Landfill Site as follows:

- Soils
- Surface Water/Sediments
- Groundwater

Remedial action objectives are developed for each medium of concern considering the contaminants of concern, potential receptors, and exposure scenarios. Given the removal action at Area B, remedial action objectives for soil differ slightly between Areas A and B of the Camp Allen Landfill Site. Remedial action objectives for the various site media are as follows:

- Soil
  - Prevent exposure to subsurface soil and debris.
  - Minimize migration of contaminants to groundwater and surface water (Area A only, since removal action at Area B has been successfully implemented).

- Surface Water/Sediment
  - Prevent exposure to potential contaminants in surface water and sediments.
  - Address indirectly through the development of soil and groundwater alternatives.

- Groundwater
  - Prevent exposure to contaminated groundwater.
  - Prevent further migration of contaminated groundwater.
  - Restore contaminated aquifers.

Cleanup goals are developed in the following sections for soils and groundwater. Cleanup goals have not been established for surface water/sediments because contamination levels do not suggest a need for active remediation of site surface water/sediments, as discussed in Section 5.2.

4.3.1 Soil Cleanup Goals

Soil analytical data obtained during the Camp Allen Landfill pre-design investigation indicate the presence of volatile organic compounds (VOCs) in subsurface soils in Areas A1 and A2. Under the influence of infiltrating precipitation, these VOCs may migrate through the unsaturated zone soils to the water table aquifer. Thus, under current conditions, the contaminated subsurface soils in Areas A1 and A2 could potentially act as sources of continuing contamination to underlying groundwater. The objective of soil cleanup goal development was to determine subsurface soil cleanup goals based on the potential for the VOCs to migrate (i.e., leach) to the water table aquifer in Areas A1 and A2 at the Camp Allen Landfill.

A spreadsheet-based transport model described by Summers was developed to determine the potential soil cleanup goals. The Summers Model is a one-dimensional advective transport model that estimates the potential contaminant concentration in leachate (emanating from the source area) at the top of the water table aquifer. The general input data for the spreadsheet model includes contaminant characteristics, unsaturated zone characteristics, hydrogeological properties of the water table aquifer, and annual precipitation data. Site-specific data were obtained from the pre-design investigation as well as from previous field investigations. A more detailed description of the Summers Model, as well as the specific modeling inputs and their sources used in the spreadsheet calculation of soil cleanup goals, are provided in the Final Camp Allen Landfill Feasibility Study.

The soil cleanup goals developed using the Summers Model for the contaminants of concern in Areas A1 and A2 are provided in Table 4-3. The soil cleanup goals shown in Table 4-3 were based on attainment of maximum contaminant levels (MCLs) in shallow groundwater immediately below the source area in order to protect the underlying Yorktown Aquifer for its potential future beneficial use (i.e., potential future drinking water supply). Since the MCLs for the contaminants of concern are less than the Federal Ambient Water Quality Criteria and Virginia Water Quality Standards, soil cleanup goals are also protective of surface water.

The soil cleanup goals were used to estimate remediation areas and the volume of contaminated soil in Area A. It should be noted that, since Area A is a landfill, the primary remediation goal for the soils is groundwater protection rather than soil cleanup. Therefore, achievement of this goal will be determined through evaluation of actual environmental monitoring results (i.e., via on-going monitoring of contaminant levels in groundwater), and will not necessarily be based on attainment of the developed soil cleanup goals, since they represent theoretical values calculated through modeling.

4.3.2 Groundwater Cleanup Goals

Cleanup goals for each aquifer have been developed based on the potential beneficial use of the aquifer. For the Yorktown Aquifer, the groundwater cleanup goals were based on attainment of federal MCLs in order to protect the aquifer for its potential future beneficial use (i.e., potential future drinking water supply). The cleanup goals for the Yorktown Aquifer are shown in Table 4-4.

It is recognized that MCLs may be impossible to achieve since it has been demonstrated that groundwater contaminant levels typically reach asymptotic levels, which may exceed MCLs.

Performance curves will be periodically (e.g., annually) developed to monitor groundwater contaminant levels. If the performance curves indicate that asymptotic levels have been reached that exceed MCLs for some contaminants, then the cleanup goals may be reevaluated at that time.

Unlike the Yorktown Aquifer, the beneficial use of the water table aquifer is nonpotable use. Therefore, nonpotable use cleanup goals were developed for the water table aquifer, which were based on a 1×10^{-6} cancer risk level and a hazard quotient of 1.0 for children, and the exposure pathways of incidental ingestion and dermal absorption of contaminants during outdoor activities, such as car washing and lawn watering. Cleanup goals for the water table aquifer also are presented in Table 4-4.

As a point of comparison, Federal Ambient Water Quality Criteria (AWQC) were included in Table 4-4 (there are no State AWQC for the contaminants of potential concern). These surface water criteria would apply to groundwater as it discharges into surface water. The Yorktown Aquifer cleanup goals (based on Federal MCLs) are less than the Federal AWQC for all contaminants. The water table aquifer cleanup goals are less than the Federal AWQC for all contaminants except toluene. However, the maximum concentration of toluene detected in groundwater (567 µg/L) is less than the Federal AWQC for toluene (5,000 µg/L). Therefore, these groundwater cleanup levels are also protective of surface water.

SECTION 4.0 TABLES

TABLE 4-1

SUMMARY TABLE OF MAXIMUM INCREMENTAL CANCER RISKS (ICR) AND HAZARD INDICES (HI) FOR MEDIA OF INTEREST, AREAS A AND B
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

	Area A				Area B - Pond/Landfill				Area B - School			
	Potential Current		Potential Future		Potential Current		Potential Future		Potential Current		Potential Future	
Medium	HI	ICR	HI(3)	ICR(3)	HI(1)	ICR(1)	HI(3)	ICR(3)	HI	ICR	HI(3)	ICR
Soils	0.82(2)	7.0×10^{-5}(1)	**6.4**	**1.8×10^{-4}(6)**	0.13	1.9×10^{-5}	**1.6**	4.5×10^{-5}(6)	0.73(5)	2.7×10^{-5}(1)	**4.5**	6.7×10^{-5}(6)
Sediments	0.38(4)	1.8×10^{-5}(4)	**4.0**	$1.2\text{x}10^{-4}$(3)	0.002	4.4×10^{-6}	**2.0**	7.1×10^{-5}(3)	(7)	(7)	0.014	(7)
Surface Waters	0.040(4)	4.2×10^{-5}(4)	0.64	**2.0×10^{-4}(3)**	0.074	2.1×10^{-6}	0.34	2.1×10^{-5}(3)	0.019(5)	3.1×10^{-6}(5)	0.03	6.3×10^{-6}(3)

Notes: Hazard indices exceeding 1 and Incremental Cancer Risks exceeding 1×10^{-4} are shown in bold face type.
(1) Industrial Use (Adults)
(2) Brig Prisoners
(3) Resident Young Child (1-6 yrs)
(4) Resident Older Child (6-15 yrs)
(5) School Children (6-12 yrs)
(6) Resident Adults.
(7) No contaminants of concern detected.

Current - Current potential exposure
Future - Future potential (residential) exposure

TABLE 4-2

SUMMARY TABLE OF MAXIMUM INCREMENTAL CANCER RISKS (ICR) AND HAZARD INDICES (HI) FOR SHALLOW AND DEEP GROUNDWATER, AREAS A AND B CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

	Area A (and Glenwood Park Residential Area)							
	Potential Current				Potential Future			
	Child		Adult		Child		Adult	
Medium	HI	ICR	HI	ICR	HI	ICR	HI	ICR
Shallow	0.003	3.8×10^{-7}	0.001	6.4×10^{-7}	**620**	**1.8×10^{-1}**	**300**	**2.7×10^{-1}**
Deep Groundwater	NA	NA	NA	NA	**12**	**5.4×10^{-3}**	**7.5**	**8.9×10^{-3}**

	Area B							
	Potential Current				Potential Future			
	Child		Adult		Child		Adult	
Medium	HI	ICR	HI	ICR	HI	ICR	HI	ICR
Shallow	NA	NA	NA	NA	**30**	**1.4×10^{-2}**	**0.19**	**2.9×10^{-2}**
Deep Groundwater	NA	NA	NA	NA	**4.6**	3.8×10^{-5}	**2.8**	8.0×10^{-5}

Notes: Hazard indices exceeding 1 and Incremental Cancer Risks exceeding 1×10^{-4} are shown in bold face type.
Current Use - Potential nonpotable use of groundwater (child, swimming pools; adults, car washing).
Future Use - Potential residential potable use of groundwater.
NA - Scenario not applicable (i.e., groundwater in Area B currently not used for potable or nonpotable).

TABLE 4-3

SOIL CLEANUP GOALS
CAMP ALLEN LANDFILL SITE, NORFOLK, VIRGINIA

CONTAMINANTS OF CONCERN	GROUNDWATER GOAL* (ppm)	SOIL CLEANUP GOAL (ppm)
1,2-Dichloroethane	0.005	0.05
1,2-Dichloroethene (cis)	0.070	3.1
1,1,1-Trichloroethane	0.200	21.3
Benzene	0.005	0.2
Ethylbenzene[(1)]	0.700	500
Tetrachloroethene	0.005	1.4
Toluene	1.000	220.7
Trichloroethene	0.005	0.5
Vinyl Chloride	0.002	0.01
Xylenes[(1)]	10.00	7000

* Soil cleanup goals are derived from groundwater goals, which are based on Federal Safe Drinking Water Act Maximum Contaminant Levels (MCLs), USEPA, May 1993.

(1) Monte Carlo analyses not performed for these compounds.

TABLE 4-4

GROUNDWATER CLEANUP GOALS (μg/L)
CAMP ALLEN LANDFILL SITE, NORFOLK, VIRGINIA

Contaminants of Concern	Yorktown Aquifer[1] Cleanup Goals (μg/L)	Water Table Aquifer[2] Cleanup Goals (μg/L)	Federal AWQC[4]		Maximum Concentration Detected in Groundwater[5]
			Freshwater Chronic	Marine Chronic	
1,2-Dichloroethane	5	190	20,000	--	600
1,2-Dichloroethene (cis)	70	15,000	--	--	3,807
1,1,1-Trichloroethane	200	13,500	--	--	ND
Benzene	5	600	--	700	600
Ethylbenzene	700	150,000	--	--	ND
Tetrachloroethene	5	340	840	450	354
Toluene	1,000	301,000	--	5,000	567
Trichloroethene	5	1,600	21,900	--	699
Vinyl Chloride	2	9	--	--	ND
Xylenes	10,000	3,000,000	--	--	672

(1) Based on federal Safe Drinking Water Act Maximum Contaminant Levels (MCLs), USEPA, May 1994.
(2) Based on incidental ingestion under a nonpotable use scenario and an incremental cancer risk of 1×10^{-6} and a hazard quotient (HQ) of 1.0 for children.
(3) Cleanup goals are based on contaminants found in soil and groundwater during the pre-design investigation.
(4) Ambient water quality criteria (AWQC) are included to present a comparison between groundwater cleanup goals and surface water quality criteria. AWQC standards are based on Federal Water Quality Criteria (USEPA Water Quality Criteria, May 1, 1991).
(5) Maximum concentration detected in groundwater during the pre-design investigation.
ND = Not detected
-- = Criteria not available

SECTION 5

5.0 SUMMARY OF REMEDIAL ALTERNATIVES

For the various contaminated media at the Camp Allen Landfill to be addressed by response actions (soils, surface water/sediment and groundwater), summaries of the remedial alternatives evaluated for each contaminated media are presented in Sections 5.1 through 5.3.

5.1 Soils

Primary contaminants of concern in Area A and Area B soils are VOCs, consisting of chlorinated organics, such as trichloroethene, and fuel-related compounds, such as benzene, present in buried waste materials. The soils in Area A and Area B are addressed separately. Remedial alternatives for Area A and Area B are summarized in the following sections.

5.1.1 Area A Soils

The Area A contaminated soils provide a potential on-going source of groundwater contamination at the site. Based on the test pit investigation performed during the pre-design study and the soil cleanup goals (see Section 4.3.1), primary source areas have been delineated in Areas A1 and A2 (Figures 2-3 and 2-4), and the total volume of contaminated soil for Area A has been estimated to be approximately 12,800 cubic yards.

Seven potential remedial alternatives for the Area A soil were developed and evaluated in the Feasibility Study. They are:

- A-SO1 - No Action
- A-SO2 - Institutional Controls
- A-SO3 - Asphalt/Geosynthetic Cap Over Brig Area with Institutional Controls
- A-SO4 - Composite Cap Over Hot Spot Areas with Institutional Controls
- A-SO5 - In Situ Treatment of Hot Spot Area Soils and Shallow Groundwater Using Dual Phase Vacuum Extraction with Institutional Controls
- A-SO6 - Thermal Treatment of Hot Spot Area Soils with Institutional Controls
- A-SO7 - Disposal of Hot Spot Area Soils in Off-site Hazardous Waste Landfill with Institutional Controls

Except for A-SO1, the No Action alternative, all the alternatives for Area A soil have several common components including maintenance of the existing fence, maintenance of the existing soil cover over the entire Area A (approximately 45 acres), and control of site access and future land use through institutional controls. There are currently no plans to close Camp Allen; however, in the event of base closure, institutional controls, such as deed restrictions, would limit the Camp Allen Landfill Area to non-residential land use.

A brief description of each alternative, as well as the estimated cost and timeframe to implement the alternative (not including 30-year monitoring or maintenance periods), are provided below:

- A-SO1 - No Action

  Estimated Capital Cost: $0
  Estimated Annual O & M Cost: $20,000 (every five years)
  Estimated Present-Worth Cost: $55,600
  Estimated Implementation Timeframe: none

  No action would be taken to remediate Area A soils or to restrict site access using institutional controls. The estimated O & M cost of $20,000 is for five-year site reviews.

- A-SO2 - Institutional Controls

  Estimated Capital Cost: $0
  Estimated Annual O & M Cost: $17,557 (annually)
  $37,557 (every five years)
  Estimated Present-Worth Cost: $325,500
  Estimated Implementation Timeframe: less than one year

  The current land use at the site is industrial/military. In the event of base closure, deed restrictions would be implemented to limit the Area A Landfill to non-residential land use. Legal procedures associated with implementation of deed restrictions would require less than one year to complete. In addition, the existing fence, which separates Area A Landfill from Glenwood Park, would be maintained to limit site access, and the existing soil cover over Area A would be maintained. The estimated O & M costs are for fence maintenance, soil cover maintenance, and five-year site reviews. Costs for implementation of deed restrictions were not estimated.

- A-SO3 - Asphalt/Geosynthetic Cap Over Brig Area with Institutional Controls

  Estimated Capital Cost: $927,200
  Estimated Annual O & M Cost: $17,557 (annually)
  $95,653 (every five years)
  Estimated Present-Worth Cost: $1,877,900
  Estimated Implementation Timeframe: less than one year, once construction begins

  An impermeable asphalt/geosynthetic cap would be placed over the brig area and the area immediately west of the brig area (an area of approximately 12 acres) to cover the hot spot areas identified in Area A1 during the pre-design investigation. The cap would minimize infiltration of surface water, thus reducing leaching and transport of contaminants from the contaminated soil. In addition, the cap would prevent potential exposure to contaminated soil.

- A-SO4 - Composite Cap Over Hot Spot Areas with Institutional Controls

  Estimated Capital Cost: $465,300
  Estimated Annual O & M Cost: $19,395 (annually)
  $39,395 (every five years)
  Estimated Present-Worth Cost: $819,100
  Estimated Implementation Timeframe: less than one year, once construction begins

  An impermeable composite cap would be placed over the hot spot areas identified in Areas A1 and A2 during the pre-design investigation (a total area of approximately 1 acre). The cap would minimize infiltration of surface water, thus reducing leaching and transport of contaminants from the contaminated soil. In addition, the cap would prevent potential exposure to contaminated soil.

- A-SO5 - In Situ Treatment of Hot Spot Area Soils and Shallow Groundwater Using Dual Phase Vacuum Extraction with Institutional Controls

  Estimated Capital Cost: $490,700
  Estimated Annual O & M Cost: $108,066 (years 1 - 4)
  $139,022 (year 5)
  $17,557 (years 6 - 30)
  Estimated Present-Worth Cost: $1,216,700
  Estimated Implementation Timeframe: five years, or possibly longer

The contaminated soil in the hot spot areas identified during the pre-design investigation would be treated with a dual phase vacuum extraction (DPVE) system, removing contaminated soil gas and shallow groundwater for subsequent treatment. DPVE is a method to remediate soil and shallow groundwater using a single extraction system. The system uses a high vacuum to strip the unsaturated zone of VOCs, while simultaneously removing groundwater (in liquid and vapor form) from the shallow aquifer. The vapor phase is treated with activated carbon, and the liquid would be sent to the on-site groundwater treatment plant, which is part of the proposed response action for groundwater at the site.

Since Area A is a landfill, the remedial action objective for the soils is groundwater protection rather than soil cleanup. Therefore, achievement of this objective would not necessarily be based on attainment of the developed soil cleanup goals (see Section 4.3.1) since they represent theoretical values calculated through modeling. In addition, the cleanup goals were developed using conservative assumptions and may not be representative of actual site conditions. Therefore, achievement of groundwater protection would be determined through development of treatment system performance curves and through evaluation of actual environmental monitoring results (i.e., via ongoing monitoring of contaminant levels in groundwater and in the extracted vapors from the in situ vacuum extraction system). Soil contaminant concentrations may eventually reach asymptotic levels below which contaminant levels cannot be reduced via in situ vacuum extraction. If treatment system performance curves indicate that the cleanup goals for some or all of the contaminants cannot be achieved, then the soil cleanup goals will be reevaluated. Contaminant trends would be analyzed using results from the groundwater monitoring program to assess whether any portion of the landfill is acting as a source of groundwater contamination over the long term.

- A-SO6 - Thermal Treatment of Hot Spot Area Soils with Institutional Controls

  Estimated Capital Cost: $6,141,500
  Estimated Annual O & M Cost: $17,557 (annually)
  $37,557 (every five years)
  Estimated Present-Worth Cost: $6,467,100
  Estimated Implementation Timeframe: less than one year, once construction begins

  The contaminated soil in the hot spot areas identified during the pre-design investigation would be treated on site using a low-temperature thermal desorption process. The treatment process involves separation of VOCs and, to a lesser degree, SVOCs from soil by heating the waste in a desorption chamber. Desorbed organic vapors are subsequently condensed and recovered as liquid for subsequent disposal (i.e., off-site incineration). This process is expected to remove more than 99 percent of the VOCs and 80 to 99 percent of SVOCs (depending on their boiling points) from the soil. The treated soil would be backfilled on site, assuming that the established soil cleanup levels have been achieved.

- A-SO7 - Disposal of Hot Spot Area Soils in Off-site Hazardous Waste Landfill with Institutional Controls

  Estimated Capital Cost: $9,867,900
  Estimated Annual O & M Cost: $17,557 (annually)
  $37,557 (every five years)
  Estimated Present-Worth Cost: $10,193,500
  Estimated Implementation Timeframe: less than one year, once construction begins

  The contaminated soil in the hot spot areas identified during the pre-design investigation would be excavated and transported off site for disposal at a RCRA-permitted hazardous waste landfill. The excavation would be backfilled with clean soil from an off-site source.

5.1.2 Area B Soils

As discussed in Section 2.4, a removal action for contaminated soil in several hot spot areas within the Area B Landfill was initiated in the summer of 1994 and has been completed. The removal action involved excavation of contaminated soil, buried drums, and debris in several hot spot areas within the Area B Landfill and off-site disposal at a RCRA-permitted hazardous waste landfill or incinerator. The objective of the removal action was to remove the sources of groundwater contamination within the Area B Landfill so that no further remedial actions would be required for Area B soils. Therefore, source control alternatives (such as capping and treatment alternatives), which were developed for Area A soils, were not developed for Area B soils.

Two potential remedial alternatives for the Area B soil were developed and evaluated. They are:

- B-SO1 - No Action
- B-SO2 - Institutional Controls

A brief description of each alternative, as well as the estimated cost and timeframe to implement the alternative (not including 30-year monitoring or maintenance periods), is provided below:

- B-SO1 - No Action

  Estimated Capital Cost: $0
  Estimated Annual O & M Cost: $20,000 (every five years)
  Estimated Present-Worth Cost: $55,600
  Estimated Implementation Timeframe: none

  No action would be taken to remediate Area B soils or to restrict site access using institutional controls. The estimated O & M cost of $20,000 is for five-year site reviews.

- B-SO2 - Institutional Controls

  Estimated Capital Cost: $0
  Estimated Annual O & M Cost: $600 (annually)
  $20,000 (every five years)
  Estimated Present-Worth Cost: $63,200
  Estimated Implementation Timeframe: less than one year

  The current land use at the site is industrial/military. In the event of base closure, deed restrictions would be implemented to limit the Area B Landfill to non-residential land use. Legal procedures associated with implementation of deed restrictions would require less than one year to complete. In addition, the existing perimeter fence would be maintained to limit site access. The estimated O & M costs are for fence maintenance and five-year site reviews. Costs for implementation of deed restrictions were not estimated.

5.2 Surface Water/Sediment (Areas A and B)

Sediment and surface water in the drainage channels surrounding Areas A and B were found to contain isolated areas of elevated organic and inorganic constituents. However, contamination levels do not suggest a need for active remediation of surface water/sediment for the following reasons:

- Relatively low levels of contaminants were detected in site surface water and sediments.

- Migration of contaminants from the surface water and sediments to groundwater is not considered to be a pathway of concern since shallow groundwater generally discharges to the drainage ditches (i.e., surface water generally does not recharge the shallow groundwater).

- Results of the baseline risk assessment for Area A and Area B surface water and sediment indicate no exceedances of human health criteria associated with exposure (via ingestion and dermal contact) to surface water or sediment under the current land uses. Therefore, under the current land uses at Area A and B, no unacceptable human health effects would be expected from exposure to surface water and sediment.

- Source control measures that have been implemented at Area B (removal action), and source control measures that are planned for Area A, are expected to improve the quality of surface water and sediment in these areas over time.

Two potential remedial alternatives for the Area A and B surface water/sediment were developed and evaluated. They are:

- SD1 - No Action
- SD2 - Institutional Controls with Monitoring

A brief description of each alternative, as well as the estimated cost and timeframe to implement the alternative (not including 30-year monitoring periods), is provided below:

- SD1 - No Action

  Estimated Capital Cost: $0
  Estimated Annual O & M Cost: $20,000 (every five years)
  Estimated Present-Worth Cost: $55,600
  Estimated Implementation Timeframe: none

  No action would be taken to remediate Area A or B surface water or sediments or to restrict site access using institutional controls. The estimated O & M cost of $20,000 is for five-year site reviews. Under the recommended soil alternative, the existing fence in Areas A and B would be maintained to limit site access, and the existing soil cover over Area A would be maintained. As previously discussed, the proposed remediation of the soil and groundwater in the area would most likely result in a decrease in contaminant levels in surface water/sediment over time.

- SD2 - Institutional Controls with Monitoring

  Estimated Capital Cost: $0
  Estimated Annual O & M Cost: $50,477 (annually)
  $70,477 (every five years)
  Estimated Present-Worth Cost: $831,600
  Estimated Implementation Timeframe: less than one year

  The current land use at the site is industrial/military. In the event of base closure, deed restrictions would be implemented to limit the area to non-residential land use. Legal procedures associated with implementation of deed restrictions would require less than one year to complete. Under the recommended soil alternative, the existing fence in Areas A and B would be maintained to limit site access, and the existing soil cover over Area A would be maintained.

  In addition, a surface water and sediment monitoring program would be implemented (estimated annual cost $50,477) to track trends in surface water and sediment contamination levels. As previously discussed, the proposed remediation of the soil and groundwater in the area would most likely result in a decrease in contaminant levels in surface water and sediment over time. The monitoring program would provide information required to track trends in contaminant levels over time in these media.

5.3 Groundwater

Potable water throughout Camp Allen and the surrounding area is supplied by the City of Norfolk. Groundwater at the site currently is not used for any purpose. Residential wells in Glenwood Park, located west of Area A1, supply water for nonpotable uses, such as lawn watering and car washing.

Groundwater contamination is present both in the water table (shallow) aquifer and the upper Yorktown (deep) Aquifer at the site. Groundwater contamination was detected in both aquifers in Areas A1, A2, and B at the site. The primary contaminants of concern in site groundwater are VOCs, with trace amounts of other contaminants. Elevated levels of some inorganics were also detected, but are believed to be associated with total suspended solids rather than dissolved in the groundwater.

The groundwater in various areas of the site is addressed separately. Remedial alternatives evaluated for Area A1, Area A2 and Area B are summarized in the following sections.

5.3.1 Area A1 Groundwater

As discussed in Section 7.0 of this PRAP, the recommended response action for contaminated soil in Area A1 is Alternative A-SO5, in situ treatment by dual phase vacuum extraction (DPVE). The DPVE system is able to extract both soil and shallow groundwater contamination with a single system. This benefit is especially valuable since it has been shown that the conventional pump and treat method would not be feasible for remediation of the water table aquifer in Area A1 due to its very low hydraulic conductivity. The shallow groundwater extracted by the DPVE system would be pumped to the proposed on-site treatment plant for contaminated groundwater. Since remediation of the water table aquifer in Area A1 would be addressed by the proposed DPVE system, remedial alternatives were not developed for the water table aquifer in this area.

Three potential remedial alternatives for Area A1 groundwater were developed and evaluated. They are:

- A1-GW1 - No Action with Monitoring
- A1-GW2 - Institutional Controls with Monitoring
- A1-GW3 - Protection of the Yorktown Aquifer for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring

A brief description of each alternative, as well as the estimated cost and timeframe to implement the alternative (not including 30-year monitoring or maintenance periods), is provided below:

- A1-GW1 - No Action with Monitoring

  Estimated Capital Cost: $0
  Estimated Annual O & M Cost: $38,600 (years 1 - 10)
  $19,600 (years 11 - 20)
  $10,100 (years 21 - 30)
  $20,000 (every five years)
  Estimated Present-Worth Cost: $476,700
  Estimated Implementation Timeframe: none

No action would be taken to actively remediate the Yorktown Aquifer in Area A1- or to restrict site access using institutional controls. However, since a primary source area and the water table aquifer within Area A1 will be remediated by DPVE (see Alternative A-SO5), contaminant levels in groundwater in the Yorktown Aquifer may gradually decrease through dilution and natural attenuation. A groundwater monitoring program would be used to assess trends in groundwater quality over time, as discussed below.

Under this alternative, a groundwater monitoring program would be implemented in Area A1. Groundwater monitoring would be conducted on a quarterly basis until a stable or decreasing trend in contaminant levels is observed. Then the frequency of monitoring would be reduced to a semi-annual or annual basis. For cost estimating purposes, it was assumed quarterly monitoring would occur in years 1 to 10, semi-annual monitoring would occur in years 11 to 20, and annual monitoring would occur in years 21 to 30. Additionally, it was assumed that seven monitoring wells and three perimeter monitoring wells in Area A1 would be included in the monitoring program.

- A1-GW2 - Institutional Controls with Monitoring

Estimated Capital Cost: $0
Estimated Annual O & M Cost: $38,600 (years 1 - 10)
$19,600 (years 11 - 20)
$10,100 (years 21 - 30)
$20,000 (every five years)
Estimated Present-Worth Cost: $476,700
Estimated Implementation Timeframe: less than one year

The current land use at the site is industrial/military. In the event of base closure, deed restrictions would be implemented under this alternative to limit the area to non-residential land use. Legal procedures associated with implementation of deed restrictions would require less than one year to complete.

Since a primary source area and the water table aquifer within Area A1 will be remediated by DPVE (see Alternative A-SO5), contaminant levels in groundwater in the Yorktown Aquifer may gradually decrease through dilution and natural attenuation. A groundwater monitoring program would be implemented, as described under Alternative A1-GW1, to assess trends in groundwater quality over time.

- A1-GW3 - Protection of the Yorktown Aquifer for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring

Estimated Capital Cost: $6,108,500
Estimated Annual O & M Cost: $187,300 (years 1 - 10)
$168,300 (years 11 - 20)
$158,800 (years 21 - 30)
$20,000 (every five years)
Estimated Present-Worth Cost: $8,870,200
Estimated Implementation Timeframe: 10 to 20 years, or possibly longer

This alternative for groundwater in Area A1 would involve protection of the Yorktown Aquifer for beneficial use (i.e., potential drinking water source) through extraction and on-site treatment. Groundwater in the upper Yorktown Aquifer would be extracted through a series of pumping wells (approximately 65 feet deep) and would be pumped to an on-site treatment system. The pumping rate would be designed to contain the current extent of contamination. If possible, the system would be operated until groundwater cleanup goals are achieved (federal MCLs for Yorktown Aquifer). An estimated groundwater pumping rate of 82 gallons per minute (gpm) would be required to contain the current extent of contamination in Area A1.

Among other factors, the time to achieve groundwater cleanup goals is dependent on the nature and extent of the sources, which are difficult to characterize within a landfill. Therefore, the time to achieve these cleanup goals cannot accurately be predicted at this time. It is possible that cleanup goals could require 10 to 20 years, or longer, to achieve. Also, MCLs may be impossible to achieve since it has been demonstrated that groundwater contaminant concentrations typically reach asymptotic levels, which may exceed MCLs. Performance curves would be periodically (e.g., annually) developed to monitor the effectiveness of the groundwater remediation system. If the performance curves indicate that asymptotic levels have been reached that exceed MCLs for some contaminants, then the cleanup goals may be reevaluated at that time.

The groundwater treatment process would include metals removal via clarification and filtration, and removal of organics via air stripping and carbon adsorption. The groundwater treatment system included under this alternative has been sized to accommodate flows from Areas A1, A2 and B plus a contingency. This approach is more cost-effective than constructing individual treatment systems for the three areas. Note that the cost for this alternative includes the entire capital cost for construction of the groundwater treatment system for all three areas of the site.

Additionally, institutional controls and a groundwater monitoring program would be implemented, as described under Alternatives A1-GW1 and A1-GW2.

5.3.2 Area A2 Groundwater

Three potential remedial alternatives for Area A2 groundwater were developed and evaluated in the Feasibility Study. They are:

- A2-GW1 - No Action with Monitoring
- A2-GW2 - Institutional Controls with Monitoring
- A2-GW3 - Protection of the Yorktown Aquifer for Beneficial Use Through Extraction and Treatment, Institutional Controls and Monitoring

When the Feasibility Study was prepared, it was believed that remediation of the water table aquifer in Area A2 could be addressed by the DPVE system. Therefore, remedial alternatives were not developed for the water table aquifer in this area in the Feasibility Study.

Since completion of the Feasibility Study, a DPVE pilot test has been performed in Area A2 (OHM, 1994). Based on the results of the pilot test, extraction of groundwater from the water table aquifer using conventional submersible pumps appears to be better suited for Area A2 than DPVE technology. Therefore, a fourth groundwater alternative, A2-GW4, has been added to this PRAP to address the water table aquifer in this area. Alternative A2-GW4, Protection of the Water Table

Aquifer for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring, is discussed in Section 7.0.

A brief description of each alternative (except A2-GW4), as well as the estimated cost and timeframe to implement the alternative (not including 30-year monitoring or maintenance periods), is provided below:

- A2-GW1 - No Action with Monitoring

  Estimated Capital Cost: $0
  Estimated Annual O & M Cost: $38,600 (years 1 - 10)
  $19,600 (years 11 - 20)
  $10,100 (years 21 - 30)
  $20,000 (every five years)
  Estimated Present-Worth Cost: $476,700
  Estimated Implementation Timeframe: none

  No action would be taken to actively remediate the groundwater in Area A2 or to restrict site access using institutional controls. However, contaminant levels in groundwater may gradually decrease through dilution and natural attenuation. A groundwater monitoring program would be used to assess trends in groundwater quality over time, as discussed below.

  Under this alternative, a groundwater monitoring program would be implemented in Area A2. Groundwater monitoring would be conducted on a quarterly basis until a stable or decreasing trend in contaminant levels is observed. Then the frequency of monitoring would be reduced to a semi-annual or annual basis. For cost estimating purposes, it was assumed quarterly monitoring would occur in years 1 to 10, semi-annual monitoring would occur in years 11 to 20, and annual monitoring would occur in years 21 to 30. Additionally, it was assumed that seven monitoring wells and three perimeter monitoring wells in Area A2 would be included in the monitoring program.

- A2-GW2 - Institutional Controls with Monitoring

  Estimated Capital Cost: $0
  Estimated Annual O & M Cost: $38,600 (years 1 - 10)
  $19,600 (years 11 - 20)
  $10,100 (years 21 - 30)
  $20,000 (every five years)
  Estimated Present-Worth Cost: $476,700
  Estimated Implementation Timeframe: less than one year

  The current land use at the site is industrial/military. In the event of base closure, deed restrictions would be implemented under this alternative to limit the area to non-residential land use. Legal procedures associated with implementation of deed restrictions would require less than one year to complete.

  No action would be taken to actively remediate the groundwater in Area A2. However, contaminant levels in groundwater may gradually decrease through dilution and natural attenuation. A groundwater monitoring program would be implemented, as described under Alternative A2-GW1, to assess trends in groundwater quality over time.

- A2-GW3 - Protection of the Yorktown Aquifer for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring

  Estimated Capital Cost: $0 (capital cost for treatment system under Alternative A1-GW3.)
  Estimated Annual O & M Cost: $59,400 (years 1 - 10)
  $40,400 (years 11 - 20)
  $30,900 (years 21 - 30)
  $20,000 (every five years)
  Estimated Present-Worth Cost: $796,000
  Estimated Implementation Timeframe: 10 to 20 years, or possibly longer

  This alternative for groundwater in Area A2 would involve protection of the Yorktown Aquifer for beneficial use (i.e., potential drinking water source) through extraction and on-site treatment. Groundwater in the upper Yorktown Aquifer would be extracted through a series of pumping wells (approximately 65 feet deep) and would be pumped to an on-site treatment system. The pumping rate is designed to contain the current extent of contamination. If possible, the system would be operated until groundwater cleanup goals are achieved (federal MCLs for Yorktown Aquifer). An estimated groundwater pumping rate of 82 gpm would be required to contain the current extent of contamination in Area A2.

Among other factors, the time to achieve groundwater cleanup goals is dependent on the nature and extent of the sources, which are difficult to characterize within a landfill. Therefore, the time to achieve these cleanup goals cannot accurately be predicted at this time. It is possible that cleanup goals could require 10 to 20 years, or longer, to achieve. Also, MCLs may be impossible to achieve since it has been demonstrated that groundwater contaminant concentrations typically reach asymptotic levels, which may exceed MCLs. Performance curves would be periodically (e.g., annually) developed to monitor the effectiveness of the groundwater remediation system. If the performance curves indicate that asymptotic levels have been reached that exceed MCLs for some contaminants, then the cleanup goals may be reevaluated at that time.

The groundwater treatment process would include metals removal via clarification and filtration, and removal of organics via air stripping and carbon adsorption. The groundwater treatment system included under Alternative A1-GW3 has been sized to accommodate flows from Areas A1, A2 and B plus a contingency. This approach is more cost-effective than constructing individual treatment systems for the three areas. Note that the entire capital cost for construction of the groundwater treatment system for all three areas of the site is included under Alternative A1-GW3. Therefore, capital costs for the groundwater treatment system are not included in this alternative. Annual O & M costs for this alternative include the incremental treatment costs associated with treating the additional flow (82 gpm) from Area A2.

Additionally, institutional controls and a groundwater monitoring program would be implemented, as described under Alternatives A2-GW1 and A2-GW2.

5.3.3 Area B Groundwater

In situ treatment of soil and shallow groundwater is not proposed for Area B under Alternative A-SO5, as was done for Area A. Therefore, since remediation of the water table aquifer in Area B has not been addressed under another alternative, remedial alternatives for Area B groundwater include remediation of both the water table aquifer and the Yorktown Aquifer.

Three potential remedial alternatives for Area B groundwater were developed and evaluated. They are:

- B-GW1 - No Action with Monitoring
- B-GW2 - Institutional Controls with Monitoring
- B-GW3 - Protection of the Water Table and Yorktown Aquifers for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring

A brief description of each alternative, as well as the estimated cost and timeframe to implement the alternative (not including 30-year monitoring or maintenance periods), is provided below:

- B-GW1 - No Action with Monitoring

  Estimated Capital Cost: $0
  Estimated Annual O & M Cost: $38,600 (years 1 - 10)
  $19,600 (years 11 - 20)
  $10,100 (years 21 - 30)
  $20,000 (every five years)
  Estimated Present-Worth Cost: $476,700
  Estimated Implementation Timeframe: none

  No action would be taken to actively remediate Area B groundwater or to restrict site access using institutional controls. However, since a primary source area within Area B has been permanently removed through a removal action (see Section 5.1.2), contaminant levels in groundwater in Area B should gradually decrease through dilution and natural attenuation. A groundwater monitoring program would be used to assess trends in groundwater quality over time, as discussed below.

Under this alternative, a groundwater monitoring program would be implemented in Area B. Groundwater monitoring would be conducted on a quarterly basis until a stable or decreasing trend in contaminant levels is observed. Then the frequency of monitoring would be reduced to a semi-annual or annual basis. For cost estimating purposes, it was assumed quarterly monitoring would occur in years 1 to 10, semi-annual monitoring would occur in years 11 to 20, and annual monitoring would occur in years 21 to 30. Additionally, it was assumed that ten monitoring wells in Area B would be included in the monitoring program.

- B-GW2 - Institutional Controls with Monitoring

Estimated Capital Cost: $0
Estimated Annual O & M Cost: $38,600 (years 1 - 10)
$19,600 (years 11 - 20)
$10,100 (years 21 - 30)
$20,000 (every five years)
Estimated Present-Worth Cost: $476,700
Estimated Implementation Timeframe: less than one year

The current land use at the site is industrial/military. In the event of base closure, deed restrictions would be implemented under this alternative to limit the area to non-residential land use. Legal procedures associated with implementation of deed restrictions would require less than one year to complete.

Since a primary source area within Area B has been remediated through a removal action (see Section 2.4), contaminant levels in groundwater in Area B should gradually decrease through dilution and natural attenuation. A groundwater monitoring program would be implemented, as described under Alternative B-GW1, to assess trends in groundwater quality over time.

- B-GW3 - Protection of the Water Table and Yorktown Aquifers for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring

Estimated Capital Cost: $0 (capital cost for treatment system under Alternative A1-GW3)
Estimated Annual O & M Cost: $62,400 (years 1 - 10)
$43,400 (years 11 - 20)
$34,000 (years 21 - 30)
$20,000 (every five years)
Estimated Present-Worth Cost: $842,500
Estimated Implementation Timeframe: 10 to 20 years, or possibly longer

This alternative for groundwater in Area B would involve protection of the water table aquifer and Yorktown Aquifer for Beneficial Use Through Extraction and on-site treatment. Groundwater in the upper Yorktown Aquifer would be extracted through a series of pumping wells (approximately 65 feet deep). Groundwater in the water table aquifer would be extracted through a series of shallow pumping wells (approximately 25 feet deep). Extracted groundwater from both aquifers would be pumped to an on-site treatment system. The pumping rate is designed to contain the current extent of contamination. If possible, the system would be operated until groundwater cleanup goals (see Section 4.3.2) are achieved. An estimated groundwater pumping rate of 42 gpm would be required to contain the current extent of contamination in Area B.

Among other factors, the time to achieve groundwater cleanup goals is dependent on the nature and extent of the sources, which are difficult to characterize within a landfill. Therefore, the time to achieve these cleanup goals cannot accurately be predicted at this time. It is possible that cleanup goals could require 10 to 20 years, or longer, to achieve. Also, MCLs may be impossible to achieve since it has been demonstrated that groundwater contaminant concentrations typically reach asymptotic levels, which may exceed MCLs. Performance curves would be periodically (e.g., annually) developed to monitor the effectiveness of the groundwater remediation system. If the performance curves indicate that asymptotic levels have been reached that exceed MCLs for some contaminants, then the cleanup goals may be reevaluated at that time.

The groundwater treatment process would include metals removal *via clarification* and filtration, and removal of organics via air stripping and carbon adsorption. The groundwater treatment system included under Alternative A1-GW3 has been sized to accommodate flows from Areas A1, A2 and B plus a contingency. This approach is more cost-effective than constructing individual treatment systems for the three areas. Note that the entire capital cost for construction of the groundwater treatment system for all three areas of the site is included under Alternative A1-GW3. Therefore, capital costs for the groundwater treatment system are not included in this alternative. Annual O & M costs for this alternative include the incremental treatment costs associated with treating the additional flow (42 gpm) from Area B.

Additionally, institutional controls and a groundwater monitoring program would be implemented, as described under Alternatives B-GW1 and B-GW2.

SECTION 6

6.0 EVALUATION OF REMEDIAL ALTERNATIVES

In this section, alternatives for soil, surface water/sediment, and groundwater are evaluated against nine evaluation criteria to determine the preferred alternative. The preferred alternatives are discussed in Section 7.0. The nine evaluation criteria have been determined by the USEPA and are presented in the publication, "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (USEPA, 1988). A summary and descriptions of the nine evaluation criteria are presented in Table 6-1. Summaries of the performance of remedial alternatives for Area A and Area B soils, Areas A and B surface water/sediment, Area A1 groundwater, Area A2 groundwater, and Area B groundwater with respect to seven of the nine evaluation criteria are presented in Tables 6-2 through 6-7.

The two remaining criteria are state acceptance and community acceptance. With respect to state acceptance, both the USEPA and VADEQ (the state) have reviewed this PRAP and concur with the selection of the preferred alternatives. However, based on new information or public comments, the DoN, in consultation with USEPA and VADEQ, may modify the preferred alternative or select another remedial alternative that is presented in the FS Report and in this PRAP. Therefore, the public is encouraged to review and comment on the remedial alternatives as well as other information presented herein. The community acceptance criteria will be assessed in the Responsiveness Summary and Final Decision Document following a review of public comments on the RI/FS Reports and this PRAP.

SECTION 6.0 TABLES

TABLE 6-1

SUMMARY OF EVALUATION CRITERIA

- **Overall Protection of Human Health and Environment** - addresses whether or not an alternative provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

- **Compliance with ARARs** - addresses whether or not an alternative will meet all of the applicable or relevant and appropriate requirements (ARARs) or other federal and state environmental statutes and/or provide grounds for invoking a waiver.

- **Long-Term Effectiveness and Permanence** - refers to the magnitude of residual risk and the ability of an alternative to maintain reliable protection of human health and the environment over time once cleanup goals have been met.

- **Reduction of Toxicity, Mobility, or Volume through Treatment** - is the anticipated performance of the treatment options that may be employed in an alternative.

- **Short-Term Effectiveness** - refers to the speed with which the alternative achieves protection, as well as the remedy's potential to create adverse impacts on human health and the environment during the construction and implementation period.

- **Implementability** - is the technical and administrative feasibility of an alternative, including the availability of materials and services needed to implement the chosen solution.

- **Cost** - includes capital and operation and maintenance costs, and for comparative purposes, net present worth values.

- **USEPA/State Acceptance** - indicates whether, based on review of the RI and FS reports and the PRAP, the USEPA and state concur with, oppose, or have no comments on the preferred alternative.

- **Community Acceptance** - will be addressed in the Decision Document following a review of the public comments received on the RI and FS reports and the PRAP.

TABLE 6-2

COMPARISON OF AREA A SOIL ALTERNATIVES
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

ALTERNATIVE A-SO1 NO ACTION	ALTERNATIVE A-SO2 INSTITUTIONAL CONTROLS	ALTERNATIVE A-SO3 ASPHALT/GEOSYNTHETIC CAP OVER BRIG AREA(1)	ALTERNATIVE A-SO4 COMPOSITE CAP OVER HOT SPOT AREAS(1)	ALTERNATIVE A-SO5 DUAL PHASE VACUUM EXTRACTION OF HOT SPOT AREAS(1)	ALTERNATIVE A-SO6 THERMAL TREATMENT OF HOT SPOT AREAS(1)	ALTERNATIVE A-S07 OFF-SITE DISPOSAL OF HOT SPOT AREAS(1)
OVERALL PROTECTION TO HUMAN HEALTH AND THE ENVIRONMENT						
No unacceptable risks from surface soils for current land use. Marginal risk from surface soils for future residential use. Potential risks from buried wastes. No additional protection from direct contact with potential soil contamination. No additional protection of groundwater.	No unacceptable risks from surface soils for current land use. Marginal risk from surface soils for future residential use. Potential risks from buried wastes. Protection from direct contact provided by institutional controls. No additional protection of groundwater.	No unacceptable risks from surface soils for current land use. Marginal risk from surface soils for future residential use. Potential risks from buried wastes. Protection from direct contact provided by institutional controls and cap. Partial protection of groundwater provided by cap over Brig area.	No unacceptable risks from surface soils for current land use. Marginal risk from surface soils for future residential use. Potential risks from buried wastes. Protection from direct contact provided by institutional controls and cap. Partial protection of groundwater provided by cap over hot spot area(s).	No unacceptable risks from surface soils for current land use. Marginal risk from surface soils for future residential use. Potential risks from buried wastes. Protection from direct contact provided by institutional controls. Protection of groundwater provided by in situ treatment of source area(s).	No unacceptable risks from surface soils for current land use. Marginal risk from surface soils for future residential use. Potential risks from buried wastes. Protection from direct contact provided by institutional controls. Protection of groundwater provided by ex situ treatment of source(s).	No unacceptable risks from surface soils for current land use. Marginal risk from surface soils for future residential use. Potential risks from buried wastes. Protection from direct contact provided by institutional controls. Protection of groundwater by off-site disposal of source area(s).
COMPLIANCE WITH ARARS						
No contaminant-, location-, or action-specific ARARs.	No contaminant-, location- or action-specific ARARs.	No contaminant-specific ARARs. Cap designed in accordance with RCRA and state solid waste regulations.	No contaminant-specific ARARs. Cap designed in accordance with RCRA and state hazardous waste regulations.	No contaminant-specific ARARs. Air emissions would be treated to comply with state air pollution standards. Any hazardous materials would be handled/disposed in accordance with RCRA and state hazardous waste regulations.	No contaminant-specific ARARs. Air emissions would be treated to comply with state air pollution standards. Any hazardous materials would be handled/disposed in accordance with RCRA and state hazardous waste regulations.	No contaminant-specific ARARs. Air emissions would be treated to comply with state air pollution standards. Any hazardous materials would be handled/disposed in accordance with RCRA and state hazardous waste regulations.
LONG-TERM EFFECTIVENESS AND PERMANENCE						
No remedial action would be taken. No reduction in risk levels; however, risks are acceptable under current use, and site is not used for residential use. No additional protection of groundwater.	Institutional actions would administratively limit future site use to nonresidential use. Risks are acceptable under current use, and site is not used for residential use. Maintenance of landfill soil cover effective in limiting surface water infiltration and erosion.	Institutional actions would administratively restrict access to site and limit future site use to nonresidential use. Risks are acceptable under current use, and site is not used for residential use. Partial long-term protection of groundwater provided by cap over potential source areas in vicinity of Brig.	Institutional actions would administratively restrict access to site and limit future site use to nonresidential use. Risks are acceptable under current use, and site is not used for residential use. Partial long-term protection of groundwater provided by cap over hot spot area(s).	Institutional actions would administratively restrict access to site and limit future site use to nonresidential use. Risks are acceptable under current use, and site is not used for residential use. Permanent long-term protection of groundwater provided by in situ treatment.	Institutional actions would administratively restrict access to site and limit future site use to nonresidential use. Risks are acceptable under current use, and site is not used for residential use. Permanent long-term protection of groundwater provided by ex situ treatment.	Institutional actions would administratively restrict access to site and limit future site use to nonresidential use. Risks are acceptable under current use, and site is not used for residential use. Permanent long-term protection of groundwater provided by off-site disposal.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME (TMV) THROUGH TREATMENT						
No reduction in TMV through treatment. Possible reduction in TMV through natural processes.	No reduction in TMV through treatment. Possible reduction in TMV through natural processes.	No reduction in TMV through treatment. Possible reduction in TMV through natural processes. Partial reduction in mobility through capping.	No reduction in TMV through treatment. Possible reduction in TMV through natural processes. Partial reduction in mobility through capping.	Reduction in TMV through in situ vacuum extraction/treatment. Effective removal of VOCs, partial removal of SVOCs.	Reduction in TMV through ex situ thermal treatment. Very effective removal of VOCs and effective removal of SVOCs.	No reduction in TMV through treatment. Reduction in mobility via disposal in secure off-site landfill.

TABLE 6-2 (Continued)

COMPARISON OF AREA A SOIL ALTERNATIVES
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

ALTERNATIVE A-SO1 NO ACTION	ALTERNATIVE A-SO2 INSTITUTIONAL CONTROLS	ALTERNATIVE A-SO3 ASPHALT/GEOSYNTHETIC CAP OVER BRIG AREA[1]	ALTERNATIVE A-SO4 COMPOSITE CAP OVER HOT SPOT AREAS[1]	ALTERNATIVE A-SO5 DUAL PHASE VACUUM EXTRACTION OF HOT SPOT AREAS[1]	ALTERNATIVE A-SO6 THERMAL TREATMENT OF HOT SPOT AREAS[1]	ALTERNATIVE A-S07 OFF-SITE DISPOSAL OF HOT SPOT AREAS[1]
SHORT-TERM EFFECTIVENESS						
No risk to human health or environment during implementation.	No risk to human health or environment during implementation.	No risk to human health or environment during implementation.	No risk to human health or environment during implementation.	Potential risks to human health and environment during operation would be controlled by air emission treatment/ monitoring. Several years required to achieve cleanup levels.	Potential risks to human health and environment during operation would be controlled by air emission treatment/ monitoring. Approx. 6 months required to complete remediation.	Potential risks to human health and environment during excavation would be controlled by dust controls. Approx. 2 months required to complete remediation.
IMPLEMENTABILITY						
Readily implementable.	Straight-forward installation of fencing. Periodic inspection and maintenance of fenced required. Legal/administrative requirements for institutional controls.	Legal/administrative requirements for institutional controls. Capping technologies demonstrated and commercially available. Periodic inspection and maintenance of cap required.	Legal administrative requirements for institutional controls. Capping technologies demonstrated and commercially available. Periodic inspection and maintenance of cap required.	Administrative requirements for institutional controls. Technologies demonstrated and commercially available. Approx. 5-year operation of treatment system.	Administrative requirements for institutional controls. Technologies demonstrated and commercially available. Trial runs may be required. Potential public opposition. Approx. 6-month operation of treatment system.	Administrative requirements for institutional controls. Technologies demonstrated and commercially available.
COST						
Capital: $0 O&M: $20,000 (every 5 years) NPW: $55,600	Capital: $0 O&M: $17,557 (annually); $20,000 (every 5 years) NPW: $325,500	Capital: $927,200 O&M: $17,557 (annually); $95,653 (every 5 years) NPW: $1,877,900	Capital: $465,300 O&M: $19,395 (annually); $39,395 (every 5 years) NPW: $819,100	Capital: $490,700 O&M: $108,066 (years 1-4) $139,022 (year 5) $17,557 (years 6-30) NPW: $1,216,700	Capital: $6,141,500 O&M: $17,557 (annually); $37,557 (every 5 years) NPW: $6,467,100	Capital: $9,867,900 O&M: $17,557 (annually); $37,557 (every 5 years) NPW: $10,193,500

[1] Alternative includes *Institutional Controls*
O&M: Operation and Maintenance
NPW: 30-year Net Present Worth

TABLE 6-3

COMPARISON OF AREA B SOIL ALTERNATIVES
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

ALTERNATIVE B-SO1 NO ACTION	ALTERNATIVE B-SO2 INSTITUTIONAL CONTROLS
OVERALL PROTECTION TO HUMAN HEALTH AND THE ENVIRONMENT	
No unacceptable risks from surface soils for current land uses, marginal risks for future residential use. Provides no additional protection from direct contact, no additional protection of groundwater. However, the removal action of sources at Area B will provide protection.	No unacceptable risks from surface soils for current land uses, marginal risks for future residential use. Provides some additional protection from direct contact by institutional controls, no additional protection of groundwater. However, the removal action of sources at Area B will provide protection.
COMPLIANCE WITH ARARS	
No contaminant-, location-, or action-specific ARARs.	No contaminant-, location- or action-specific ARARs.
LONG-TERM EFFECTIVENESS AND PERMANENCE	
No remedial action; however, the removal action will provide effective and permanent source removal.	Institutional controls would limit future land use to non-residential. The removal action will provide effective and permanent source control.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME (TMV) THROUGH TREATMENT	
No reduction in TMV through treatment. Possible reduction in TMV through natural processes.	No reduction in TMV through treatment. Possible reduction in TMV through natural processes.
SHORT-TERM EFFECTIVENESS	
No risks to human health or environment during implementation.	No risks to human health or environment during implementation.
IMPLEMENTABILITY	
No action; therefore, no implementability concerns.	Periodic inspection and maintenance of fenced required. Legal/administrative requirements for institutional controls.
COST	
Capital: $0 O&M: $20,000 (every 5 years) NPW: $55,600	Capital: $0 O&M: $600 (annually); $20,000 (every 5 years) NPW: $63,200

O&M: Operation and Maintenance
NPW: 30-year Net Present Worth

TABLE 6-4

COMPARISON OF SURFACE WATER/SEDIMENT ALTERNATIVES
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

ALTERNATIVE SD-1 NO ACTION	ALTERNATIVE SD-2 INSTITUTIONAL CONTROLS WITH MONITORING
OVERALL PROTECTION TO HUMAN HEALTH AND THE ENVIRONMENT	
No unacceptable human health risks associated with exposure to Area A or Area B surface water/sediment. No unacceptable risks associated with elementary school in Area B. Marginal risks for future residential use. Low levels of contaminants. Migration of contaminants to groundwater not considered to be a pathway. Provides no additional protection.	No unacceptable human health risks associated with exposure to Area A or Area B surface water/sediment. No unacceptable risks associated with elementary school in Area B. Marginal risks for future residential use. Low levels of contaminants. Migration of contaminants to groundwater not considered to be a pathway. Provides some additional protection through institutional controls.
COMPLIANCE WITH ARARS	
Minor exceedances of federal and state standards for surface water. No action- or location-specific ARARs.	Minor exceedances of federal and state standards for surface water. No action- or location-specific ARARs.
LONG-TERM EFFECTIVENESS AND PERMANENCE	
No remedial action -- risks same as in baseline risk assessment. However, source control actions in Areas A and B are expected to improve surface water/sediment quality over time.	Institutional controls would limit future land use to non-residential. Monitoring would provide information to track contaminant levels in these media.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME (TMV) THROUGH TREATMENT	
No reduction in TMV through treatment. Possible reduction in TMV through natural processes.	No reduction in TMV through treatment. Possible reduction in TMV through natural processes.
SHORT-TERM EFFECTIVENESS	
No risks to human health during implementation.	No risks to human health during implementation.
IMPLEMENTABILITY	
No action; therefore, no implementability concerns.	Legal/administrative requirements for institutional controls. Monitoring easily implemented.
COST	
Capital: $0 O&M: $20,000 (every 5 years) NPW: $55,600	Capital: $0 O&M: $50,477 (annually); $70,477 (every 5 years) NPW: $831,600

O&M: Operation and Maintenance
NPW: 30-year Net Present Worth

TABLE 6-5

COMPARISON OF AREA A1 GROUNDWATER ALTERNATIVES
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

ALTERNATIVE A1-GW1 NO ACTION[1]	ALTERNATIVE A1-GW2 INSTITUTIONAL CONTROLS[1]	ALTERNATIVE A1-GW3 PROTECTION OF YORKTOWN AQUIFER FOR BENEFICIAL USE THROUGH EXTRACTION AND TREATMENT[2]
OVERALL PROTECTION TO HUMAN HEALTH AND THE ENVIRONMENT		
Would not contain or treat contaminated groundwater. Groundwater on site not currently used for any purpose. Off-site shallow groundwater used for nonpotable residential use. Off-site deep groundwater used for industrial use. Deep groundwater contamination would continue to migrate off site. Shallow groundwater contamination does not appear to be migrating off site.	Would not contain or treat contaminated groundwater. Groundwater on site not currently used for any purpose. Off-site shallow groundwater used for nonpotable residential use. Off-site deep groundwater used for industrial use. Deep groundwater contamination would continue to migrate off site. Shallow groundwater contamination does not appear to be migrating off site. If necessary in the future, institutional controls would prevent potable use and limit nonpotable use of contaminated groundwater.	Would contain and treat contaminated groundwater in the Yorktown Aquifer to established cleanup goals. Groundwater on site not currently used for any purpose. Off-site shallow groundwater used for nonpotable residential use. Off-site deep groundwater used for industrial use. Shallow groundwater contamination does not appear to be migrating off site. If necessary in the future, institutional controls would prevent or limit use of contaminated groundwater.
COMPLIANCE WITH ARARs		
Shallow and deep contaminated groundwater exceeds federal MCLs. Both aquifers, however, currently are not used for drinking water purposes.	Shallow and deep contaminated groundwater exceeds federal MCLs. Both aquifers, however, currently are not used for drinking water purposes.	Both aquifers currently are not used for drinking water purposes. Intent of alternative is to restore Yorktown Aquifer to federal MCLs. Extracted groundwater and air emissions would comply with all local, state, and federal ARARs.

TABLE 6-5 (Continued)

COMPARISON OF AREA A1 GROUNDWATER ALTERNATIVES
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

ALTERNATIVE A1-GW1 NO ACTION(1)	ALTERNATIVE A1-GW2 INSTITUTIONAL CONTROLS(1)	ALTERNATIVE A1-GW3 PROTECTION OF YORKTOWN AQUIFER FOR BENEFICIAL USE THROUGH EXTRACTION AND TREATMENT(2)
LONG-TERM EFFECTIVENESS AND PERMANENCE		
Risks would exceed acceptable levels if shallow and deep aquifers were used for potable use on site. Currently no unacceptable risks associated with off-site nonpotable use of groundwater. Periodic groundwater monitoring would effectively track potential contaminant migration.	Risks would exceed acceptable levels if shallow and deep aquifers were used for potable use on site. Currently no unacceptable risks associated with off-site nonpotable use of groundwater. Potential future risks would be mitigated through institutional controls. Periodic groundwater monitoring would effectively track potential contaminant migration.	Risks would exceed acceptable levels if shallow and deep aquifers were used for potable use on site. Currently no unacceptable risks associated with off-site nonpotable use of groundwater. Extraction system should prevent off-site migration of contamination above cleanup goals. Potential future risks would be mitigated through institutional controls. Periodic groundwater monitoring would effectively track potential contaminant migration.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME (TMV) THROUGH TREATMENT		
No reduction in TMV through treatment. Possible reduction in toxicity over time through dilution and dispersion.	No reduction in TMV through treatment. Possible reduction in toxicity over time through dilution and dispersion.	Toxicity and volume reduced to established cleanup goals through extraction and treatment. Mobility reduced through extraction.
SHORT-TERM EFFECTIVENESS		
No risk to human health or environment during implementation.	No risk to human health or environment during implementation.	Air emissions from treatment system would be monitored to protect human health and the environment.

TABLE 6-5 (Continued)

COMPARISON OF AREA A1 GROUNDWATER ALTERNATIVES
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

ALTERNATIVE A1-GW1 NO ACTION[1]	ALTERNATIVE A1-GW2 INSTITUTIONAL CONTROLS[1]	ALTERNATIVE A1-GW3 PROTECTION OF YORKTOWN AQUIFER FOR BENEFICIAL USE THROUGH EXTRACTION AND TREATMENT[2]
IMPLEMENTABILITY		
Groundwater monitoring could be readily implemented.	Groundwater monitoring could be readily implemented.	Treatment system components are demonstrated and commercially available.
COST		
Capital: $0 O&M: $38,600 (years 1-10) $19,600 (years 11-20) $10,100 (years 21-30) $20,000 (every 5 years) NPW: $476,700	Capital: $0 O&M: $38,600 (years 1-10) $19,600 (years 11-20) $10,100 (years 21-30) $20,000 (every 5 years) NPW: $476,700	Capital: $6,108,500 O&M: $187,300 (yrs 1-10) $168,300 (yrs 11-20) $158,800 (yrs 21-30) $20,000 (every 5 yrs) NPW: $8,870,200

(1) Alternative includes groundwater monitoring.
(2) Alternative cost includes extraction and treatment system capital cost.
O&M: Operation and maintenance.
NPW: Net present worth.

TABLE 6-6

COMPARISON OF AREA A2 GROUNDWATER ALTERNATIVES
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

ALTERNATIVE A2-GW1 NO ACTION[1]	ALTERNATIVE A2-GW2 INSTITUTIONAL CONTROLS[1]	ALTERNATIVE A2-GW3 PROTECTION OF YORKTOWN AQUIFER FOR BENEFICIAL USE THROUGH EXTRACTION AND TREATMENT[2]
OVERALL PROTECTION TO HUMAN HEALTH AND THE ENVIRONMENT		
Would not contain or treat contaminated groundwater. Groundwater on site not currently used for any purpose. Off-site shallow groundwater used for nonpotable residential use. Off-site deep groundwater used for industrial use. Deep groundwater contamination would continue to migrate off site. Shallow groundwater contamination does not appear to be migrating off site.	Would not contain or treat contaminated groundwater. Groundwater on site not currently used for any purpose. Off-site shallow groundwater used for nonpotable residential use. Off-site deep groundwater used for industrial use. Deep groundwater contamination may continue to migrate off site. Shallow groundwater contamination does not appear to be migrating off site. If necessary in the future, institutional controls would prevent potable use and limit nonpotable use of contaminated groundwater.	Would contain and treat contaminated groundwater to established cleanup goals. Groundwater on site not currently used for any purpose. Off-site shallow groundwater used for nonpotable residential use. Off-site deep groundwater used for industrial use. Shallow groundwater contamination does not appear to be migrating off site. If necessary in the future, institutional controls would prevent or limit use of contaminated groundwater.
COMPLIANCE WITH ARARs		
Shallow and deep contaminated groundwater exceeds state and federal MCLs. Both aquifers, however, currently are not used for drinking water purposes.	Shallow and deep contaminated groundwater exceeds state and federal MCLs. Both aquifers, however, currently are not used for drinking water purposes.	Both aquifers currently are not used for drinking water purposes. Intent of alternative is to restore Yorktown Aquifer to state and federal MCLs. Extracted groundwater and air emissions would comply with all local, state, and federal ARARs.

TABLE 6-6 (Continued)

COMPARISON OF AREA A2 GROUNDWATER ALTERNATIVES
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

ALTERNATIVE A2-GW1 NO ACTION(1)	ALTERNATIVE A2-GW2 INSTITUTIONAL CONTROLS(1)	ALTERNATIVE A2-GW3 PROTECTION OF YORKTOWN AQUIFER FOR BENEFICIAL USE THROUGH EXTRACTION AND TREATMENT(2)
LONG-TERM EFFECTIVENESS AND PERMANENCE		
Risks would exceed acceptable levels if shallow and deep aquifers were used for potable use on site. Currently no unacceptable risks associated with off-site nonpotable use of groundwater. Periodic groundwater monitoring would effectively track potential contaminant migration.	Risks would exceed acceptable levels if shallow and deep aquifers were used for potable use on site. Currently no unacceptable risks associated with off-site nonpotable use of groundwater. Potential future risks would be mitigated through institutional controls. Periodic groundwater monitoring would effectively track potential contaminant migration.	Risks would exceed acceptable levels if shallow and deep aquifers were used for potable use on site. Currently no unacceptable risks associated with off-site nonpotable use of groundwater. Extraction system should prevent off-site migration of contamination above cleanup goals. Potential future risks would be mitigated through institutional controls. Periodic groundwater monitoring would effectively track potential contaminant migration.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME (TMV) THROUGH TREATMENT		
No reduction in TMV through treatment. Possible reduction in toxicity over time through dilution and dispersion.	No reduction in TMV through treatment. Possible reduction in toxicity over time through dilution and dispersion.	Toxicity and volume reduced to established cleanup goals through extraction and treatment. Mobility reduced through extraction.
SHORT-TERM EFFECTIVENESS		
No risk to human health or environment during implementation.	No risk to human health or environment during implementation.	Air emissions from treatment system would be monitored to protect human health and the environment.

TABLE 6-6 (Continued)

COMPARISON OF AREA A2 GROUNDWATER ALTERNATIVES
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

ALTERNATIVE A2-GW1 NO ACTION[1]	ALTERNATIVE A2-GW2 INSTITUTIONAL CONTROLS[1]	ALTERNATIVE A2-GW3 PROTECTION OF YORKTOWN AQUIFER FOR BENEFICIAL USE THROUGH EXTRACTION AND TREATMENT[2]
IMPLEMENTABILITY		
Groundwater monitoring could be readily implemented.	Groundwater monitoring could be readily implemented.	Treatment system components are demonstrated and commercially available.
COST		
Capital: $0 O&M: $38,600 (years 1-10) $19,600 (years 11-20) $10,100 (years 21-30) $20,000 (every 5 years) NPW: $476,700	Capital: $0 O&M: $38,600 (years 1-10) $19,600 (years 11-20) $10,100 (years 21-30) $20,000 (every 5 years) NPW: $476,700	Capital: $0 O&M: $59,400 (yrs 1-10) $40,400 (yrs 11-20) $30,900 (yrs 21-30) $20,000 (every 5 yrs) NPW: $796,000

(1) Alternative includes groundwater monitoring.
(2) Alternative cost includes only additional O&M costs for Area A2 groundwater treatment.
O&M: Operation and maintenance.
NPW: Net present worth.

TABLE 6-7

COMPARISON OF AREA B GROUNDWATER ALTERNATIVES
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

ALTERNATIVE B-GW1 NO ACTION(1)	ALTERNATIVE B-GW2 INSTITUTIONAL CONTROLS(1)	ALTERNATIVE B-GW3 PROTECTION OF WATER TABLE AND YORKTOWN AQUIFERS FOR BENEFICIAL USES THROUGH EXTRACTION AND TREATMENT(2)
OVERALL PROTECTION TO HUMAN HEALTH AND THE ENVIRONMENT		
Would not contain or treat contaminated groundwater, however, groundwater on site and immediately downgradient of contamination is not currently used for any purpose.	Would not contain or treat contaminated groundwater, however, groundwater on site and immediately downgradient of contamination is not currently used for any purpose. Institutional controls would prevent future potable use and limit nonpotable use of contaminated groundwater.	Would contain and treat contaminated groundwater to established cleanup goals. Contamination below cleanup goals would continue to migrate off site. Groundwater on site and immediately downgradient of contamination is not currently used for any purpose. If necessary in the future, institutional controls would prevent or limit use of contaminated groundwater.
COMPLIANCE WITH ARARs		
Shallow and deep contaminated groundwater exceeds state and federal MCLs. Both aquifers, however, currently are not used for drinking water purposes.	Shallow and deep contaminated groundwater exceeds state and federal MCLs. Both aquifers, however, currently are not used for drinking water purposes.	Both aquifers currently are not used for drinking water purposes. Intent of alternative is to restore the water table and Yorktown Aquifers to their respective cleanup goals. Extracted groundwater and air emissions would comply with all local, state, and federal ARARs.

TABLE 6-7 (Continued)

COMPARISON OF AREA B GROUNDWATER ALTERNATIVES
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

ALTERNATIVE B-GW1 NO ACTION[1]	ALTERNATIVE B-GW2 INSTITUTIONAL CONTROLS[1]	ALTERNATIVE B-GW3 PROTECTION OF WATER TABLE AND YORKTOWN AQUIFERS FOR BENEFICIAL USES THROUGH EXTRACTION AND TREATMENT[2]
LONG-TERM EFFECTIVENESS AND PERMANENCE		
Risks would exceed acceptable levels if shallow or deep aquifers were used for potable use on site. Periodic groundwater monitoring would effectively track potential contaminant migration.	Risks would exceed acceptable levels if shallow or deep aquifers were used for potable use on site. Potential future risks would be mitigated through institutional controls. Periodic groundwater monitoring would effectively track potential contaminant migration.	Risks would exceed acceptable levels if shallow and deep aquifers were used for potable use on site. Extraction system should prevent off-site migration of contamination above cleanup goals. Potential future risks would be mitigated through institutional controls. Periodic groundwater monitoring would effectively track potential contaminant migration.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME (TMV) THROUGH TREATMENT		
No reduction in TMV through treatment. Possible reduction in toxicity over time through dilution and dispersion.	No reduction in TMV through treatment. Possible reduction in toxicity over time through dilution and dispersion.	Toxicity and volume reduced to established cleanup goals through extraction and treatment. Mobility reduced through extraction.
SHORT-TERM EFFECTIVENESS		
No risk to human health or environment during implementation.	No risk to human health or environment during implementation.	Air emissions from treatment system would be treated and monitored to protect human health and the environment.

TABLE 6-7 (Continued)

COMPARISON OF AREA B GROUNDWATER ALTERNATIVES
CAMP ALLEN LANDFILL, NORFOLK, VIRGINIA

ALTERNATIVE B-GW1 NO ACTION[1]	ALTERNATIVE B-GW2 INSTITUTIONAL CONTROLS[1]	ALTERNATIVE B-GW3 PROTECTION OF WATER TABLE AND YORKTOWN AQUIFERS FOR BENEFICIAL USES THROUGH EXTRACTION AND TREATMENT[2]
IMPLEMENTABILITY		
Groundwater monitoring could be readily implemented.	Groundwater monitoring could be readily implemented.	Treatment system components are demonstrated and commercially available.
COST		
Capital: $0 O&M: $38,600 (years 1-10) $19,600 (years 11-20) $10,1000 (years 21-30) $20,000 (every 5 years) NPW: $476,700	Capital: $0 O&M: $38,600 (years 1-10) $19,600 (years 11-20) $10,100 (years 21-30) $20,000 (every 5 years) NPW: $476,700	Capital: $0 O&M: $62,400 (years 1-10) $43,400 (years 11-20) $34,000 (years 21-30) $20,000 (every 5 years) NPW: $842,500

(1) Alternative includes groundwater monitoring.
(2) Alternative cost includes only additional O&M costs for Area B groundwater treatment.
O&M: Operation and maintenance.
NPW: Net present worth.

SECTION 7

7.0 SUMMARY OF THE PREFERRED ALTERNATIVES

7.1 Identification of Preferred Alternatives

The preferred alternative for each medium of concern for Areas A and B is identified below:

Area A1 Soil

Alternative A-SO5: In Situ Treatment by Dual Phase Vacuum Extraction with Institutional Controls.

Area A2 Soil

Alternative A-SO2: Institutional Controls

Area B Soil

Alternative B-SO2: Institutional Controls

Surface Water/Sediment (Areas A and B)

Alternative SD-2: Institutional Controls with Monitoring

Area A1 Groundwater

Alternative A1-GW3: Protection of the Yorktown Aquifer for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring

Area A2 Shallow Groundwater (Water Table Aquifer)

Alternative A2-GW4: Protection of the Water Table Aquifer for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring

Area A2 Deep Groundwater (Yorktown Aquifer)

Alternative A2-GW2: Institutional Controls with Monitoring

Area B Groundwater

Alternative B-GW3: Protection of the Water Table and Yorktown Aquifers for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring

7.2 Preferred Alternative Selection Rationale

Based on available information and the current understanding of site conditions, each preferred alternative appears to provide the best balance of trade-offs with respect to the nine CERCLA evaluation criteria. In addition, the selected alternatives are anticipated to meet the following statutory requirements:

- Protection of human health and the environment
- Compliance with ARARs (or justification of a waiver)
- Cost-effectiveness
- Utilization of permanent solutions and alternative treatment or resource recovery technologies to the maximum extent practicable

The proposed response actions (or preferred alternatives) identified in this PRAP address all contaminated media of concern at the site and comprise the overall cleanup strategy for the site. Contaminated media addressed by the preferred alternatives include contaminated soil, surface water/sediment, and groundwater in Areas A and B. The reasons for selection of the preferred alternatives for the various media are briefly described below.

7.2.1 Preferred Soil Alternatives

Area A1

The preferred alternative for contaminated soil in Area A1 is Alternative A-SO5, In Situ Treatment by Dual Phase Vacuum Extraction (DPVE). The DPVE system offers a significant advantage over other treatment alternatives in that it is able to extract both soil and shallow groundwater (water table aquifer) contamination with a single system. This benefit is especially valuable since it has been shown that the conventional pump and treat method would not be feasible for remediation of the water table aquifer in Area A1 due to its very low hydraulic conductivity. The groundwater extracted by the DPVE system would be pumped to the proposed on-site treatment plant for contaminated groundwater, which would be constructed as part of Alternatives A1-GW3, A2-GW4, and B-GW3.

Area A2

The preferred alternative for Area A2 soils is A-SO2 - Institutional Controls. In contrast to Area A1, the DPVE pilot test performed in Area A2 yielded no identifiable contaminants in either the extracted groundwater or soil vapors, indicating that the extent of soil contamination in Area A2 is very limited. The test results also showed that the DPVE technology is not well-suited for extraction of groundwater from the water table aquifer in Area A2, and that conventional submersible pumps are more appropriate for the water table aquifer in this area. Any contamination that may migrate from the soil to the water table aquifer would be captured by the groundwater extraction system proposed for Area A2.

Area B

Since the primary source of groundwater contamination in Area B appeared to be concentrated in a relatively small volume of contaminated soil, a removal action was performed for the Area B contaminated soil. The removal action involved excavation of contaminated soil and debris in hot spot areas within Area B and off-site disposal of the excavated material at a RCRA-permitted hazardous waste management facility (landfill or incinerator). Since it is expected that this removal action has permanently removed the primary sources of contamination in Area B, the preferred alternative for Area B soils is Alternative B-SO2, Institutional Controls (deed restrictions).

7.2.2 Preferred Surface Water/Sediment Alternative

The preferred alternative for surface water/sediment in Areas A and B is Alternative SD-2, Institutional Controls and Monitoring. The proposed remediation of the soil and groundwater in the Camp Allen Landfill Area is expected to result in a decrease in contaminant levels in surface water/sediment over time. Therefore, a post-remediation surface water/sediment monitoring program would be used to track trends in contamination levels over time in these media in the surrounding drainage channels. Additional sampling/analysis of surface water/sediment is proposed in the immediate future to establish baseline conditions of surface water/sediment in the vicinity of the Camp Allen Landfill Site for the proposed monitoring program.

7.2.3 Preferred Groundwater Alternatives

Area A1

The preferred alternative for groundwater in Area A1 is Alternative A1-GW3, Protection of the Yorktown Aquifer for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring. The water table aquifer in Area A1 will be addressed by the DPVE system that is proposed for Area A1 soils. Although there are no downgradient residential receptors for groundwater in this area, extraction and treatment of groundwater in the Yorktown Aquifer is recommended in Area A1, since the contaminant plume could migrate off of Navy property in this area. Groundwater in the Yorktown Aquifer would be extracted through a series of mid-depth (approximately 65 feet) pumping wells and would be pumped to an on-site treatment system. The treatment system, which would include metals removal via clarification/filtration, and removal of volatile organics via air stripping and carbon adsorption, would be sized to accommodate groundwater flows from Areas A1, A2, and B. A groundwater monitoring program would be implemented to assess trends in groundwater quality over time and to evaluate the effectiveness of the groundwater extraction and treatment system. Additionally, deed restrictions would be implemented to limit the area to non-residential land uses.

Area A2

The preferred alternative for the water table aquifer in Area A2 is A2-GW4 - Protection of the Water Table Aquifer for Beneficial Use Through Extraction and Treatment, Institutional Controls, and Monitoring. This alternative was not included in the Feasibility Study because shallow groundwater remediation was addressed by the DPVE alternative developed for Area A2 soils. However, results of the DPVE pilot test indicate that the DPVE technology is not well-suited for extraction of groundwater from the water table aquifer in Area A2, and that conventional submersible pumps are more appropriate for the water table aquifer in this area. Therefore, Alternative A2-GW4 is proposed to contain shallow groundwater contamination in Area A2, which could migrate horizontally, or vertically to the Yorktown Aquifer. Implementation of this alternative would be very similar to Alternatives A1-GW3 and B-GW3. Groundwater in the water table aquifer would be extracted through shallow extraction wells (approximately 25 feet deep). Extracted groundwater would be pumped to the on-site groundwater treatment system proposed for Alternatives A1-GW3 and B-GW3.

At this time, the preferred alternative for the Yorktown Aquifer in Area A2 is Alternative A2-GW2, Institutional Controls with Monitoring. Since there are no receptors for groundwater immediately downgradient of Area A2, and the contaminant plume is not expected to migrate off of Navy property in this area, extraction and treatment of groundwater in the Yorktown Aquifer is not recommended in Area A2. Since the water table aquifer within Area A2 will be remediated under Alternative A2-GW4, contaminant levels in groundwater in the Yorktown Aquifer may gradually decrease through dilution and natural attenuation. A groundwater monitoring program would be implemented to assess trends in groundwater quality over time. As previously noted, the on-site treatment system would be sized to treat flows from Areas A1, A2 and B. In the event that extraction and treatment of the Yorktown Aquifer in Area A2 becomes necessary, treatment capacity would be available. Additionally, deed restrictions would be implemented to limit the area to non-residential land uses.

Area B

The preferred alternative for groundwater in Area B is Alternative B-GW3, protection of the Water Table and Yorktown Aquifers for Beneficial Use Through Extraction and Treatment, Institutional

Controls, and Monitoring. Extraction and treatment of both aquifers in Area B is recommended because, in general, the levels of contaminants in Area B groundwater are higher than in Areas A1 and A2. Additionally, although there are no groundwater users downgradient of Area B, extraction and treatment of groundwater in both aquifers is recommended in this area to contain the contaminant plume. Groundwater in the upper Yorktown Aquifer would be extracted through a series of pumping wells (approximately 65 feet deep). Groundwater in the water table aquifer would be extracted through a series of shallow pumping wells (approximately 25 feet deep). Extracted groundwater from both aquifers would be pumped to an on-site treatment system. The treatment system, which would include metals removal via clarification/filtration, and removal of organics via air stripping and carbon adsorption, would be sized to accommodate groundwater flows from Areas A1, A2, and B. A groundwater monitoring program would be implemented to assess trends in groundwater quality over time and to evaluate the effectiveness of the groundwater extraction and treatment system. Additionally, deed restrictions would be implemented to limit the area to non-residential land uses.

This combination of response actions is expected to provide effective source control at the site, to substantially reduce the potential for migration of contamination, and to significantly reduce potential human health and environmental risks associated with the site. For a more detailed analysis and evaluation of remedial alternatives, the reader is referred to the Camp Allen Landfill Site Final Feasibility Study.

SECTION 8

8.0 COMMUNITY PARTICIPATION

A critical part of the selection of a remedial action alternative is community involvement. The following information is provided to the community in order to obtain input that addresses the selection of remedial action alternatives for the Camp Allen Landfill.

8.1 Public Comment Period

The public comment period will begin on March 6, 1995 and end on April 5, 1995 for this Proposed Remedial Action Plan for the Camp Allen Landfill site. A public meeting will be held following the public comment period if it is requested during the public comment period. Written comments should be sent to the following address:

Commander, Naval Base Norfolk
Public Affairs Office
1530 Gilbert Street, Suite 200
Norfolk, Virginia 23511-2797
Attention: Ms. Beth Baker

8.2 Information Repositories

A collection of information regarding the Camp Allen Landfill is available to the community at the following locations. The administrative record is available at the Kirn Memorial Library.

Larchmont Public Library
6525 Hampton Blvd.
Norfolk, VA
804/441-5455

Mary Pretlow Public Library
9640 Granby Street
Norfolk, VA
804/441-1750

Naval Air Station Library
Building C-9, Bacon Street
Naval Air Station
Norfolk, VA
804/433-6565

Kirn Memorial Branch
Norfolk Public Library
301 East City Hall Avenue
Norfolk, Virginia 23510
804/441-2173

If you have any questions about the Camp Allen Landfill Proposed Remedial Action Plan, please contact one of the following:

Commander
Atlantic Division
Naval Facilities Engineering Command
1510 Gilbert Street (Bldg. N-26)
Norfolk, Virginia 23511-2699
Attention: Mr. David M. Forsythe
(804) 322-4783

Remedial Project Manager
USEPA, Region III
841 Chestnut Building
Philadelphia, Pennsylvania 19107
Attention: Mr. Robert Thomson, P.E.
(215) 597-1110

Virginia Department of Environmental Quality
Federal Facilities Program
P.O. Box 10009
Richmond, Virginia 23240-0009
Attention: Ms. Patricia McMurray
(804) 762-4201

Commander, Naval Base Norfolk
Public Affairs Office
1530 Gilbert Street, Suite 200
Norfolk, Virginia 23511-2797
Attention: Ms. Beth Baker
(804) 444-2163

8.3 Mailing List

If you are not on the mailing list and would like to receive future publications pertaining to the Camp Allen Landfill project, please fill out, detach, and mail this form to:

Commander, Naval Base Norfolk
Public Affairs Office
Attention: Ms. Beth Baker
1530 Gilbert Street, Suite 200
Norfolk, Virginia 23511-2797

Name ____

Address ____

Affiliation ____

Phone (___)____________________

SECTION 9

9.0 REFERENCES

Camp Allen Landfill Area B Removal Action Closeout Report. Prepared for the Department of the Navy. Atlantic Division Naval Facilities Engineering Command. OHM Remediation Services Corp., March 1995.

Camp Allen Landfill Baseline Risk Assessment. Final. Prepared for the Department of the Navy, Atlantic Division Naval Facilities Engineering Command. Baker Environmental, Inc., November 1994.

Camp Allen Landfill Basis of Design Report. Final. Prepared for the Department of the Navy. Atlantic Division Naval Facilities Engineering Command. Baker Environmental, Inc., May 1994.

Camp Allen Landfill Engineering Evaluation/Cost Analysis. Final. Prepared for the Department of the Navy, Atlantic Division Naval Facilities Engineering Command. Baker Environmental, Inc., August 1993.

Camp Allen Landfill Feasibility Study Report. Final. Prepared for the Department of the Navy, Atlantic Division Naval Facilities Engineering Command. Baker Environmental, Inc., November 1994.

Camp Allen Landfill Industrial Wastewater Treatment Plant Engineering Analysis Report. Final. Prepared for the Department of the Navy, Atlantic Division Naval Facilities Engineering Command. Baker Environmental, Inc., January 1994.

Camp Allen Landfill Remedial Design Work Plan. Final. Prepared for the Department of the Navy, Atlantic Division Naval Facilities Engineering Command. Baker Environmental, Inc., May 1994.

Camp Allen Landfill Remedial Investigation Report. Final. Prepared for the Department of the Navy, Atlantic Division Naval Facilities Engineering Command. Baker Environmental, Inc. July 1994.

Camp Allen Salvage Yard - Preliminary Assessment/Site Inspection Report. Final. Prepared for the Department of the Navy, Atlantic Division Naval Facilities Engineering Command. Baker Environmental, Inc., May 1994.

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Initial Assessment Study of Sewells Point Naval Complex, Norfolk, Virginia. Malcolm Pirnie, February 1983.

Installation Restoration Program, Remedial Investigation, Interim Report, , Norfolk, Virginia. Malcolm Pirnie, May 1988.

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