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Site 20903-5640 (White Oak)
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Final

FEASIBILITY STUDY REPORT

DAHLGREN DIVISION DETACHMENT, WHITE OAK SILVER SPRING, MARYLAND

Prepared for:

Naval Facilities Engineering Command
Chesapeake Division
Washington, D.C. 20374

Contract No. N62477-85-C-0060

October 1993

Malcolm Pirnie, Inc.
ENVIRONMENTAL ENGINEERS, SCIENTISTS & PLANNERS

Section: 04.03
Site 20903-5640 (White Oak)
Doc. #: 0001

FINAL REPORT

INSTALLATION RESTORATION PROGRAM FEASIBILITY STUDY

DAHLGREN DIVISION DETACHMENT, WHITE OAK NAVAL SURFACE WARFARE CENTER SILVER SPRING, MARYLAND

Prepared for:

Chesapeake Division
Naval Facilities Engineering Command
Washington, DC 20374
Contract: N62477-85-C-0060

Engineer-in-Charge: Heath Wells

October 1993

Prepared by:

MALCOLM PIRNIE, INC.
Environmental Engineers, Scientists and Planners
11832 Rock Landing Drive
Suite 400
Newport News, Virginia 23606

0931-031-200

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.
ENVIRONMENTAL ENGINEERS, SCIENTISTS & PLANNERS

January 12, 1994

Chesapeake Division EFA
Attn: Mr. Heath Wells, Code 181
901 M Street, S.E., Building 212
Washington, DC 20374-5018

Re: Final Feasibility Study
Naval Surface Warfare Center, White Oak
Silver Spring, Maryland

Dear Mr. Wells:

Malcolm Pirnie is pleased to provide to EFA Chesapeake this **final submittal** of the **Feasibility Study, Naval Surface Warfare Center, Dahlgren Division Detachment, White Oak (NSWCWODET), Silver Spring, Maryland** in support of the Navy's Installation Restoration Program.

It has been a pleasure to provide this document to EFA Chesapeake. We look forward to further discussions relative to this project.

Very truly yours,

MALCOLM PIRNIE, INC.

Anthony K. Pace

Anthony K. Pace
Project Manager

djk
0931-031-200

Enclosure

DKL0112.AKP/File 1.0

11832 ROCK LANDING DRIVE SUITE 400 NEWPORT NEWS, VA 23606-4206 804-873-8700 FAX: 804-873-8723

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1.0 INTRODUCTION

Malcolm Pirnie, Inc. was retained by the Chesapeake Division of the Naval Facilities Engineering Command (NAVFAC) to complete a Remedial Investigation (RI) Study and Feasibility Study (FS) under the Installation Restoration Program (IRP) at the Dahlgren Division Detachment, White Oak, Naval Surface Warfare Center (NSWCWODET), Silver Spring, Maryland. The sites in question were defined by the Naval Energy and Environmental Support Activity (NEESA) during the performance of the Initial Assessment Study (IAS) for the Navy Assessment and Control of Installation Pollutants (NACIP) program. Although none of the NSWCWODET sites scored high enough to qualify for the National Priority List (NPL), the Navy's policy is that all of the remedial investigation activities will be performed in accordance with the U.S. Environmental Protection Agency (USEPA) guidelines contained in ***Guidance on Remedial Investigations and Feasibility Studies under CERCLA***, USEPA Office of Solid Waste and Emergency Response (OSWER) Directive 9335.3-01, March 1988, and the contents of 40 CFR §300, National Oil and Hazardous Substances Pollution Contingency Plan (National Contingency Plan, NCP).

1.1 PURPOSE

The purpose of this FS is to develop remediation options and to develop viable mitigation and remediation methods for each of the seven sites. The results of the RI study are used to identify contaminated media and develop potentially applicable remedial measures. The specific objectives for the FS are to:

- Select and describe remedial alternatives as options appropriate for mitigating environmental contamination at each of the seven sites.
- Develop conceptual design drawings, operational descriptions, and a preliminary project schedule for implementation.

The scope of this FS is limited and addresses only those actions necessary to reduce risks to human health and the environment as identified and determined to be unacceptable in the ***Remedial Investigation Report***, Malcolm Pirnie, October 1992. Unacceptable risk are those identified to be in excess of criteria established in the USEPA document ***Risk***

Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), USEPA, 1989, and *Risk Assessment Guidance for Superfund, Volume I: Human Health (Supplemental Guidance)*, *Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual*, USEPA, 1989, and *"Standard Default Exposure Factors," Interim Final*, USEPA, 1991. In addition, this FS is limited in that it addresses only those media which cause or contribute to the unacceptable level of risk. Unacceptable risks, which constitute the rationale for remedial action, are discussed for each site in detail in Section 3.1.

Remedial alternatives will be evaluated according to nine criteria specified in the NCP, 40 CFR §300.430 (e)(9)(iii). These nine criteria include the following:

- Overall protection of human health and the environment
- Overall compliance with ARARs
- Long-term effectiveness and permanence
- Reduction in toxicity, mobility or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- Community acceptance
- State acceptance

1.2 REPORT ORGANIZATION

Section 1.0 of this report presents an introduction to the FS to include its purpose, report organization, and the Technical Review Committee's recommendations regarding selection of the preferred remedial alternatives for each site.

Section 2.0 of this report presents facility description summary information including facility and site location and history. The summary of the RI includes information on regional and site ecology, geology, and hydrogeology and site-specific information such as

a summary of contamination assessment, fate and transport, human health evaluation, and risk assessment.

Section 3.0 of this report details the identification and initial screening of remedial alternatives considered for the FS. The section also reviews the remedial objectives, general response actions, discusses the ARARs and evaluation criteria that must be considered. A summary of the preliminary screening of the remedial technologies is provided at the end of this section.

Section 4.0 of this report further develops the remedial technologies and alternatives for groundwater, soil, sediment and source control, including the no action alternative.

Section 5.0 provides a detailed analysis of remedial alternatives as compared to the nine required criteria and provides a comparative analysis of the alternatives.

Section 6.0 provides a summary of the preferred remedial alternatives for each site with conceptual design criteria, conceptual drawings, and costs for those alternatives.

1.3 TECHNICAL REVIEW COMMITTEE

The Technical Review Committee (TRC) whose membership includes U.S. Navy personnel, representatives from various regulatory agencies including USEPA Region III, the Maryland Department of the Environment (MDE), the Prince George's County Health Department and the Montgomery County Department of Environmental Protection, and a representative of the Hillandale Citizens Association reviews all documents and findings of the Installation Restoration Program for NSWCWODET. The following is an endorsement of the remedial alternatives for the seven sites as recommended by the TRC.

The TRC hereby endorses the following based upon a review of the FS and these conditions:

- The information provided in the RI/FS is correct and accurate.
- The recommended option will meet all federal, state, and local statutes, be they ARARs, discharge requirements or monitoring requirements.
- If significant differences between what was found in the RI/FS and what is in the field are found in the design process, the recommended option will be re-reviewed by the TRC.
- The TRC will be asked for comments and review during the design phase.

- The endorsement hereon is as a member of the TRC and does not necessarily signify complete or final acceptance of the option by the member or the members organization. The affiliation is only shown for reference.

The TRC of White Oak hereby recommends:

- **Site 2 - Apple Orchard Landfill**

  Cap landfill with an impermeable cover that will prevent under flow and infiltration.

  Sediment will be treated with on-site low temperature thermal desorption with on-site disposal.

- **Site 3 - Pistol Range Landfill**

  Cap landfill with an impermeable cover that will prevent under flow and infiltration.

  Groundwater will be treated by extraction wells with Activated Carbon treatment and discharge to surface water.

- **Site 4 - Chemical Burial Site**

  Excavate source site, solid material disposed of legally off-site, soil treated with low temperature thermal desorption, and on-site disposal.

  Groundwater will be treated by extraction wells with Activated Carbon treatment and discharge to surface water.

- **Site 7 - Ordnance Burn Area**

  Soil will be treated by a combination of in-situ and ex-situ soil washing with on-site disposal.

  Groundwater will be treated by extraction wells with Activated Carbon treatment and discharge to surface water.

- **Site 8 - Abandoned Chemical Disposal Pit**

  Excavate source site, solid material disposed of legally off-site, soil treated with low temperature thermal desorption, and on-site disposal.

  Groundwater will be treated by extraction wells with Activated Carbon treatment and discharge to surface water.

- **Site 9 - Industrial Wastewater Disposal Area 300**

  Excavate source site, solid material disposed of legally off-site, soil treated with low temperature thermal desorption, and on-site disposal.

  Groundwater will be treated by extraction wells with Activated Carbon treatment and discharge to surface water.

- **Site 11 - Industrial Wastewater Disposal Area 100**

  Excavate source site, solid material disposed of legally off-site, soil treated with low temperature thermal desorption, and on-site disposal.

  Groundwater will be treated by extraction wells with Activated Carbon treatment and discharge to surface water.

Remedial Project Manager U.S. Navy	Environmental Coordinator, NSWCWODET
Commanding Officer NSWCWODET	Malcolm Pirnie, Inc.
Hillandale Citizens Association	Environmental Coordinator, NSWCDD
Montgomery County Department of Environment Protection	Prince George's County Environmental Health Department
Maryland Department of the Environment - CERCLA	Maryland Department of the Environment - RCRA

2.0 FACILITY DESCRIPTION AND RI SUMMARY

2.1 FACILITY LOCATION

Naval Surface Warfare Center, Dahlgren Division Detachment, White Oak (NSWCWODET) is a Navy-owned and operated laboratory for naval surface warfare research, located approximately 5 miles north of Washington, D.C. off New Hampshire Avenue. The facility is located in both Prince George's and Montgomery Counties. NSWCWODET is bordered to the north by a mixture of residential, park and industrial/commercial properties, to the east by residential properties, to the southeast by the Harry Diamond Laboratory and United States Naval Reserve (USNR) training center, to the southwest by the Hillandale residential community, and to the west by New Hampshire Avenue.

A complete description of the NSWCWODET facility is provided in the ***Remedial Investigation Report***, Malcolm Pirnie, October 1992.

2.1.1 Regional Ecology

NSWCWODET covers approximately 732 acres. Areas occupied by roads, buildings and landscaping comprise 96.8 acres. The remaining acreage consists of 270.6 acres of open field and scrub-shrub community, 32 acres of pine forest, and 332.6 acres of hardwood forest (NSWCWODET, 1985).

Vegetation communities on the facility have formed as a result of a variety of land uses, soil conditions, and slope. Former land uses such as gravel mining, building construction, landfilling, and logging have influenced the successional stages and plant species composition of the site. This, in turn, has affected the animal communities on the facility. The physical environment of, and various land uses on, the facility are typical of the region. Thus, the vegetation communities and wildlife habitats on-site are representative of regional patterns. A description of site ecology is provided in the ***Remedial Investigation Report***, Malcolm Pirnie, October 1992.

2.1.2 Regional Geology

The area surrounding NSWCWODET straddles the Piedmont and the Coastal Plain Physiographic Provinces. The boundary between these two provinces is approximately 2,000 feet west and parallel to the Prince George's and Montgomery County Line. Both provinces are divided into eastern and western subdivisions by geographic features; the Piedmont by Parrs Ridge and the Coastal Plain by the Chesapeake Bay. The NSWCWODET straddles the eastern Piedmont subdivision and the western Coastal Plain subdivision. The topography of both subdivisions can be characterized as rolling to hilly uplands with steeply eroded stream valleys. A complete description of regional geology is provided in the ***Remedial Investigation Report***, Malcolm Pirnie, October 1992.

2.1.3 Facility Geology

NSWCWODET is situated within the Beltsville geologic quadrangle. Geologic units of the Piedmont and Coastal Plain provinces underlie NSWCWODET. The boundary between these two units crosses the NSWCWODET from southwest to northeast. On the NSWCWODET facility, Piedmont units are exposed at elevations below approximately 340 feet above mean sea level (MSL) and are overlain by Coastal Plain deposits at elevations above approximately 340 feet MSL. A full discussion of site geology is provided in the ***Remedial Investigation Report***, Malcolm Pirnie, October 1992.

2.1.4 Facility Soils

Surficial soils of the facility tend to be moderately acidic with a pH ranging from 4 to 6 (Soil Survey Report, U.S. Naval Ordnance Laboratory, White Oak, Maryland, 1920). This may be due to the presence of hydroxyl, humic, and fulvic acids derived from the decay of organic matter. With the exception of streambed soils, the area soils tend to be moderately to excessively well drained and moderately to severely eroded.

2.1.5 Regional Hydrogeology

Groundwater in Coastal Plain units occurs under both unconfined and confined conditions. Groundwater in the Coastal Plain sediments occurs within the permeable sand, gravel, and coarse-grained silt units (aquifers). The low permeable clay and fine-grained silt units restrict groundwater flow (aquitard) and may reduce or prevent local recharge to deeper aquifers. The uppermost aquifer in the Coastal Plain Province is referred to as the

water table aquifer or surficial aquifer and is considered unconfined. Aquifers situated between two aquitards are considered confined.

Groundwater in the Piedmont Province occurs within the crystalline rocks and/or the overlying saprolite. Groundwater movement in crystalline rocks is controlled by the presence, interconnection, and the orientation of structural features such as joints (fractures), cleavage planes, and faults. Joints commonly occur in sets of three (a joint system) oriented perpendicularly to one another. Two sets tend to be almost vertically inclined and the third is almost horizontal to slightly inclined. Thus, joints and other structural features provide vertical paths for groundwater infiltration and horizontal paths for lateral groundwater flow. Although groundwater can move underground for miles in crystalline rocks such as those in the NSWCWODET area, movement is restricted by the lack of laterally extensive well-integrated networks of large interconnected structural features such as joints, fractures or faults. Studies on the Maryland Piedmont indicate that groundwater circulation occurs in the upper 300 feet of a saprolite and/or bedrock section and that the individual water-bearing fractures probably do not extend laterally more than a few hundred feet (Nutter, 1977). A complete description of regional hydrogeology is provided in the ***Remedial Investigation Report***, Malcolm Pirnie, October 1992.

2.1.6 Facility Hydrogeology

The results of the previous investigations provided the general geologic framework of each site and an initial estimate of groundwater flow direction at each site. Site work conducted during the Remedial Investigation (RI) identified hydrogeological characteristics at each of the seven sites.

Groundwater occurs in both unconfined and confined conditions under the facility. The sand and gravel units of the Coastal Plain Province and the upper most weathered zone of the Piedmont Province, comprise the unconfined or water table aquifer. Based on drill logs from the recent field investigation, the saprolite characteristically underlying the site acts as an aquitard in places where it has a high clay content and unfractured texture. Therefore, the saprolite can limit the water flow between the overlying water table and the underlying fractured Wissahickon Formation of the Piedmont Province when there is a high clay content. Groundwater flow within the competent bedrock is limited to fractures and occurs under confined conditions at most sites.

Interconnection between the groundwater flow confined within the fractures of the bedrock and the water table aquifer appears limited based on analysis of soil borings during the RI field investigations. However, it is likely that where the structural fabric of the fractures has been retained in the saprolite despite weathering, hydraulic connection occurs. At points of interconnection between the two aquifers, relative hydrostatic pressure determines the direction of groundwater movement. In topographically high areas, the hydrostatic pressure of the water table aquifer is generally higher than the confined aquifer and, therefore, recharge into the fractures probably occurs. In topographically low areas where the confined groundwater is under high hydrostatic pressure, groundwater flow is probably out of the fractures and into the water table aquifer.

Within the sediments that comprise the water table aquifer, variability in grain size produce interbedded layers of high and low permeability. The low permeability units which consists predominately of silty clays, produce locally perched water table conditions.

Groundwater circulation occurs within the upper portion of the unconsolidated material. At the large scale, groundwater moves from recharge zones in upland areas to discharge zones which support perennial stream flow such as Paint Branch Creek and its tributaries. The RI determined that, in general, groundwater flow mimics the topographic surface, and flows from topographically high areas to topographically low areas. Groundwater flow is also influenced by the surface water drainage pattern of Paint Branch Creek and its unnamed tributaries which transect the site.

A full description of site hydrogeology, including specific for each area under investigation, is provided in the ***Remedial Investigation Report***, Malcolm Pirnie, October 1992.

2.2 FACILITY HISTORY

In 1944, the Navy acquired 870 acres of land in White Oak, Maryland for the expansion of the Washington Navy Yard-based Naval Ordnance Laboratory (NOL). On November 9, 1945, the Bureau of Ordnance Chief, Admiral Hussey, assigned NOL its first mission to carry out research and development for naval ordnance including explosives, projectiles, mines, and related munitions and control systems. In June 1948, the command and administration functions of NOL were officially transferred from the Washington Navy Yard to the facility. The site expanded rapidly during the Korean War, but has developed at a slower pace since the 1950s. On November 3, 1969, 137 acres of land were transferred

from the NOL to the United States Army. This area is now the location of the Harry Diamond Laboratories.

In September 1974, the NOL was renamed the Naval Surface Weapons Center during the consolidation of NOL with the Naval Weapons Laboratory located in Dahlgren, Virginia. Recent reorganizations within the Navy have resulted in assignment of the facility as a division detachment to Dahlgren. The laboratory was renamed Naval Surface Warfare Center, Dahlgren Division Detachment, White Oak (NSWCWODET).

NSWCWODET has kept the same basic mission throughout its history serving as a principal Research, Development, Test and Evaluation Center (RDT&E) for naval surface warfare weapon systems, ordnance technology, and strategic systems support. However, it is expected that in 1994, as a result of base realignment by Naval Sea Systems Command (NAVSEA), most of the research and testing functions of NSWCWODET will be transferred to another facility and NSWCWODET will mainly perform only administrative functions.

Because of its function as an ordnance RDT&E center, the contaminants of concern at the facility are typically:

- Laboratory solvents, acids and bases
- Residuals from explosives (nitroaromatics)
- Solid wastes

2.3 REMEDIAL INVESTIGATION SUMMARY

2.3.1 Introduction

This summary presents the results of Phase I and Phase II of the RI for seven sites NSWCWODET, White Oak, Maryland as performed for Naval Facilities Engineering Command (NAVFAC), Chesapeake Division, Washington, D.C. under the Navy's Installation Restoration Program (IRP). The seven sites investigated during the RI included:

- Apple Orchard Landfill (Site 2)
- Pistol Range Landfill (Site 3)

- Chemical Burial Site (Site 4)
- Ordnance Burn Area (Site 7)
- Abandoned Chemical Disposal Pit (Site 8)
- Industrial Wastewater Disposal Area 300 (Site 9)
- Industrial Wastewater Disposal Area 100 (Site 11)

The locations of the seven sites are shown on Figure 2-1.

It is Navy policy is that all of the remedial investigation activities be performed in accordance with the U.S. Environmental Protection Agency (USEPA) protocol as set forth in ***Guidance on Remedial Investigations and Feasibility Studies under CERCLA***, EPA Office of Solid Waste and Emergency Response (OSWER) Directive 9335.3-01, March 1988. Accordingly, the NSWCWODET RI involved an investigation of the general nature, extent, fate, and transport of contamination as well as a baseline risk assessment at each site.

2.3.2 Background

The basis for the RI is a November 1984 ***Initial Assessment Study (IAS) Report***, NEESA 13-050, conducted at NSWCWODET and submitted to NAVFAC by the Naval Energy and Environmental Support Activity, Port Hueneme, California. The IAS concluded that 7 of 14 sites investigated at NSWCWODET posed a potential threat to human health or the environment sufficient to warrant further study.

In April 1987, a ***Verification Phase Report*** was submitted to NAVFAC, Chesapeake Division by Malcolm Pirnie. The report concluded that subsequent investigative efforts should be conducted at the NSWCWODET for all seven sites so as to characterize the extent of contamination, define the impact on the environment by the sites, if any, and to design appropriate remediation methods to clean up the affected sites.

2.3.3 RI Purpose

The purpose of the RI was to collect specific information concerning chemical contamination so as to evaluate the extent of contamination in various media, the transport mechanisms in various media, and the risk posed by the contamination to human health and the ecosystem. The various media of concern include the surface water, groundwater, air,

stream sediment, and soil. Phase I of the RI was conducted by Malcolm Pirnie, Inc. from January 1989 until April 1990. The results were summarized in a draft RI Report submitted to NAVFAC in April 1990. Phase I was intended to define the nature and extent of contamination at the seven sites. Phase II of the RI was conducted in August, 1990 and was completed with the submittal in December 1992 of the ***Remedial Investigation Report***. Phase II was intended to develop sufficient data to support the Feasibility Study (FS).

2.4 SITE-SPECIFIC SUMMARY

The nature and extent of contamination, the contaminant fate and transport, the baseline risk assessment, and the remedial objectives for each of the seven sites investigated is summarized in the following sections. Detailed information relative to each site is available in the ***Remedial Investigation Report***, Malcolm Pirnie, October 1992.

2.4.1 Site 2 - Apple Orchard Landfill

Site Description

The Apple Orchard Landfill is an abandoned landfill approximately 0.8 acres in size and is located south of Perimeter Road approximately one-half mile south of the northwest facility boundary. The landfill is situated on a small hill approximately 340 feet MSL in elevation. A small unnamed stream located adjacent to the site flows to the west and south of the landfill. The Apple Orchard Landfill was operated as an open disposal area and landfill from 1948 until 1982. The landfill is a single unit that is composed of several disposal areas. In addition to domestic refuse, wastes reportedly disposed of consisted of oils containing polychlorinated biphenyls (PCBs), solvents, paint residue, acids and miscellaneous compounds. The Initial Assessment Study (IAS) reported an estimated 500 gallons of PCB-contaminated oils were deposited at this site prior to 1970.

Previous Investigations

Three groundwater wells, ten sediment and four surface water sampling locations were sampled during the Verification Phase. The analytical data suggested that the landfill was contributing leachate to shallow groundwater, which in turn, was discharging to the adjacent stream. The Verification Phase Final Report recommended that additional data was necessary to evaluate the site. A two-phase Remedial Investigation was conducted to further delineate the nature and extent of contamination.

Remedial Investigation

The Remedial Investigation contaminant characterization included the collection and analysis of samples collected from six surface water, ten stream sediments, 16 surficial and three subsurface soil, and five groundwater wells, an environmental and a hydrogeologic investigation. In addition, nine surficial soil samples and three shallow soil borings, were collected from areas beyond the landfill boundary. Investigation techniques and findings are discussed in detail in the ***Remedial Investigation Report***, Malcolm Pirnie, October 1992.

Contamination Summary

The soil sampling and soil gas survey results delineated the nature and extent of contamination within the surface soils at Site 2. The results of the soil gas survey indicated the presence of volatile organic compounds (VOC) in the soil vapor at concentrations less than 3 ppm to the west of the landfill near Building 111 and to the east of the landfill near Perimeter Road. Metals (mostly chromium, copper, lead, and zinc), PCBs, VOCs, and SVOC were detected in the surface soils at Site 2. No VOCs were detected in the surface soil by the first round of sampling. During the second round of sampling, the VOCs detected were largely confined to acetone and methylene chloride which are common laboratory contaminants. A wide variety of SVOC were detected in the surface soil samples during both rounds of sampling. The horizontal distribution of the SVOC appears to be somewhat random, with the highest soil concentrations close to the periphery of the landfill and lower concentrations towards the center of the landfill.

Subsurface soil samples were collected only during the second round of sampling to delineate the vertical extent of contamination within the upper five feet of soil at Site 2. Metals, PCBs, and VOCs were detected in the subsurface soil at Site 2. Lead was identified as the only regulated metal present at levels above background in the subsurface soil. The VOCs were largely confined to acetone and methylene chloride which are both common laboratory contaminants. The vertical distribution of PCB and metals within the soil to a depth of 5 feet appears to be randomly distributed with the highest values occurring to the northwestern and southern portion of the landfill. The horizontal distribution of the metals, PCBs, and SVOC appears to be randomly distributed across the site. The horizontal distribution of the VOCs appears to be more uniform across the site.

Groundwater sampling was conducted during both sampling rounds to determine the nature and extent of contamination in the groundwater at Site 2. The contaminants of greatest concern in the groundwater at Site 2 are cadmium, mercury, and trichloroethene

(TCE). The cadmium concentration in the groundwater has not varied significantly between the first and second sampling rounds except for a slight decrease in concentration at Monitoring Well 2GW32 and an increase in concentration at Monitoring Well 2GW31. The presence of elevated levels of metals in all of the wells at Site 2 suggests leachate migration maybe radial from the landfill. TCE concentrations in the groundwater from samples collected from Monitoring Well 2GW32 increased from the Verification Phase to the first round of sampling during the RI and a decreased in concentration between the first and second sampling rounds of the RI.

Stream sediment and surface water samples were collected to determine the nature and extent of contamination in the stream sediment and surface water at Site 2. The PCBs are the contaminants of greatest concern in the stream sediments but show a progressive decrease in concentration in the downstream direction. The levels of metals (chromium, copper, lead, and zinc) in the sediment and surface water are within the range of background concentrations for the NSWCWODET facility. The metals levels detected in the sediments indicate a decrease in concentration in the downstream direction. Volatile organic compound concentration (TCE) in the surface water and sediment are only slightly elevated above the detection limit.

Fate and Transport

At Site 2, the primary contamination of concern are the PCBs in surface soils and stream sediments and TCE and cadmium in the groundwater. The major potential routes of migration include the transport of contaminants through the soil system, groundwater system, surface water system, and air system. At Site 2, soil agitation by heavy machinery can generate PCB contaminated fugitive dust which can be transported by wind currents. The fate of the fugitive migration was not determined because the predominant wind direction, velocity, and particle size were not determined. PCB contaminated surface soil can be transported via sheetflow erosion and deposited into the stream. The PCB contaminated sediments will migrate downstream when stream conditions are severe enough to erode or scour the stream bed. The rate of sediment migration was not determined because the high and low stream flow conditions and the particle size of sediments were not determined.

Transport of TCE and dissolved metals in the groundwater is predominantly to the east-southeast. Based on the groundwater condition, and the potential mobility and concentration of the contaminants detected in the groundwater, transport of the TCE and

dissolved metals in the groundwater system has been low. Based on the analytical results of the surface water samples, TCE and dissolved metals contaminated groundwater entering the stream is diluted by the flow of the stream.

Human Health Evaluation

The human health evaluation addresses the consequences of "reasonable maximum exposure" to site contaminants. The United States Environmental Protection Agency (USEPA) recommends use of this approach, which yields the maximum exposure that is reasonably expected to occur at a site. Frequent exposure to contaminants is considered, even though exposure may be infrequent. The approach is conservative and consistent with that recommended by the USEPA in the Human Health Evaluation Manual.

PCB is the only contaminant of concern in the soil and sediment. An oral Reference Dose (RfD) for PCBs has not been established and, therefore, a quantitative evaluation for non-cancer risks was not performed. For NSWCWODET workers, the estimated cancer risks for ingestion of and dermal contact with soil and dermal contact with sediment are within the USEPA Superfund remediation goal.

The total cancer risk for off-site adults who potentially have dermal contact with contaminated sediment is about twp in 100 million which is less than the USEPA Superfund remediation goal. The total cancer risk for adolescents who potentially have dermal contact with contaminated sediment is about 2 in 10 million which is also less than the USEPA Superfund remediation goal.

Thus, based on the human health evaluation, consideration of the need for remediation of surface soils and sediment (on-site adjacent to the landfill) at Site 2 is warranted.

Ecological Risk Assessment

In determining the potential risk to wildlife of inorganic analytes and PCBs in the media at Site 2, the toxicity and availability of the parameters for many compounds are dependent on many factors including water chemistry, soil chemistry, chemical species, and the presence of the other compounds within the media.

Concentrations of cadmium in food sources for the indicator species selected for this risk assessment were slightly above the acceptable levels. Therefore, a low to moderate risk to wildlife in general is expected from the presence of cadmium in contaminated media at the Site 2.

Copper levels in American Eel caught downstream of Site 2 were twice as high as the calculated acceptable level. Copper levels in dace species were below the calculated acceptable level. The risk from exposure to copper in the contaminated media at the site is expected to be low.

Concentrations of Arochlor 1260 in food sources were significantly higher than the acceptable levels in the Belted Kingfisher. This, combined with the consistently high levels found in all media at the site, and the high frequency of detection, would suggest a high risk to wildlife from exposure to PCBs in the contaminated media at the Site 2.

Conclusions

The hydrogeologic investigation from Phase I and Phase II provided the information necessary to determine the direction of groundwater flow, the groundwater gradient, and the hydraulic conductivity and transmissivity of the unconfined aquifer.

The biota identified at the landfill during the ecological investigation consisted primarily of disturbed old field areas and mixed deciduous forest with commonly associated mammalian species. Two White Oak plant had fungal growth. The combination of a visible oil sheen on the surface of the water, a high amount of organic material in the substrate, a predominance of oligocheate worms in the benthic population, and a lack of fish in the stream indicate that the water quality is poor in the stream at Site 2.

Metals and PCBs were identified in the surface soil, subsurface soil, and the stream sediments at Site 2. PCBs concentrations at detectable levels in the soils and sediments exceeded the USEPA guidance levels. PCBs in the surface soils may be transported as fugitive dust in the atmospheric system or eroded by sheetflow processes, and to some extent, migrate downward into the soil profile. PCBs and metals in the stream sediments can migrate as a suspended load when the stream conditions are severe enough to erode the stream bed.

Metals and TCE were identified in the groundwater beneath Site 2 during both Phase I and Phase II. Migration of the contaminants in the groundwater beneath Site 2 is predominantly towards the east southeast, although groundwater near the stream diverges from the predominant direction and flows toward the stream. The migration of the contaminants in the groundwater at Site 2 is considered low based on the flow velocity of the groundwater.

A quantitative evaluation of the non-carcinogenic health effects was not performed because an oral RfD for PCBs has not been established. Based on the human health evaluation, consideration of the need for remediation of soil and sediment at Site 2 is warranted.

According to the ecological risk assessment, there is a low to moderate risk to wildlife expected from exposure to metals contamination in media. There is an expected high risk to wildlife from exposure to PCBs in the contaminated media.

Preliminary Remedial Action Objectives

The risk assessment of contamination present at Site 2 indicates that the primary threat to human health and the environment is from PCB contaminants in the sediment and soil. The primary exposure route would be through ingestion and dermal contact to the soil and dermal contact of the sediment. The remedial objective is to remove or contain any remaining source(s) of contaminants, to prevent further contaminant migration into the soil and stream sediments, and to reduce the health risk associated with the exposure to contaminated surface soils and stream sediment to acceptable levels under the USEPA Superfund remediation goal.

2.4.2 Site 3 - Pistol Range Landfill

Site Description

The Pistol Range Landfill is located directly north of Dahlgren Road approximately one-third mile south of the northeast facility boundary. A small unnamed stream located adjacent to the western edge of the site flows southward past Site 3. The Pistol Range Landfill was operated from the late 1940s until the mid-1970s. Fill materials were pushed into a gully that was formed by a small perennial tributary which flows into Paint Branch Creek. The landfill is about 0.9 acres in size. The IAS reported wastes disposed at this site to include solid wastes, solvents, oils possibly containing PCBs, sodium nitrate, and miscellaneous metallic objects. The primary wastes of concern are about 8,000 gallons of solvents and oils reportedly disposed of at the site over a period of 30 years.

Previous Investigations

Three groundwater monitoring wells, three surface water, and six stream sediment sampling locations were sampled during the Verification Phase. The analytical data suggests that leachate from the landfill was migrating to the shallow groundwater. The Verification Phase Final Report recommended that additional data was necessary to evaluate the site.

A two-phase investigation was conducted to further delineate the nature and extent of contamination at Site 3.

Remedial Investigation

The Remedial Investigation contamination characterization included the collection and analysis of samples collected from four surface water, four sediment, soil, four groundwater wells, an environmental and a hydrogeologic investigation. Investigation techniques and findings are discussed in detail in the ***Remedial Investigation Report***, Malcolm Pirnie, October 1992.

Contamination Summary

The soil gas survey indicated the presence of VOCs in the soils at Site 3. The areas with the highest soil gas contamination were located along the landfill side of the stream and in an area to the south of Dahlgren Road. The analytical results from the soil samples confirmed the presence of metals contamination (cadmium, chromium, copper, and lead) in the surficial soil along the face of the landfill. SVOC were identified in the surficial soil during Phase I sampling but were not identified during Phase II sampling. However, the soil contamination appears to be limited based on the RI sampling results.

The analytical results from the groundwater sampling confirmed the presence of VOCs and metals in the groundwater beneath Site 3 as a result of leachate migration from the landfill. The metals in unfiltered samples identified in the groundwater at levels above background or Maximum Contaminant Levels (MCLs) were cadmium, chromium, and lead. No metals above background levels or MCLs were detected in filtered samples.

The surface water and stream sediment analytical data indicated that there has been little impact to the quality of the stream by the landfill. Although, low levels of metals were identified in the stream sediments adjacent to the landfill, low levels of metals were also identified in the sediments where the stream enters the facility.

Fate and Transport

At Site 3, the primary source of contamination is dissolved metals and VOC leachate generated from the Pistol Range Landfill. The major potential routes of migration include the transport of contaminants through the soil and groundwater system. Based on the shallow groundwater conditions and the potential mobility and concentration of the contaminants detected in the groundwater, transport of the landfill leachate in the groundwater system has been moderate. The direction of the leachate migration in the

groundwater is to the south-southwest of the landfill.

Based on the analytical results from the surface water and stream sediment samples, any migration of leachate into the stream system has been diluted to levels below the detection limit of the analysis.

Human Health Evaluation

The non-cancer and cancer risks associated with exposure to contaminants at Site 3 may be summarized as follows. Adverse non-carcinogenic health effects in the residential population (adults and children) from exposure to the chemicals of potential concern in the groundwater are unlikely. The total hazard indices for the pathways for both adults and children are less than the criterion of 1.0. The total cancer risk for on- and off-site adults and children who potentially may ingest, have dermal contact with or inhale airborne chemicals from contaminated groundwater is within the USEPA Superfund remediation goal. Ingestion of groundwater constitutes the pathway of greatest concern for residential adults and children with TCE being the chemical of potential concern as the main contributor to the risk.

Thus, based on the cancer risk evaluation, consideration of the need for remediation of groundwater at Site 3 is warranted.

Ecological Risk Assessment

In determining the potential risk of inorganic analytes and polychlorinated biphenyls in the media at the Pistol Range Landfill to wildlife, it should be noted that for many compounds, the toxicity and availability of the parameters are dependent on many factors including water chemistry, soil chemistry, the form in which the particular compound is in at the site, and the presence of other compounds within the media.

Concentrations of copper in food sources for the indicator species selected for this risk assessment were slightly below the acceptable levels calculated. The risk from exposure to copper in the contaminated media at the site is expected to be very low.

Concentrations of mercury in food sources were significantly higher than the acceptable levels for the Belted Kingfisher. This, combined with the presence of mercury in the sediment at Site 3, would suggest a high risk to wildlife from exposure to mercury in the contaminated media at the Pistol Range Landfill.

Concentrations of Aroclor 1254 and Aroclor 1260 in food sources for the indicator species selected were well above the acceptable levels calculated. However, samples were not collected for PCB analysis from any of the media sampled at Site 3. The origin of the Aroclor 1254 and Aroclor 1260 in the biota at the site is not known. Therefore, the risk

that Site 3 poses to the biota in the area is not known.

Conclusions

The hydrogeologic investigations performed during the RI provided the information necessary to determine the direction of groundwater flow, the groundwater gradient, and the hydraulic conductivity of the unconfined aquifer.

A soil gas survey, conducted during the initial sampling round, identified the presence of volatile organic constituents in the soil gas vapor. Metals contamination was confirmed in the surficial soils along the face of the landfill during the follow-up round of sampling.

Metals and volatile organic contaminants were identified in the groundwater beneath Site 3 during both sampling rounds. The source for the groundwater contamination is the generation of leachate from the landfill. Migration of the leachate in the groundwater is to the south-southwest and is considered to be moderate in magnitude. The analytical results for the surface water and sediment and the benthic survey indicate that the landfill has not impacted the quality of the surface water system.

Preliminary Remedial Action Objectives

The risk assessment of contamination present at Site 3 indicates that the primary threat to human health and the environment is from the volatile organic contaminants and metals in the groundwater. The primary exposure route would be through ingestion of groundwater and soil. The remedial objective is to limit migration of contaminants by covering the landfill with an impermeable cover. The liner would limit contaminated leachate generation by preventing percolation of rainwater downward through the landfill and mixing with contaminants within the landfill, from migrating into the groundwater. In addition, the remedial objective is to limit further migration of the contamination in the groundwater outside the landfill.

2.4.3 Site 4 - Chemical Burial Site

Site Description

The Chemical Burial Site is located south of Perimeter Road and is about 400 yards northeast of Site 3. The Chemical Burial Site was used from the mid-1950s until the early 1970s for chemical disposal in four discrete locations within the site and is about 1.1 acres in size. Wastes suspected to have been disposed at this site included acids, explosive compounds, kerosene, chlorinated solvents and numerous unidentified laboratory compounds with a total volume of chemical substances buried in the four areas estimated at about 600 cubic feet.

Previous Investigations

Six groundwater Monitoring Wells were sampled during the Verification Phase. The analytical data indicated that the burial site was leaching organic compounds to the shallow groundwater.

Remedial Investigations

The Remedial Investigation contamination characterization included the collection and analysis of samples collected from the two surficial soil and three subsurface soil and 17 groundwater wells, a contaminant source investigation, an ecological and a hydrogeologic investigation. Investigation techniques and findings are discussed in detail in the ***Remedial Investigation Report***, Malcolm Pirnie, October 1992.

Contamination Summary

The results of the contamination source investigation confirmed the presence of four burial pits and suggested the possibility of waste chemical drums, containers, and or/rock within the four pits.

Subsurface soil contamination was insignificant for the compounds analyzed during Phase I sampling, and elevated levels of VOCs and SVOCs were detected during Phase II sampling. The surficial soil and soil gas survey delineated the nature and extent of contamination within the surface soil at Site 4. The soil gas survey indicated the presence of VOCs in the soils.

Groundwater sampling conducted during both phases of sampling to determine the nature and extent of contamination in the groundwater at Site 4. The analytical results from the groundwater sampling during both phases confirmed the presence of VOCs and dissolved metals in the groundwater beneath Site 4 as a result of leachate migration from the burial pits. The TCE from the four possible sources converge beneath Site 4 to form one plume.

Fate and Transport

At Site 4, the primary contamination are VOCs (predominately TCE), bis(2-ethylhexyl)phthalate and low levels of metals. The major potential routes of migration include the transport of contaminants through the soil and groundwater systems. Based on the shallow groundwater conditions and the potential mobility and concentration of the contaminants detected in the groundwater, transport of the leachate in the groundwater system has been moderate. The direction of the leachate migration in the groundwater is to the south of the burial pits.

Human Health Evaluation

The non-cancer and cancer risks associated with exposure to contaminated groundwater at Site 4 may be summarized as follows. Adverse non-carcinogen health effects in the residential population (adults and children) from exposure to groundwater are unlikely. The total hazard indices for the pathways for adults and children are less than the criterion of 1.0. The total cancer risk for on- and off-site adult and child residents who potentially may be exposed to contaminated groundwater from Site 4 exceeds the USEPA Superfund remediation goal. For adults and children, ingestion of contaminated water constitutes the greatest concern. Vinyl chloride and TCE are the main contributors to the cancer risk.

Thus, based on the cancer risk evaluation, consideration of the need for remediation of groundwater at Site 4 is warranted.

Ecological Risk Assessment

TCE is not known to bioaccumulate in animals. In addition, TCE was found in relatively low concentrations. This would suggest a low risk to wildlife from exposure to TCE in the contaminated media at the Chemical Burial Site.

This risk assessment is based upon sampling and analysis of surface soil. Actual levels of contaminants in vegetation and wildlife inhabiting the site and its vicinity were not determined. Some uncertainty is present in the assessment of actual risks to various species of concern. Adverse impacts due to the contaminants found, therefore, have not been quantified. Additional investigative activities would be needed to quantitatively determine impacts.

Conclusions

The hydrogeologic investigation from both sampling rounds provided the information necessary to determine the direction of groundwater flow, the groundwater gradient, and the hydraulic conductivity and transmissivity of the unconfined aquifer.

Information from the Ground Penetrating Radar (GPR) survey was used to delineate the boundaries of the four burial pits and to identify the presence of objects within the pits. The soil gas survey, conducted during the first sampling round identified the presence of volatile organic constituents in the soil gas vapor. The analytical results from the surficial soil samples indicated the presence of semi-volatile and volatile organic compounds in surficial soils during the follow-up sampling round.

Metals and VOCs contamination were identified in the groundwater beneath Site 4 during both sampling rounds. The groundwater contamination emanates from multiple sources associated with the chemical burial pits and converges to form one plume. The volatile organic compound plume of greatest concern is the TCE plume. Migration of the leachate in the groundwater is to the south toward the center of the facility.

The risk assessment identified TCE and vinyl chloride contaminated groundwater as a potential concern for total cancer risk for on- and off-site adults and children who may be exposed to the groundwater from Site 4. Based on the cancer risk evaluation, remediation of the groundwater at Site 4 should be considered. The risk to the ecosystem was not quantified.

Preliminary Remedial Action Objectives

The risk assessment of contamination present at Site 4 indicates that the primary threat to human health and the environment is from groundwater contaminated with vinyl chloride and TCE. The primary exposure route would be through ingestion of contaminated groundwater. The remedial objective is to remove or contain any remaining source(s) of contaminants, to prevent further contaminant migration into the soil and groundwater, and to reduce the health risk associated with the exposure to contaminated groundwater to acceptable levels under the USEPA Superfund remediation goal.

2.4.4 Site 7 - Ordnance Burn Area

Site Description

The Ordnance Burn Area (Site 7) is located north of Dahlgren Road about 300 yards southeast of the Chemical Burial Site (Site 4). The Ordnance Burn Area was used for disposal by thermal destruction of waste ordnance compounds from 1948 until 1968. The site consists of a swale about 250 feet long and 20 feet wide. Wastes disposed at this site included various types of explosives, primarily nitroaromatics and nitroaliphatics. About 33,000 pounds of explosives are suspected to have been destroyed by burning at this site over a period of 20 years.

Previous Investigations

One groundwater monitoring well and 54 soil boring locations were sampled during the Verification Phase. The analytical data demonstrated nitroaromatic contamination of soils and shallow groundwater. Soil contamination was considered significant within the drainage swale.

Remedial Investigations

The Remedial Investigation included sampling and analysis of samples collected from the 29 soil locations and three groundwater monitoring well locations, an ecological and a hydrogeologic investigation. Investigation techniques and findings are discussed in detail in the ***Remedial Investigation Report***, Malcolm Pirnie, October 1992.

Contamination Summary

Soil samples were collected during the RI to determine the nature and extent of contamination in the surface and shallow subsurface (within 15 feet of ground surface) soils at Site 7. Soil sampling results confirmed that nitroaromatic contamination is present along and in the swale. The nitroaromatic compounds detected in the soil at Site 7 were Cyclotetramethylenetetranitramine (HMX), Cyclotrimethylenetrinitramine (RDX), and 2,4,6-trinitrotoluene (TNT). A review of the analytical data collected during both sampling rounds indicates a downward vertical migration of nitroaromatic contaminants within the soils in the swale and in the area outside the swale.

Groundwater samples were collected during the RI to delineate the nature and extent of contamination in the groundwater under the site. The analytical results from the groundwater sampling confirmed the presence of nitroaromatic constituents in the groundwater beneath Site 7 as a result of downward migration of contaminants from the burn area. Nitroaromatic compounds were identified in the groundwater at levels above the background and guidance levels. Metals were detected at levels slightly above the MCLs in the groundwater a Site 7 during Phase I sampling; however, the total metals analytical results were below the MCLs during Phase II sampling. Several VOCs were detected at low concentrations in the groundwater from samples collected from Monitoring Well 7GW8 during the second round of sampling. The presence of the VOCs in the groundwater at Monitoring Well 7GW8 is not consistent with the characteristics of potential releases associated with Site 7. It is likely that these VOCs are associated with contamination from Site 4.

Fate and Transport

At Site 7, the primary contamination of concern are the nitroaromatic compounds (HMX, RDX, and 2,4,6-TNT in the soil and HMX and RDX in the groundwater). The major potential routes of migration include the transport of contaminants through the soil and groundwater systems. The analytical results for the soils and groundwater indicate that nitroaromatic compounds have migrated vertically downward through the soil at some point

and into the groundwater beneath the burn area. Based on the groundwater conditions, and the potential mobility and concentration of the contaminants detected in the groundwater, transport of the nitroaromatics in the groundwater system has been low. The direction of the migration in the groundwater is to the south of the burn area.

Human Health Evaluation

The non-cancer and cancer risks associated with exposure to contaminated surface soils and groundwater at Site 7 may be summarized as follows. Adverse non-carcinogenic health effects for NSWCWODET workers from exposure to surface soils are unlikely. The total hazard indices for the pathways are less than the criterion of 1.0. Adverse non-carcinogenic health effects in the on- and off-site residential population (adults and children) from exposure to groundwater from Site 7 are likely. The total hazard indices are much greater than the criterion of 1.0. Thus, based on non-cancer, consideration of the need for remediation of groundwater at Site 7 is warranted.

The total cancer risk for NSWCWODET workers who potentially may be exposed to surface soils at Site 7 is within the Superfund remediation goal. The total cancer risk for on- and off-site residents who potentially may be exposed to groundwater from Site 7 exceeds the Superfund remediation goal. For adults and children, ingestion of groundwater constitutes the greatest concern.

Thus, based on cancer risk estimates, consideration of the need for remediation of soils and groundwater at Site 7 is warranted.

Ecological Risk Assessment

Several nitroaromatic compounds were detected in groundwater and surface soil samples for Site 7, including 2,4- Dinitrotoluene (2,4-DNT), 2,6-DNT, HMX, RDX, 1,3,5-Trinitrobenzene (1,3,5-TNB), and 2,4,6-TNT. DNT and TNT compounds are known to have low bioaccumulation potential and, therefore, pose a low risk to wildlife at Site 7. The risk that nitroaromatic compounds including 1,3,5-TNB, RDX, and HMX pose to wildlife at Site 7 is unknown.

Conclusions

The hydrogeologic investigation provided the information necessary to determine the direction of groundwater flow, the groundwater gradient, and the hydraulic conductivity and transmissivity of the unconfined aquifer.

The biota identified during the ecological investigation at Site 7 consisted primarily of mature deciduous forest and disturbed old field areas with commonly associated mammalian species. Several plant species had fungal growth and leaf structure deformities.

The cause for the leaf deformities is unknown.

Nitroaromatic compounds and low levels of metals were detected in the surface soils at Site 7 in the area of the swale and in areas outside the swale and burn area. The vertical soil contamination profile indicates that the nitroaromatic contaminants are migrating from the surface down into the soil profile.

Nitroaromatic compounds, VOCs and low levels of metals contamination were identified in the groundwater beneath Site 7 during both rounds of sampling. The volatile organic compound plume appears to be related to the migration of volatile organics from Site 4. Migration of the nitroaromatics in the groundwater beneath the burn area is to the south towards the center of the facility

The risk assessment identified a potential concern for adverse non-cancer and total cancer risk for on- and off-site adults and children who may be exposed to the groundwater from Site 7. Based on the risk evaluation, remediation of the soil and groundwater at Site 7 should be considered.

Based on the ecological risk assessment, nitroaromatics have a low bioaccumulation potential and therefore, pose a low risk to wildlife at Site 7. The actual risk to wildlife was not quantified.

Preliminary Remedial Action Objectives

The risk assessment of contamination present at Site 7 indicates that the primary threat to human health and the environment is from the nitroaromatic contaminants in the soils and groundwater. The primary exposure route would be through ingestion of groundwater and soil. The remedial objective is to remove any remaining source of nitroaromatic compounds within the soil to prevent further downward contaminant migration and prevent contaminants within the soil from reaching groundwater. In addition, the remedial objective is to limit further migration of the contaminants identified in the groundwater.

2.4.5 Site 8 - Abandoned Chemical Disposal Pit

Site Description

The Abandoned Chemical Disposal Pit is located along the southern facility boundary at the end of Perimeter Road. The Abandoned Chemical Disposal Pit was used from 1951 until 1971 for disposal of miscellaneous waste chemicals from laboratories at the facility. The site was described as a pit about 10 feet by 10 feet by 12 feet. Wastes disposed at this site included acids, mercury, solvents and numerous unidentified waste chemicals. The

primary wastes of concern are solvents and mercury. It is estimated by the IAS study that about 180 pounds of mercury were disposed of at this location.

Previous Investigations

Four groundwater monitoring wells were installed and sampled during the Verification Phase to determine the existence of groundwater contamination and groundwater flow direction. The analytical data from these wells suggested that no mercury contamination of the groundwater existed as a result of past disposal practices. Some metal and VOC contamination was detected in the groundwater in all of the wells but significant elevated levels were detected in only one well. The Verification Phase report recommended that more data was necessary to adequately characterized the contamination at the site.

Remedial Investigations

The Remedial Investigation contamination characterization included the collection and analysis of samples collected from two surficial soil and five groundwater monitoring well locations, a contaminant source investigation, and a hydrogeologic investigation. Investigation techniques and findings are discussed in detail in the ***Remedial Investigation Report***, Malcolm Pirnie, October 1992.

Contamination Summary

The results of the GPR survey confirmed the existence and general location of the disposal pit at Site 8. No potential point sources within the suspected pit area were identified.

The results of the initial round of soil sampling indicated that metals (mostly chromium, copper, lead, and zinc) were detected in surface soils.

Groundwater contaminants detected at levels greater than the MCLs for drinking water at Site 8 included two VOCs (1,1,2-Trichloroethane (1,1,2-TCA) and chloroform), and one SVOC (bis(2-ethylhexyl)phthalate). The low levels of volatile organic and semi-volatile organic compounds detected in the groundwater samples suggest that the extent of contamination is localized near the abandoned disposal pit area. The horizontal distribution of the contaminants in the groundwater suggests radial flow of contaminants with a predominant direction to the north.

Fate and Transport

According to the Risk Assessment for Site 8, the primary contaminants of concern are 1,1,2-TCA and bis(2-ethylhexyl)phthalate in the groundwater. The major potential routes of migration include the transport of contaminants through the groundwater system.

Transport of the organic contaminants in the groundwater is predominantly to the north towards the center of the facility although, based on the analytical data, some radial flow from the east to the west has occurred. Based on the groundwater condition, and the potential mobility and concentration of the contaminants detected in the groundwater, transport of the organic compounds in the groundwater system has been very low.

Human Health Evaluation

The non-cancer and cancer risks associated with exposure to groundwater at Site 8 may be summarized as follows. Adverse non-carcinogenic health effects in the residential population (adults and children) from exposure to groundwater are unlikely. The total hazard indices for the pathways for adults and children are less than the criterion of 1.0. The total cancer risk for on- and off-site adult and child residents who potentially may be exposed to contaminated groundwater from Site 8 exceeds the USEPA Superfund remediation goal. For adults and children, ingestion of groundwater constitutes the greatest concern.

Thus, based on cancer risk estimates, consideration of the need for remediation of groundwater at Site 8 is warranted.

Conclusions

The hydrogeologic investigation provided the information necessary to determine the direction of groundwater flow, the groundwater gradient, and the hydraulic conductivity of the unconfined aquifer. The biota identified at the landfill during the ecological investigation consisted primarily of mature forest areas with commonly associated mammalian species.

Metals were identified in the surface soil at Site 8 during the initial sampling round. Metals, VOCs and SVOCs were identified in the groundwater beneath Site 8 during both rounds of sampling. Migration of the contaminants in the groundwater beneath Site 8 is predominantly towards the north. The migration of the contaminants in the groundwater at Site 8 is considered very low based on the flow velocity of the groundwater and the distribution of contaminants in the groundwater samples.

The risk assessment identified a potential concern for total cancer risk for on- and off-site populations who may be exposed to the groundwater from Site 8. Based on the human health evaluation, consideration of the need for remediation of groundwater at Site 8 is warranted.

Preliminary Remedial Action Objectives

The risk assessment of contamination present at Site 8 indicates that the primary threat to human health and the environment is from 1,1,2-TCA and bis(2-ethylhexyl)phthalate in the groundwater. The primary exposure route would be through ingestion of the groundwater. The remedial objective is to remove or contain any remaining source(s) of contaminants, to prevent further contaminant migration into the groundwater, and to reduce the health risk associated with the exposure to contaminated groundwater to acceptable levels under the USEPA Superfund remediation goal.

2.4.6 Site 9 - Industrial Wastewater Disposal Area 300

Site Description

The Industrial Wastewater Disposal Area 300 is located to the south of Dahlgren Road along the Montgomery/Prince George's County line and extends to the southeastern facility boundary. A perennial tributary of Paint Branch Creek flows to the west and south of this site, and an intermittent tributary of the creek flows along the eastern edge of the site. The Industrial Wastewater Disposal Area 300 was used from the early 1950s until the mid-1970s. Several leaching wells and above ground discharge points to the soil were used in this area for disposal of liquid wastes containing explosive compounds. Wastes disposed at this site included TNT, RDX, and several other explosive related compounds. It was estimated in the IAS study that at least 7,200 pounds of these wastes were disposed at this site over a period of approximately 25 years. It is also reported in the same report that solvents were disposed in the same manner as the explosive compounds.

Previous Investigations

Seven groundwater monitoring wells and 15 stream sediment locations were sampled during the Verification Phase. The Verification Phase for this work concluded that additional information was necessary to adequately characterize the site.

Remedial Investigations

The Remedial Investigation included the collection and analysis of samples collected from the two surficial soil and six subsurface soil, three surface water, ten sediment, and 13 groundwater monitoring well locations and ecological and a hydrogeologic investigation. Investigation techniques and findings are discussed in detail in the ***Remedial Investigation Report***, Malcolm Pirnie, October 1992.

Contamination Summary

The soil gas surveys indicated the presence of VOCs at low concentrations in the soils near Buildings 336, Building 328, Building 310, Building 311 and no VOCs in the soil gas were detected adjacent to Building 304 and Buildings 344 and 345. The analytical results for the surficial soil revealed elevated levels of metals and semi-volatile above the background concentrations.

The contaminants of greatest concern in the groundwater are the nitroaromatic compounds and TCE. The nitroaromatic compounds present consist of HMX, RDX, 2,6-DNT and nitrobenzene. Nitroaromatic and TCE contamination in the groundwater was identified in four distinct areas as Site 9. The largest area of contamination is a plume located south of the Ordnance Waste Water Treatment facility (Building 318). This plume extends to the southern boundary of Site 9. The second largest area of contamination is a TCE plume located south of Building 304 and extending towards the south to approximately Building 336. The other two areas of contamination are much smaller nitroaromatic and TCE plumes which are located near Building 311, Building 310 and Building 336.

No significant contamination was detected in the surface water at Site 9. The levels of metals detected in the sediment during both rounds of sampling were only slightly higher than the background levels. Low levels of carbon disulfide, 2-butanone, and 1,1,1-TCA were detected in the sediment which suggest the contribution of solvents to the stream sediments as a possible result of the activities at Site 9. The nitroaromatics compounds detected at one sampling point are also probably related to the activities at Site 9.

The bioassay conducted on fish collected from the surface water at Site 9 showed that copper, mercury, and PCBs were present in the fish collected from the lower stretch of the stream. It is not known whether the elevated levels of contaminants are due to sources on the NSWCWODET or from outside the facility.

Fate and Transport

At Site 9, the primary source of contamination are nitroaromatic compounds (HMX, RDX, and 2,6-DNT) and VOCs (namely TCE) and low levels of dissolved metals. The major potential routes of migration include the transport of contaminants through the soil and groundwater systems. Based on the shallow groundwater conditions and the potential mobility and concentration of the contaminants detected in the groundwater, transport of the leachate in the groundwater system has been moderate. The direction of the volatile organic compound and nitroaromatic contaminants in the groundwater is to the south-

southeast towards the confluence of the perennial stream and the intermittent stream.

Human Health Evaluation

The non-cancer and cancer risks associated with exposure to groundwater from Site 9 may be summarized as follows. Adverse non-carcinogenic health effects in the residential population (adults and children) from exposure to groundwater from Site 9 are likely. The total hazard indices for the pathways for adults and children are greater than the criterion of 1.0. The total cancer risk for on- and off-site adult and child residents who potentially may be exposed to contaminated groundwater from Site 9 exceeds the USEPA remediation goal. Ingestion of contaminated groundwater constitutes the greatest concern.

Thus, based on the non-cancer and cancer risk estimates, consideration of the need for remediation of groundwater at Site 9 is warranted.

Ecological Risk Assessment

In determining the potential risk to wildlife of contaminants in the media at Industrial Wastewater Disposal Area 300, it should be noted that for many compounds, the toxicity and availability of the parameters are dependant on many factors including water chemistry, soil chemistry, the form of the particular compound is in at the site, and the presence of other compounds within the media.

Concentrations of copper in food sources of the indicator species selected for this risk assessment were slightly below the acceptable levels. However, this compound was not detected in any of the media sampled at Site 9. Therefore, the risk from exposure to copper in the stream is unknown.

Concentrations of mercury and Aroclor 1260 in food sources were significantly higher than the acceptable levels for the Belted Kingfisher. These compounds were not detected in any of the media sampled at Site 9. Therefore, the risk from exposure to mercury and Aroclor 1260 is unknown.

Concentrations of Aroclor 1254 in food sources for the indicator species selected were well above the acceptable levels calculated. However, this compound was not detected in any of the media sampled at Site 9. Therefore, the risk from exposure to mercury and Aroclor 1254 is unknown.

Conclusions

The hydrogeologic investigation provided the information necessary to determine the direction of groundwater flow, the groundwater gradient, and the hydraulic conductivity and transmissivity of the unconfined aquifer. Based on the shallow groundwater conditions and the potential mobility and concentration of the contaminants detected in the groundwater,

transport of the leachate in the groundwater system has been moderate.

At Site 9, the primary source of contamination are nitroaromatic compounds and VOCs and low levels of dissolved metals. The direction of the VOC and nitroaromatic contaminants in the groundwater is to the south-southeast towards the confluence of the perennial stream and the intermittent stream.

Soil gas surveys near Buildings 304, 344, and 345 detected no VOCs in the soils while soil gas surveys near Buildings 336, 328, 310, and 311 documented the presence of VOCs in the soils. This indicates that former leaching wells/fields at those locations used to dispose of industrial laboratory wastewater that contaminated various VOCs have impacted shallow soil and possibly groundwater in the area.

Based on the cancer risk evaluation, remediation of the groundwater at Site 9 should be considered.

Preliminary Remedial Action Objectives

The risk assessment of contamination present at Site 9 indicates that the primary threat to human health and the environment is from the nitroaromatic and volatile organic contaminants in the groundwater. The primary exposure route would be through ingestion of groundwater. The remedial objective is to remove any remaining source(s) of contaminants to prevent contaminant migration into soil or groundwater and to limit further migration of the contaminant plume in the groundwater.

2.4.7 Site 11 - Industrial Wastewater Disposal Area 100

Site Description

The Industrial Wastewater Disposal Area 100 is located near the western facility boundary adjacent to the main entrance. Ten former leaching wells used for wastewater disposal from the laboratories were located within the Industrial Wastewater Disposal Area 100. The leaching wells are scattered over an area of approximately 16 acres. Wastes disposed in the wells reportedly include dissolved metals, acids, chlorinated and non-chlorinated solvents, alcohols, lead, and organic explosive compounds. The primary wastes of concern are solvents and solutions containing metals such as silver, chromium, and lead. It is estimated that about 20,000 gallons of liquid wastes were disposed of in these wells.

Previous Investigations

Eight groundwater monitoring wells were sampled during the Verification Phase. Total Organic Carbon (TOC), Total Organic Halogen (TOX), and Volatile Organic Compound (VOC) data indicated groundwater contamination in all the wells at the site with

greatest levels in those wells adjacent to the chemical waste disposal leaching wells. Metals were also detected at significantly elevated levels throughout the site. The Verification Phase concluded that additional information was necessary to adequately characterize the site.

Remedial Investigations

The Remedial Investigation included the collection and analysis of samples collected from the two surficial soil, subsurface surface water, sediment, and 21 groundwater monitoring wells, an ecologic investigation, and a hydrogeologic investigation. Investigation techniques and findings are discussed in detail in the ***Remedial Investigation Report***, Malcolm Pirnie, October 1992.

Contamination Summary

No elevated and reproducible levels of organic vapor were detected in the in the soils during the RI. The surficial soil samples collected at Site 11, due the to the lack of detection of contaminants of concern, were used as background levels for the facility. The soil gas surveys indicated the presence of VOCs at low concentrations in the soils behind Buildings 2 and 5, behind Buildings 3 and 5, and in the softball field behind Building 30. No VOCs were detected in the soil gas vapor behind Buildings 2 and 5.

The contaminants of greatest concern in the groundwater are the VOCs and metals. The VOCs detected in the groundwater at concentrations with the range of or above the MCL's or background levels have decreased since the Verification Phase, suggesting horizontal movement and dispersion of the contaminants in the groundwater.

No levels of contamination above background or surface water standards were detected in either surface water sampling location. Stream sediment samples were collected at three locations. Analytical results from the stream sediment sample collected where the stream enters the facility indicate the presence of slightly elevated levels of SVOCs and metals in the stream sediment. The levels of contaminants decreases downstream, suggesting the contribution of solvents and metals to the stream sediments as a possible result of off-site activities at Site 11.

The bioassay conducted on fish collected from the surface water at Site 11 showed that copper, mercury, and PCBs were present in the fish collected from the lower stretch of the stream. The ecological risk assessment identified chromium, copper, and PCBs (Aroclor 1254 and Aroclor 1260) in food sources for the indicator species selected were well above the acceptable levels calculated. Samples were not collected for PCB analysis from

any of the media sampled at Site 11; therefore, the risk to wildlife from exposure to chromium, copper, Aroclor 1254 and Aroclor 1260 in the media is unknown at this time. It is not known whether the elevated levels of contaminants are due to sources on the NSWCWODET or from outside the facility.

Fate and Transport

At Site 11, the primary source of contamination are VOCs and low levels of dissolved metals. The major potential routes of migration include the transport of contaminants through the soil and groundwater systems. Based on the shallow groundwater conditions and the potential mobility and concentration of the contaminants detected in the groundwater, transport of the leachate in the groundwater system has been moderate. The direction of the VOC contaminants in the groundwater is to the south-southeast towards the confluence of the perennial stream and the intermittent stream.

Human Health Evaluation

The non-cancer and cancer risks associated with exposure to contaminated groundwater at Site 11 may be summarized as follows. Adverse non-carcinogenic health effects in the on- and off-site residential population (adults and children) from exposure to groundwater are unlikely. The total hazard indices for the pathways for adults and children are less than the criterion of 1.0. The total cancer risk for on- and off-site adult and child residents who potentially may be exposed to contaminated groundwater from Site 11 exceeds the USEPA Superfund remediation goal. Ingestion of groundwater contributes the greatest risk.

Thus, based on cancer risk estimates, consideration of the need for remediation of groundwater at Site 11 is warranted.

Ecological Risk Assessment

In determining the potential risk to wildlife of contaminants in the media at Industrial Wastewater Disposal Area 100, it should be noted that for many compounds, the toxicity and availability of the parameters are dependant on many factors including water chemistry, soil chemistry, the form of the particular compound is in at the site, and the presence of other compounds within the media.

Concentrations of copper in food sources of the indicator species selected for this risk assessment were twice the acceptable levels. The risk from exposure to copper in the contaminated media at the site is expected to be moderate.

Concentrations of Aroclor 1254 and Aroclor 1260 in food sources for the indicator species selected were well above the acceptable levels calculated. However, this compound was not selected for analysis in any of the media sampled at Site 11. The origin of the Aroclor 1254 and Aroclor 1260 in the biota is not known. Therefore, the risk that Site 11 poses to the biota in the area is unknown.

Conclusions

The hydrogeologic investigation provided the information necessary to determine the direction of groundwater flow, the groundwater gradient, and the hydraulic conductivity and transmissivity of the unconfined aquifer.

Metals and VOCs contamination were identified in the groundwater beneath Site 11. The groundwater contamination appears to emanate from multiple sources associated with the former leaching wells. Migration of the leachate in the groundwater is to the south toward the center of the facility

The risk assessment identified contaminated groundwater as a potential concern for total cancer risk for on- and off-site adults and children who may be exposed to the groundwater from Site 11. Based on the cancer risk evaluation, remediation of the groundwater at Site 11 should be considered.

Preliminary Remedial Action Objectives

The risk assessment of contamination present at Site 11 indicates that the primary threat to human health and the environment is from the volatile organic contaminants in the groundwater. The primary exposure route would be through ingestion of groundwater. The remedial objective is to remove any remaining source(s) of contaminants to prevent contaminant migration into soil or groundwater and to limit further migration of the contaminant plume in the groundwater.

3.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

The purpose of this section is to develop the general response objectives and actions, and to identify and screen remedial technologies applicable to the seven sites under investigation at Naval Surface Warfare Center, Dahlgren Division Detachment (NSWCWODET), White Oak. Identified technologies will be screened and only those technologies that are applicable to the existing site conditions will be evaluated. Technologies will be screened based on effectiveness, implementability and cost. Identification and screening of remedial technologies is performed in two steps:

- Identifying of potential treatment technologies that address site problems and meet remedial goals and objectives.
- Screening of technologies for suitability based on their effectiveness, implementability and cost as well as the technical reliability of the technology.

3.1 REMEDIAL ACTION OBJECTIVES

The remedial action objectives described in this section were developed for each site based on the site-specific risk assessment presented in the Remedial Investigation (RI) Report, and will be used as the basis to select the most cost effective remedial action for each site at NSWCWODET. The risk assessment determined the risk to human health and the environment, if any, from exposure to contaminated media at the various sites. Tables 3-1 and 3-2 provide a site-specific summary of the human health and ecological risk assessments conducted as part of the RI. For sites and media where minimal risk exists, no remedial action may be needed. For sites with a greater risk to human health and the environment, a range of actions may be needed to mitigate the risk. The following is a site by site summary of risk assessment conclusions and remedial action objectives for each site.

3.1.1 Site 2 - Apple Orchard Landfill

The risk assessment concluded that the contaminants detected in the groundwater are not migrating toward a human receptor and, therefore, pose a minimal threat to human health. The Polychlorinated Biphenyl (PCB) levels detected in the sediments and soils could

TABLE 3-1

SITE-SPECIFIC HUMAN HEALTH EVALUATION SUMMARY

MEDIA	NSWCWODET Sites						
	Site 2	Site 3	Site 4	Site 7	Site 8	Site 9	Site 11
Ground Water	--	X	X	X	X	X	X
Surface Soils	X	--	--	X	--	--	--
Sediment	X	--	NP	NP	NP	--	--
Surface Water	--	--	NP	NP	NP	--	--

Notes:

X = Potential risk (cancer or non-cancer) is present, consideration for remediation is warranted.
-- = No risk present based on human health evaluation conducted.
NP = Media not present at this site.

TABLE 3-2

SITE-SPECIFIC ECOLOGICAL RISK SUMMARY

	NSWCWODET Sites						
	Site 2	Site 3	Site 4	Site 7	Site 8	Site 9	Site 11
Biota	H	U	L	L	L	U	U

Notes:

Risk Levels:

L - Low risk to fish and wildlife
M - Moderate risk to fish and wildlife
H - High risk to fish and wildlife
U - Potential risk to fish and wildlife is unknown because contaminants detected in food species were not detected in the environmental media at the site.

pose a risk to human health (on-site NSWCWODET workers) and the environment (i.e., fish in stream adjacent to landfill and Paint Branch Creek and wildlife in the vicinity of the site). The stream adjacent to the site flows into Paint Branch Creek approximately 1000 feet north of NSWCWODET.

The **remedial action objectives** for this site are:

- To remediate/control surface soil contamination to reduce ingestion and dermal contact risk to PCBs to less than 10^{-6}.
- To control leachate generation from the landfill to prevent further impacts to groundwater and surface water quality.
- To control surface runoff from the landfill to the stream to prevent further impacts on stream sediment quality.
- To remediate through removal, treatment and disposal of the sediment locations where the PCB levels exceed U.S. Environmental Protection Agency (EPA) action levels which also would minimize potential off-site migration of the PCBs in the stream sediment.

3.1.2 Site 3 - Pistol Range Landfill

The risk assessment analysis concluded that groundwater contamination poses a threat to human health based on the pathways of exposure and concentrations of contaminants. Contaminants detected in the surface water and stream sediment pose a minimal threat to human health. Mercury concentrations detected in food sources were significantly higher than acceptable levels for the Belted Kingfisher, however, the concentrations detected in the sediment and surface water were lower than EPA standards and criteria and remediation of these media is not recommended.

The **remedial action objectives** at Site 3 are:

- To remediate the contaminated groundwater to prevent ingestion of and dermal contact with water having carcinogens in excess of Maximum Contaminant Levels (MCLs) and a total excess cancer risk of greater than 10^{-6}.
- To control leachate generation from the landfill to prevent further impacts to groundwater and surface water quality.
- To control runoff from the landfill to prevent further impacts to stream sediment quality.

3.1.3 Site 4 - Chemical Burial Site

The risk assessment identified groundwater contamination as the principle threat to human health (exposure by off-site residential population) at this site resulting from leaching of contaminants from the burial pits through the shallow soil to the groundwater.

The **remedial action objectives** for Site 4 are:

- To remove/control source material and contaminated soil from the burial areas to prevent further degradation of groundwater quality.
- To remediate the contaminated groundwater to prevent ingestion of and dermal contact with water having carcinogens in excess of MCLs and a total excess cancer risk of greater than 10^{-6}.

3.1.4 Site 7 - Ordnance Burn Area

Investigations at Site 7 revealed nitroaromatic contamination in the shallow unsaturated soils and groundwater contamination at one well located with the swale. The risk assessment identified exposure to contaminated surface soils (on-site NSWCWODET workers) and contaminated groundwater (off-site residential populations) as posing a threat to human health.

The **remedial action objectives** for Site 7 are:

- To remove/control contaminated soil from the swale to reduce ingestion and dermal contact risk to nitroaromatics to less than 10^{-6} and prevent further degradation of groundwater quality.
- To remediate the contaminated groundwater to prevent ingestion of and dermal contact with water having non-carcinogens in excess of MCLs or reference doses and having carcinogens in excess of MCLs and a total excess cancer risk of greater than 10^{-6}.

3.1.5 Site 8 - Abandoned Chemical Disposal Pit

The risk assessment identified groundwater contamination as the principle threat to human health (exposure by off-site residential population) at this site resulting from leaching of contaminants from the burial pit through the shallow soil to the groundwater.

The **remedial action objectives** for Site 8 are:

- To remove/control source material and contaminated soil from the burial area to prevent further degradation of groundwater quality.
- To remediate the contaminated groundwater to prevent ingestion of and dermal contact with water having carcinogens in excess of MCLs and a total excess cancer risk of greater than 10^{-6}.

3.1.6 Site 9 - Industrial Wastewater Disposal Area 300

The risk assessment of contamination present at Site 9 indicates that the primary threat to human health (off-site residential populations) is from exposure to the nitroaromatics and chlorinated solvents in the groundwater.

The **remedial action objectives** for Site 9 are:

- To control or remove the source (leaching wells) of the contamination to prevent further degradation of groundwater quality.
- To remediate the contaminated groundwater to prevent ingestion of and dermal contact with water having non-carcinogens in excess of MCLs or reference doses and having carcinogens in excess of MCLs and a total excess cancer risk of greater than 10^{-6}.

3.1.7 Site 11 - Industrial Wastewater Disposal Area 100

The risk assessment of Site 11 concluded that the primary threat to human health (off-site residential populations) is from exposure to chlorinated solvents in the groundwater.

The **remedial action objectives** for Site 11 are:

- To control or remove the source (leaching wells) of the contamination to prevent further degradation of groundwater quality.
- To remediate the contaminated groundwater to prevent ingestion of and dermal contact with water having non-carcinogens in excess of MCLs or reference doses and having carcinogens in excess of MCLs and a total excess cancer risk of greater than 10^{-6}.

3.2 GENERAL RESPONSE ACTIONS

3.2.1 General Response Action Categories

General response actions to meet the remedial objectives at NSWCWODET fall into the following categories:

- No Action
- Technologies to Restrict/Extract Groundwater Contamination
- Technologies to Restrict/Remove Soil/Sediment/Source Contamination
- Treatment Technologies
- Disposal Options

3.2.1.1 No Action

Under "No Action" the sites would not be remediated and monitoring would be conducted to determine the extent of contaminate migration in groundwater, soil and sediment.

3.2.1.2 Groundwater Contamination Restriction and Extraction Technologies

To reduce contaminant mobility, technologies to restrict contaminant migration would be considered. For groundwater contamination, appropriate technologies include the following:

- Cut-off trenches or slurry walls for contaminant migration restriction
- Pumping wells for extraction of contaminants
- Horizontal and vertical barriers
- Leachate control systems

3.2.1.3 Soil/Sediment/Source Restriction and Removal Technologies

To reduce contaminant mobility in soils and sediment, technologies to restrict contaminant migration and to remove contamination would be considered. To limit source

material leaching, technologies to prevent source leaching and to remove source materials would be considered. These technologies could include the following:

- Sheet piling, grouting, slurry walls
- In-situ soil flushing
- Landfill cover or cap to restrict movement of contaminants
- Regrading and revegetation
- Excavation of contaminated soils/sediments and source materials
- Surface water diversion channels/conduits

3.2.1.4 Treatment Technologies

Technologies to treat extracted groundwater and soils/sediments include the following:

- Air stripping
- Carbon absorption
- Biological treatment (on-site/off-site)
- Advanced oxidation processes
- Thermal Treatment
- Chemical extraction of contaminants

Technologies for in-situ treatment may include the following:

- In-situ vacuum extraction
- In-situ vitrification
- In-situ stabilization/immobilization

3.2.1.5 Disposal Options

Subsequent to treatment, disposal of contaminants and treated media in accordance with Applicable or Relevant and Appropriate Requirements (ARARs) would be required. Disposal alternatives for groundwater include discharge to surface water (National Pollution Discharge Elimination System (NPDES) permit may be required), infiltration and/or reinjection to groundwater and discharge to Publicly Owned Treatment Works (POTW). Disposal alternatives for soils include placement back on the site after treatment and disposal in a Resource Conservation and Recovery Act (RCRA) Subtitle C or D landfill.

3.2.2 Site-specific General Response Actions

Based on the remedial action objectives for each site as described in Section 3.2.1, the following subsections discuss the general response actions available for each medium at each site. Section 3.5 develops and screens the applicable technologies associated with these general response actions.

3.2.2.1 Site 2 - Apple Orchard Landfill

The general response actions for PCB-contaminated surface soil and buried waste materials at Site 2 include containment.

The general response actions for PCB-contaminated stream sediment at Site 2 include: collection, off-site treatment, and off-site disposal; collection, and on-site treatment, and on- or off-site disposal.

3.2.2.2 Site 3 - Pistol Range Landfill

The general response actions for metal-contaminated surface soil and source material (fill material) at Site 3 include containment.

The general response actions for groundwater at Site 3 include: collection, on-site treatment, and on-site disposal.

3.2.2.3 Site 4 - Chemical Burial Site

The general response actions for soil (soil in the burial areas) at Site 4 include: containment; collection, off-site treatment and off-site disposal; collection, on-site treatment, and on- or off-site disposal.

The general response actions for source materials (buried containers, debris, etc.) at Site 4 include: containment, collection, and off-site disposal.

The general response actions for groundwater at Site 4 include: collection, on-site treatment, and on-site disposal.

3.2.2.4 Site 7 - Ordnance Burn Area

The general response actions for soil (nitroaromatic-contaminated soil within the swale) at Site 7 include: containment; collection, off-site treatment, and off-site disposal; collection, on-site treatment, and on- or off-site disposal; and in-situ treatment.

The general response actions for groundwater at Site 7 include: collection, on-site treatment, and on-site disposal.

3.2.2.5 Site 8 - Abandoned Chemical Disposal Pit

The general response actions for soil (soil within the burial pit) at Site 8 include: containment; collection, off-site treatment, and off-site disposal; collection, on-site treatment, and on- or off-site disposal.

The general response actions for source materials at Site 8 include: containment, collection, and off-site disposal.

The general response actions for groundwater at Site 8 include: collection, on-site treatment, and on-site disposal.

3.2.2.6 Site 9 - Industrial Wastewater Disposal Area 300

The general response actions for soil (soil within leaching wells) at Site 9 include: containment; collection, off-site treatment, and off-site disposal; collection, on-site treatment, and on- or off-site disposal.

The general response actions for source materials (leaching well construction material) at Site 9 include: containment, collection, and off-site disposal.

The general response actions for groundwater at Site 9 include: collection, on-site treatment, and on-site disposal.

3.2.2.7 Site 11 - Industrial Wastewater Disposal Area 100

The general response actions for soil (soil within leaching wells) at Site 11 include containment; collection, off-site treatment, and off-site disposal; collection, on-site treatment, and on- or off-site disposal.

The general response actions for source materials (leaching well construction materials) at Site 11 include: containment, collection, and off-site disposal.

The general response actions for groundwater at Site 11 include: collection, on-site treatment, and on-site disposal.

3.3 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

The National Contingency Plan (NCP) and Section 121 of Comprehensive Environmental Response, Compensation and Liabilities Act (CERCLA) require that CERCLA remedial actions attain Federal and state ARARs unless specific waivers are granted. State ARARs must be attained under Section 121(d) of CERCLA, if they are legally enforceable and consistently enforced statewide. ARARs may be classified as either applicable or relevant and appropriate. In addition to ARARS, other guidance and regulations may be classified as guidance "to be considered" (TBC). Potential ARARs and TBCs are identified in this section to aid in development of remedial actions and in establishment of required cleanup levels. Additionally, ARARs and TBCs are used to scope and formulate remedial action alternatives and to govern implementation and operation of the selected remedial alternatives.

Discussions of ARARS and TBC criteria are provided in the following subsections.

3.3.1 Applicable Requirements

Applicable requirements refer to those Federal or State requirements that would be legally enforceable. An example of an applicable requirement would be the Safe Drinking Water Act's Maximum Contaminant Levels (MCLs) for a site that causes contamination of a public drinking water supply.

3.3.2 Relevant and Appropriate Requirements

Relevant and appropriate requirements are Federal or State standards, criteria or guidelines that are not legally enforceable at a site, but application is appropriate because

they address problems similar to those on-site. During the FS process, relevant and appropriate requirements have the same weight and consideration as applicable requirements.

3.3.3 To Be Considered (TBC)

Other Federal and State recommended standards or criteria applicable to a specific site which are not generally enforceable but are advisory are categorized as "to be considered" during the FS process. For example, where no specific ARAR exists for a chemical or situation, or where such an ARAR is not sufficient to be protective of human health or the environment, federal and/or state guidance or advisories may be considered in determining the necessary level of cleanup for protection of public health and the environment. An example of a TBC would be use of EPA Health Advisories for specific chemicals in determining action or cleanup levels. ARARs and TBCs are further categorized as either chemical-specific, location-specific or action-specific.

3.3.4 Chemical Specific

Chemical-specific requirements define acceptable exposure levels for specific hazardous substances and therefore may be used as a basis for establishing preliminary remediation goals and cleanup levels for chemicals of concern in the designated media. Chemical-specific ARARs and TBCs are also used to determine treatment and disposal requirements for remedial actions. In the event a chemical has more than one requirement, the more stringent of the two requirements will be used.

3.3.5 Location Specific

Location-specific requirements set restrictions on the types of remedial actions that can be performed based on site-specific characteristics or location. Alternative remedial actions may be restricted or precluded based on Federal and State laws for hazardous waste facilities, proximity to wetlands or floodplains, or to man-made features such as existing landfills, disposal areas and local historic landmarks or buildings.

3.3.6 Action Specific

Action-specific requirements set controls or restrictions on the design, implementation and performance of remedial actions. They are triggered by the particular types of

treatment or remedial actions that are selected to accomplish the cleanup. After remedial alternatives are developed, action-specific ARARs and TBCs which specify remedial action performance levels as well as specific contaminant levels for discharge of media or residual chemical levels for media left in place, are used as a basis for assessing the feasibility and effectiveness of the remedial action.

3.3.7 Waiver of ARARs and TBCs

Provided that protection of human health and the environment is still assured, CERCLA allows that ARARs be waived under the following conditions:

- The selected remedial action is an interim remedy or portion of a total remedy which will attain standards when complete.
- Compliance with the ARARs or TBCs will result in an increased risk to human health and the environment.
- Compliance with the ARARs or TBCs is technically impracticable from an engineering perspective.
- The selected remedial action will provide an equivalent standard of performance to the ARAR or TBC using another approach.
- The ARAR or TBC requirement is a state requirement that has been inconsistently applied.
- The alternative will not provide a balance between public health and environmental welfare and the availability of funds to respond to existing or potential threats at other sites, taking into account the relative immediacy of the threats.

3.3.8 Identification of ARARs and TBCs

ARARs and TBCs that have been identified as relating to the Feasibility Study (FS) include the following:

- EPA Water Quality Standards (40 CFR 131)
- Maryland Groundwater Protection Standards
- Maryland Surface Water Standards
- Safe Drinking Water Act Maximum Contaminant Levels (40 CFR 141)

- "A Guide on Remedial Action at Superfund Sites with PCB Contamination," (OSWER Directive 9355.4-01, PB90-274432)
- Corrective Action for Solid Waste Management Units, Proposed Rule, Federal Register, Vol. 55, No. 145, July 27, 1990
- Washington Suburban Sanitary Commission (WSSC) POTW Discharge Criteria
- National and Maryland Pollution Discharge Elimination System Regulations (40 CFR 121)
- EPA Health Advisories

Other ARARs or TBCs that may have an impact on the design and implementation of remedial measures include:

- Montgomery County and Prince George's County Noise Regulations
- RCRA Groundwater Protection Standards (40 CFR §264, Subpart F)
- Clean Water Act, Water Quality Criteria (Section 304)(May 1, 1987 - Gold Book)
- National Ambient Air Quality Standards (NAAQS) (40 CFR §50)
- RCRA Land Disposal Restrictions (40 CFR §268)
- National Emissions Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR §61)
- Occupational Safety and Health Standards for Hazardous Responses and General Construction Activities (29 CFR §1940, 1910, 1926)

Potential chemical-specific ARARs for the chemicals of concern for water and soil/sediment are provided in Tables 3-3 and 3-4. Potential location-specific ARARs are provided in Table 3-5 while action-specific ARARs are provided in Table 3-6.

3.4 EVALUATION CRITERIA

Remedial alternatives will be screened to eliminate those that are not effective, implementable or reasonable in cost. A description of the criteria used to determine the effectiveness, implementability, and economical cost of a remedial alternative to be used in

TABLE 3–3
CHEMICAL–SPECIFIC ARARs (Water)

TARGET COMPOUNDS	MCLs(1)	EPA WQ Stds		Maryland GW Stds(4)	RCRA Corrective Action Levels(5)	DWELs(6)
		Water/Orgs(2)	Orgs(3)			
METALS – Results and standards reported in ug/l.						
Chromium	100	33,000	670,000	50	NS(7)	200
Cadmium	5	16	170	10	NS	20
Copper	1,000	1,300	NS	NS	NS	NS
Lead	50/15	50	NS	50	NS	NS
Mercury	2	0.14	0.15	2	NS	10
Zinc	--	NS	NS	NS	NS	1,100
VOLATILE ORGANICS – Results and standards reported in ug/l.						
Benzene	5	1.2	71	NS	NS	NS
Chlorobenzene	100	680	21,000	NS	NS	700
1,2–Dichloroethane	5	0.38	99	NS	NS	NS
trans 1,2–Dichloroethene	100	700	140,000	NS	NS	600
1,1,2,2–Tetrachloroethane	NS	0.17	11	NS	2	NS
Tetrachloroethene	5	0.8	8.85	NS	0.7	500
1,1,1–Trichloroethane	200	3,100	170,000	NS	3,000	1,000
Trichloroethene	5	2.7	80.7	NS	NS	300
Vinyl Chloride	2	2	525	NS	NS	NS
NITROAROMATICS – Results and standards reported in ug/l.						
HMX	NS	NS	NS	NS	NS	2,000
RDX	NS	NS	NS	NS	NS	100
2,4–Dinitrotoluene	NS	0.11	9.1	NS	NS	100
2,6–Dinitrotoluene	NS	NS	NS	NS	NS	40

Notes:
1. MCLs – EPA Maximum Contaminant Levels (40 CFR 141 and 143)
2. Proposed EPA Water Quality Standards (40 CFR 131) – Consumption of Water and Organisms
3. Proposed EPA Water Quality Standards (40 CFR 131) – Consumption of Organisms Only
4. Maryland Groundwater Protection Standards (COMAR 26.13.05.06A)
5. Proposed RCRA Corrective Action Rule – Action Levels (Appendix A)
6. DWELs – EPA Health Advisory (Dec 1992), Drinking Water Equivalent Levels
7. NS – No standard

TABLE 3–4
CHEMICAL–SPECIFIC ARARs (Soil/Sediment)

TARGET COMPOUNDS	RCRA CORRECTIVE ACTION LEVELS (1)	EPA PCB GUIDE (2)
METALS – Results and standards reported in mg/kg.		
Chromium	NS(3)	NA(4)
Cadmium	40	NA
Copper	NS	NA
Lead	NS	NA
Mercury	20	NA
Zinc	NS	NA
VOLATILE ORGANICS – Results and standards reported in mg/kg.		
Benzene	NS	NA
Chlorobenzene	2,000	NA
1,2–Dichloroethane	8	NA
trans 1,2–Dichloroethene	NS	NA
1,1,2,2–Tetrachloroethane	40	NA
Tetrachloroethene	10	NA
1,1,1–Trichloroethane	7,000	NA
Trichloroethene	60	NA
Vinyl Chloride	NS	NA
NITROAROMATICS – Results and standards reported in mg/kg.		
HMX	NS	NA
RDX	NS	NA
TNT	NS	NA
2,4–Dinitrotoluene	NS	NA
2,6–Dinitrotoluene	NS	NA
OTHER CHEMICALS – Results and standards reported in mg/kg.		
PCBs	0.09	10 – 25 (a) 0.19 – 19 (b)

Notes:

1. Proposed RCRA Corrective Action Rule – Action Levels (Appendix A)
2. "A Guide on Remedial Actions at Superfund Sites with PCB Contamination", OSWER Directive 9355.4–01 FS, PB90–274432
   a. Action Levels for PCB–contaminated soils in industrial areas.
   b. Sediment Quality Criteria for PCB–contaminated sediments.
3. NS – No standard
4. NA – Not applicable

TABLE 3-5

POTENTIAL LOCATION-SPECIFIC ARARs

ARARs	Description/Requirements	Applicability
40 CFR 6, Appendix A, Fish & Wildlife Act	Avoid adverse effect to floodplain	A
33 CFR 320-330/50 CFR 200	Action to conserve endangered species	NA
40 CFR 230, CWA Sec. 404	Prohibit discharge of dredge into wetland	NA
50 CFR 35.1, Wilderness Act	Preserve wilderness area	NA
50 CFR 27	Wildlife refuge considerations	NA
40 CFR 6.302(e), Wild & Scenic River	Avoid activity that will affect wild and scenic rivers	NA
40 CFR 264.18(a)	TSD of hazardous waste prohibited within 200 feet of a fault	NA
40 CFR 264.18(b)	Design TSD facility to avoid washout with 100 year flood	A
36 CFR 65 and 800	Action to preserve artifacts of historic property	NA

Notes:
A - Applicable
NA - Not applicable

TABLE 3-6

ACTION-SPECIFIC ARARs

ARARs	Description/Requirements	Soil							Groundwater
		Capping	Excavate and Treat		In-Situ		Soil Washing	Thermal Treatment	Pump, Treat and Dispose On-Site
			On-Site Disposal	Off-Site Disposal	Fixation	Flushing			
TSCA 40 CFR 761.75	Chemical Waste Landfill Requirements	RA	RA	A	N/A	N/A	N/A	N/A	N/A
TSCA 40 CFR 761.120-139	* PCB Spill Cleanup Policy	N/A	TBC	TBC	N/A	N/A	TBC	TBC	N/A
TSCA 40 CFR 761.60(e)(i)	Alternative Treatment of Chemical Waste	N/A	A	A	N/A	N/A	A	A	N/A
TSCA 40 CFR 761.70	* Special Performance Standards for Incineration of PCBs	N/A	N/A	N/A	N/A	N/A	N/A	A	N/A
OSHA 29 CFR 1910	Workers Engaged in Response Actions	A	A	A	A	A	A	A	A
RCRA 40 CFR 264.301 & 264.310(a) & (b)	Capping & Closure Requirements for Landfills	RA	RA	N/A	N/A	N/A	N/A	N/A	N/A
RCRA 40 CFR 264.228(a) & (b)	Closure & Post-Closure Secure Landburial Facility	RA	RA	N/A	N/A	N/A	N/A	N/A	N/A
RCRA 40 CFR 264.117(c)	Use of Property/Post-Closure Requirements	A	A	N/A	N/A	N/A	N/A	N/A	N/A
RCRA 40 CFR 264.111	Closure Requirements to Minimize Maintenance & Engineering Controls	RA	RA	N/A	N/A	N/A	N/A	N/A	N/A
RCRA 40 CFR 264.178 & Tank System .197 & .288 & 258	Closure Requirements/ Decontamination of all Residues/Equipment	RA	RA	N/A	RA	RA	RA	RA	RA
RCRA 40 CFR 264.373	* Thermal Treatment Requirements	N/A	N/A	N/A	N/A	N/A	N/A	RA	N/A

TABLE 3-6

(Continued)

ARARs	Description/Requirements	Soil							Groundwater
		Capping	Excavate and Treat		In-Situ		Soil Washing	Thermal Treatment	Pump, Treat and Dispose On-Site
			On-Site Disposal	Off-Site Disposal	Fixation	Flushing			
RCRA 40 CFR 268(D)	Land Ban Restrictions & Storage	N/A	A	A	N/A	N/A	N/A	N/A	N/A
RCRA 40 CFR 264.340-399 (Subpart O)	* Performance Standards for Incinerators	N/A	N/A	N/A	N/A	N/A	N/A	RA	N/A
RCRA 40 CFR 263	Generator Requirement for Manifesting Waste for Off-Site Disposal	N/A	N/A	RA	N/A	N/A	N/A	N/A	N/A
RCRA 40 CFR 270	Transporter Requirements for Off-Site Disposal	N/A	N/A	RA	N/A	N/A	N/A	N/A	N/A
RCRA 40 CFR 264.191-195	Tank Storage Design Requirements	N/A	N/A	N/A	N/A	N/A	TBC	TBC	TBC
RCRA 40 CFR 264.314	Noncontainerized Liquid Hazardous Waste May Not be Landfilled	N/A	RA	RA	N/A	N/A	N/A	N/A	N/A
RCRA 40 CFR 264.171 & 264.172	Storage of RCRA Hazardous Waste (Waste Reduction) Lead	N/A	A	A	N/A	N/A	N/A	N/A	N/A
NESHAP 40 CFR 61 and National Ambient Air Quality Standards	Air Emissions Standards	N/A	N/A	N/A	N/A	N/A	RA	RA	RA
40 CFR 122	NPDES Permit Requirements	N/A	N/A	N/A	N/A	N/A	N/A	N/A	A

TABLE 3-6

(Continued)

ARARs	Description/Requirements	Soil							Groundwater
		Capping	Excavate and Treat		In-Situ		Soil Washing	Thermal Treatment	Pump, Treat and Dispose On-Site
			On-Site Disposal	Off-Site Disposal	Fixation	Flushing			
40 CFR 125.1	Best Management Practices to Prevent Toxic Release to Surface Water	N/A	N/A	N/A	N/A	N/A	N/A	N/A	A
40 CFR 403.5	Discharge to Local POTW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	A
40 CFR 136.1	Use Approved Test Methods & QA/QC for Monitoring Effluent	N/A	N/A	N/A	N/A	N/A	N/A	N/A	A
49 CFR 107 & 171	DOT Rules for Hazardous Materials Transport	N/A	N/A	A	N/A	N/A	N/A	N/A	N/A
40 CFR 144	Underground Injection Control (UIC) Program	N/A	N/A	N/A	N/A	N/A	N/A	N/A	A
40 CFR 146	UIC Program: Criteria and Standards	N/A	N/A	N/A	N/A	N/A	N/A	N/A	A
Noise Regulation	Noise	A	A	A	A	A	A	A	A

LEGEND:

N/A - Not applicable or relevant and appropriate
A - Applicable
RA - Relevant and appropriate
TBC - To be considered
* - Technology-specific

this initial screening is provided below. These criteria are utilized again (in conjunction with others) during the detailed analysis evaluation in Section 5.0 of this report. In the screening step, technologies are evaluated qualitatively only based on their effectiveness, implementability, and cost.

3.4.1 Effectiveness Evaluation

A key aspect of the screening process is evaluation of the effectiveness of each alternative in protecting human health and the environment. Each alternative is evaluated based on its effectiveness in providing protection and in reducing the contaminants' toxicity, mobility or volume. Both short- and long-term components of effectiveness are evaluated. Short-term effects are those which occur during the construction and implementation period, and long-term effects refer to the period after the remedial action is complete. Reduction of toxicity, mobility or volume refers to changes in one or more characteristics of the hazardous substances or contaminated media by the use of treatment that decreases the inherent threats or risks associated with these substances.

3.4.2 Implementability Evaluation

Implementability is a measure of both the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. It is used during screening to evaluate the combinations of process options with respect to conditions at a specific site. Technical feasibility refers to the ability to construct, reliably operate and meet technology-specific regulations for process options until a remedial action is complete. It also includes operation, maintenance, replacement, and monitoring of technical components of an alternative, if required, after the remedial action is complete. Administrative feasibility refers to the ability to obtain approvals from other offices and agencies, the availability of treatment, storage and disposal services and capacity, and the requirements for, and availability of, specific equipment and technical specialists.

3.4.3 Cost Evaluation

Typically, alternatives are defined well enough before screening to estimate some costs for comparison to other alternatives. However, because uncertainties associated with the definition of alternatives often remain, it is not practical to define the costs of alternatives with the accuracy desired for the detailed analysis. At this stage in the

evaluation, the cost analysis is made on the basis of engineering judgment. The costs of each process option are compared with costs of other process options in the same technology type.

3.5 IDENTIFICATION OF POTENTIAL REMEDIAL TECHNOLOGIES

This section presents a list of remedial response actions considered for preliminary screening. This group of remedial actions includes the no action alternative and unit processes for the treatment and/or disposal of contaminants present at the various NSWCWODET sites. Response actions are first identified and evaluated based on their applicability to a specific media. Some responses may require action be taken on other media. For instance, based on the results of the risk assessment, the surface water at the sites contain no contaminants which could be harmful to human health or the environment. However, the treatment of the stream sediments could require recovering the surface water and discharging it elsewhere.

Remedial action technologies were divided into the following broad groups, and evaluated based on their applicability to the media and the contaminants of concern:

- No Action
- Containment Technologies
- Diversion Technologies
- Collection Technologies
- Treatment Technologies

Table 3-7 provides a master list of potentially feasible technologies which could be applied to the NSWCWODET sites. The technologies in this table include all those pertaining to landfills and chemical disposal sites as listed in the USEPA Handbook, "Remedial Action at Waste Disposal Sites," 1985. These technologies are screened in the sections that follow. As stated in Section 3.4, the remedial technologies listed in Table 3-7 were screened initially based on:

TABLE 3-7

SUMMARY OF POTENTIAL REMEDIAL TECHNOLOGIES

MEDIA	GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTIONS
Groundwater	No Action	No Action	No action
	Containment	Horizontal Cap	Caps or surface seals
		Vertical Groundwater Barriers	Sheet piling, grouting, and slurry walls
	Diversion	Regrading and Revegetation	Regrading/revegetation to reduce ponding or infiltration of rainwater and minimize transport to groundwater
	Collection	Groundwater Collection	Extraction/pumping wells
		Leachate Collection	A leachate collection system to include drains, groundwater pumping, barriers, etc.
	Treatment	Physical	Extraction with sedimentation
			Precipitation/flocculation
			Coagulation
			Activated Carbon
			Air stripping
			Aeration
			Filtration
		Biological	Use of organisms to biologically degrade or destroy contaminants
		Chemical	Neutralization
			Oxidation/reduction
			Ion exchange
			Ozonation

TABLE 3-7
(Continued)

MEDIA	GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY TYPE	PROCESS OPTIONS
Sediment and soil	No Action	No Action	No Action
	Containment	Capping with horizontal barriers	Landfill caps and surface seals
		Surface water diversion	Diversion channels and pipes
	Collection	Excavate and remove	Excavation
	Treatment	Thermal	Soil thermal treatment/incineration
		Physical/Chemical	Soil Venting
			Chemical extraction
			Soil washing
			In-situ soil flushing
			Chemical and silicate fixatives
			Vitrification
			Glycolate dechlorination
		Biological	Land farming, activated sludge and composting
Sources	No Action	No Action	No Action
	Containment	Capping with horizontal barriers	Landfill caps and surface seals
		Surface water diversion	Diversion channels and pipes
	Collection	Excavate and remove	Excavation

- Effectiveness
- Implementability
- Cost

3.6 DESCRIPTION AND INITIAL SCREENING OF GROUNDWATER REMEDIAL TECHNOLOGIES

3.6.1 No-Action

The no-action technology, by definition, involves no remedial action at a site, and therefore has no technological barriers. The potential risks to human health and the environment identified in the risk assessment would not be mitigated by this response. For example, leachate would continue to be generated by the landfills at the Sites 2 and 3 and discharged to the groundwater. The no-action response at Sites 2 and 3 would not reduce or eliminate the risk identified by the risk assessment. However, the no-action response might be appropriate for sites identified as sources of no potential risk.

No-action with monitoring is essentially the present status of the site. A monitoring system for each site was established during the RI to obtain groundwater samples. The groundwater sample data base has been used to delineate the extent and nature of environmental contamination at each NSWCWODET site. At site locations where no remedial action is possible, the correlation of future data with existing data will help to track contaminant migration and identify the point at which further action is necessary. This technology may be desirable when the risk to the environment from disturbing the contamination may be greater than the risk to the environment from leaving it untouched.

3.6.2 Containment

Containment is a method of source control which reduces the possibility of physical contact with contaminated media and the potential of groundwater contamination. Containment includes covering or "capping" the contaminated area with an impermeable barrier to prevent infiltration. Containment may involve establishing impermeable barriers around the perimeter of contaminated areas in addition to capping to control the migration of contaminated water from the site or to redirect groundwater away from the contamination source.

3.6.2.1 Capping

Capping techniques are used when materials are to be left in place. Caps or surface seals are impermeable barriers placed over waste disposal sites to:

- Reduce surface water infiltration.
- Reduce water erosion.
- Reduce wind erosion and fugitive dust emissions.
- Contain and control gases and odors.
- Provide a surface for vegetation and other post-closure uses.

Various capping materials are available; including soil, soil mixed with additives and/or cement, clay (bentonite), polyurethane foam, resins, synthetic membranes, and sprayed bituminous membranes. Clay covers are commonly used to restrict the infiltration of precipitation through the waste. Synthetic materials made of polyvinyl chloride, ethylene propylene rubber, hypalon, chlorinated polyethylene (CPE), butyl rubber, elasticized polyolefin or neoprene are often used as caps. Other possible capping materials such as polyurethane foam and resins have not been fully demonstrated. Sprayed bituminous membranes such as asphalt are susceptible to cracking and require special application procedures.

Capping has limitations due to the physical characteristics of a site. In the case of the landfills at Sites 2 and 3, decomposition and consolidation of wastes would be expected to occur at varying rates. This variable compaction may damage the continuity and integrity of the cover material. Thus, rigid cap designs of concrete, asphalt, and chemical sealant materials would most likely fail due to waste compaction as a result of decomposition, but might be appropriate for other RI sites where compaction would not be a factor. Synthetic membranes, clays, and soil with additives all have advantages and disadvantages as capping materials, but tend to complement each other when combined in a multi-layered cap.

Multi-layered caps, as required by RCRA regulations (40 CFR 264.310), have established design standards. RCRA recommends a three-layer capping system, where the upper layer of top soil is vegetated to prevent erosion, the middle drainage layer of sand or other permeable material provides drainage for the upper vegetative layer, and the lower

layer of compacted low permeability material or a synthetic membrane prevents precipitation from infiltrating to the buried wastes.

The low permeability soil layer has the advantage of being relatively thick and somewhat plastic; therefore, it can conform to the decomposing landfill waste and reduce the chance of sudden failure. Infiltration may still occur to a small extent through cracks in the soil caused by flexing during shrinkage. However, in a composite cap, a synthetic membrane is used to cover a low permeability soil which provides a continuous barrier against infiltration particularly on flatter, upper landfill surface areas. The synthetic membrane prevents water from infiltrating to the buried wastes thus creating a leachate that could impact groundwater quality. It may not be feasible to use a synthetic membrane on the slopes of the landfill at Sites 2 and 3 without significant regrading because of the possibility of slippage and cap failure.

According to RCRA standards, a final cover for a Subtitle C or D landfill must be designed and constructed to provide long-term minimization of migration of liquids through the closed landfill, function with minimum maintenance, promote surface drainage and minimize erosion or abrasion of the cover, accommodate settling and subsidence to maintain the cover's integrity, and have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils. A cap conforming to these standards for the landfills at Sites 2 and 3 could include a soil cover constructed of low permeability material, such as clay or a composite cap.

Containment of the contaminant source, especially at the landfill sites (Sites 2 and 3) could sufficiently mitigate most of the environmental risk from the site. Capping could also be appropriate at other sites (Sites 4, 7, and 8) where limiting infiltrating rainwater could reduce discharge of leachate to groundwater. Historically, capping is a less expensive alternative compared to other technologies.

3.6.2.2 Vertical Groundwater Barriers

By constructing a groundwater barrier along the upgradient side of a landfill, the total volume of leachate that could discharge to the shallow groundwater could be significantly reduced. Following is a list of vertical barriers used for this type of application:

- Soil-bentonite slurry wall

- Cement-bentonite slurry wall
- Vibrating beam/asphalt
- Grout curtains
- Steel sheet piling

The hydrogeologic framework at NSWCWODET is not suitable for construction of a groundwater barrier because there is no confining unit in which the barrier may be imbedded so as to prevent movement (or migration) of contamination to deeper portions of the aquifer. Although the barrier could be imbedded into bedrock (gneiss of the Wissahickon Formation) because the bedrock is fractured, a complete bedrock barrier would not exist. Groundwater contaminants could migrate vertically into the fractures and then under the barrier.

Of the listed technologies, sheet piling is eliminated because it tends to leak more than other methods, depth of application becomes a technical concern, and costs are similar to more desirable technologies. Grout curtains are not often used in this type of hydrogeologic situation but more often implemented in consolidated rock, and therefore, this technology is not considered further. Results that have been obtained with the vibrating beam/asphalt curtain have shown less than satisfactory performance and for that reason have been eliminated from the list of possible technologies.

Of the slurry walls, soil-bentonite is somewhat less expensive than cement-bentonite and has the advantage of being less permeable. Since EPA Region III has not granted approval for implementation of a slurry wall barrier as a remedial response action, this technology will not be considered further.

The effectiveness of upgradient, vertical groundwater barriers at any of the sites at NSWCWODET would be limited due to the hydrogeologic conditions of the site. Therefore, use of upgradient barriers is not a practical remedial action. For this reason, this remedial technology will not be considered further.

3.6.3 Diversion

3.6.3.1 Regrading and Revegetation

Regrading is the general term used for techniques to reshape a landfill cap or cover surface in order to manage surface water infiltration and run-off while controlling erosion.

Surface grading addresses several potential problems related to groundwater quality and the following landfill-cap surface management issues:

- Reduces ponding which minimizes infiltration and transport of contaminants to groundwater.
- Reduces runoff velocities which reduces soil erosion.
- Roughens and loosens soils in preparation for revegetation.

Hence, regrading can be useful to reduce leaching of contaminants caused by infiltration of precipitation. Periodic regrading may be necessary to eliminate depressions formed through differential settlement and compaction of a landfill or to repair slopes that have slumped or eroded.

Revegetation is designed to decrease erosion by wind and water and contribute to the development of a naturally fertile and stable landfill surface environment. A revegetation plan includes: (1) selection of suitable plant species, (2) seedbed preparation, (3) seeding/planting, (4) mulching and/or chemical stabilization, and (5) fertilization and maintenance. In addition, the technique can be used to upgrade the appearance of disposal sites. The use of vegetative covers as a means of surface management typically involves grading the site surface, covering it with a layer of topsoil, and seeding with vegetative materials. Direct surface exposure to the contaminants is controlled by this method, but the generation of leachate from infiltration occurs. Because infiltration is not eliminated, this technology is generally used in conjunction with some other remedial response actions such as capping.

Regrading and revegetation are applicable at all sites at NSWCWODET after final remediation has occurred. Because capping activities typically address regrading and revegetation issues, the further development of these technologies will be discussed in the development of the alternatives for sites that include capping as a technology.

3.6.4 Collection

3.6.4.1 Groundwater Collection

Groundwater pumping through use of extraction wells or trenches can be used to actively collect and contain groundwater contamination. It is likely that a groundwater

pumping system, if implemented, would be used for a combination of both groundwater extraction and containment. Additionally, groundwater pumping can be used for extracting leachate and/or groundwater from the wastes, and/or soils. Theoretically, future spread of contamination could be controlled by intercepting flow at the site.

Groundwater pumping as a form of groundwater collection is a potentially implementable technology at several of the sites at NSWCWODET and will be further developed in Sections 4.0 and 5.0 of this document.

3.6.4.2 Leachate Collection Systems

The control of landfill leachate at the NSWCWODET sites will directly influence the groundwater quality at several sites. Leachate infiltration has impacted groundwater quality at several sites at NSWCWODET. Leachate collection technology such as drains, trenches or extraction wells will have variable effectiveness when combined with other technologies.

It is expected that a cap will sufficiently reduce the amount of leachate generated and thus the level of effectiveness of the leachate collection system, while soil cover or no-action will result in generation of leachate at rates similar to the present situation. Because the installation of a cap at Sites 2 and 3 is expected, the need for additional leachate collection in the form of a leachate collection system is not expected, and therefore, this technology will not be considered in the development of alternatives.

3.6.5 Treatment

Off-site treatment of leachate and groundwater could be accomplished by treatment at an approved treatment facility, or on-site. It is estimated that on-site treatment of liquid waste (i.e., contaminated groundwater and leachate) at the NSWCWODET sites would entail the construction of fixed treatment facilities due to the extensive length of time needed to collect and treat the volume of liquids present.

Several treatment technologies are potentially effective and implementable to the wastes present at the NSWCWODET sites and are briefly discussed in the following paragraphs.

3.6.5.1 Physical Treatment

Precipitation

Precipitation involves the addition of lime, caustic soda, or sodium sulfide to react directly with dissolved acidic waste constituents whereby soluble constituents become insoluble and precipitate out of solution. Precipitation requires chemical storage and feed equipment and a rapid mix tank used for the treatment of metal-contaminated wastes.

Sedimentation

Sedimentation involves the separation of solids from liquids via gravity forces acting on flow retained in a quiescent state. This process requires impoundment with a clarifier tank with inflow and outflow devices and a sludge removal mechanism.

Flocculation

Flocculation involves the slow agitation of liquid wastes in order to agglomerate precipitates into larger particles which can be settled out of the waste. It requires a mixing tank with the use of slow mixers, baffles, or diffused air injection.

Coagulation

Coagulation involve the addition of alum, lime, or ferric salts to reduce the electrical repulsive forces at particle surfaces. A coagulation process requires chemical storage and feed equipment and a rapid mix tank or an impoundment with mixer equipment.

Activated Carbon Adsorption

Activated carbon adsorption involves the selected removal of certain contaminants from an aqueous solution or an air stream by contact with activated carbon via flow through a series of columns or treatment beds. The process of carbon adsorption involves passing the liquid or vapor phase through granular activated carbon which adsorbs hazardous organic materials. When the carbon reaches its ultimate capacity for adsorption, it is removed for disposal, destruction, or regeneration.

A liquid phase activated carbon treatment system would require packed bed pressure columns in a series arrangement with a backwash system. A vapor phase activated carbon system would require a carbon bed with adequate ductwork from the aeration system, a preheater to remove excess moisture and a blower to force the air into the bed. Exhausted carbon may be regenerated or disposed.

Activated carbon has proven effective in the removal of a variety of chlorinated hydrocarbons and other organic compounds. Associated with air-stripping to remove the

large volumes of organic volatiles, activated carbon adsorption could be an important component of a leachate treatment system or a groundwater treatment system.

Air Stripping

Air stripping consists of separating volatile materials dissolved in water by means of an air current passing through the liquid. Air stripping most commonly makes use of packed towers filled with contact media to aid mass transfer. This technology is effective in removing volatile organic hydrocarbons and for deodorization. Problems associated with air stripping include reduced efficiency during cold weather, plugging of the system with metals and solids precipitates, and the possible need to treat off-gases in order to achieve air quality standards.

There are 3 types of air stripping units widely available for use in remediation projects: packed columns, bubble diffusion, and shallow tray units.

Packed columns represent the most traditional form of air stripping. Volatilization occurs by pumping the contaminated groundwater to the top of the column packed with dispersion media, which increases the surface area of the groundwater stream and enhances transfer of the volatile organic contaminants to a low velocity counter-current air stream as the water falls through the column.

Bubble diffusion air stripping utilizes a rectangular tank fitted with air spargers to volatilize contamination as the water passes through the unit. Since the effective surface area of the water stream is smaller in comparison to that achieved with the packed column, a higher air flow rate is typically necessary to effect comparable volatilization.

Shallow tray air stripping involves the use of a compact series of trays and a high capacity blower to volatilize contamination as it passes through the unit. The trays are staggered within the unit to allow for gravity flow of the water from the top of the unit to the bottom. The air current is directed through small orifices in the trays, and is of sufficient velocity to prevent the water from passing through the orifices.

Air Sparging

Air sparging methods inject air under high pressure to create an in-situ air stripper in the subsurface, with the saturated soil column acting as the packing. The induced air flow directly contacts the contaminated soil within the area of influence of the air injection point and increases the rate of contaminant diffusion within zones of low permeability in the soil, as well as degrading volatile contaminants. This technology is generally utilized in concert with soil vapor extraction technologies. Based on the low permeability of the saturated zone

at several sites and the widespread location of source areas at Sites 9 and 11, the area of influence of a single injection/extraction point would be small and a large number of injection/extraction points would be required to effectively reduce contamination creating high installation and operating costs. On this basis, air sparging would not be effective for most sites at NSWCWODET.

Filtration

Filtration involves the separation of solids from liquids via passage through granular material under gravity or pressure forces. This process requires influent feed and effluent removal equipment and backflushing equipment to clean the filter. Removal efficiencies are dependent upon the pore size of the media.

Summary of Physical Treatment Technologies

Precipitation of contaminants would be an effective treatment of water containing high concentrations of metals but would not be effective in the case of organics. Sedimentation, flocculation, filtration and coagulation are only effective for the removal of suspended solids from water. In the case of the NSWCWODET sites, groundwater contaminants are typically in a dissolved phase; therefore, these treatment techniques are not expected to be applicable. Carbon adsorption could be employed where volatiles are a concern; however, is not effective in metals removal. In addition, air stripping could also be used to treat water contaminated with volatiles and semi-volatiles.

Overall, the treatment technologies of air stripping for volatile organics and activated carbon for volatile organics, semivolatile organics and nitroaromatics are applicable due to their effectiveness for the chemicals of potential concern and their implementability at the NSWCWODET sites.

3.6.5.2 Biological Treatment

Biological treatment involves the introduction of an organics-laden waste stream into biological treatment units where micro-organisms decompose the organic contaminants into carbon dioxide, water and small amounts of other non-hazardous compounds. Biological treatment units typically require a trained operator to ensure proper operation. In addition, this type of treatment is not as effective for the wastes present at the NSWCWODET sites as other technologies such as air stripping. Biological treatment will be adversely affected by the high concentrations of chlorinated organics at most of the sites. Biological treatment has many uncertainties with respect to its removal efficiencies. Due to the uncertainties in

effluent quality and the high level of maintenance required, biological treatment will not be considered further.

3.6.5.3 Chemical Treatment

Chemical treatment involves a chemical addition process to detoxify a waste stream by altering the chemical makeup. This chemical reduction of contaminant load can be achieved by several processes, including oxidation, ultraviolet (UV)/ozone, and reduction.

Chemical oxidation involves detoxification of organic wastes by raising the oxidation state of selected constituents. Ultraviolet/ozone oxidation involves degradation of wastes by irradiation with UV light, reaction with ozone and/or hydrogen peroxide. The ozone acts as a strong oxidant on waste constituents converting them to higher oxidation states at high rates. Although UV/ozone treatment would probably be effective on the contaminants at the NSWCWODET sites, they are extremely costly.

Ion exchange is a process whereby contaminant ions (metals and some organics) are removed from the aqueous phase by being exchanged with innocuous ions held by the ion exchange resin. This process requires a resin contact bed with acid, alkali or salt solutions, and regeneration of the contact resin.

No chemical treatment will receive further consideration for the NSWCWODET sites because of the high costs and level of maintenance associated with these technologies.

3.7 DESCRIPTION AND INITIAL SCREENING OF SOIL/SEDIMENT AND SOURCE REMEDIAL TECHNOLOGIES

3.7.1 No-Action

The no-action technology, by definition, involves no remedial action at a site, and therefore would have no technological impediments. The potential effects from contamination present at a site to human health and the environment, if any, would not be mitigated. By definition, there would be no institutional constraints to implement no-action, however, no-action would not reduce the risk to the environment or human health from media identified in the risk assessment. No-action might be appropriate for sites not identified as a risk.

No-action with sampling is essentially the present status of the site. A sampling program for each site was established during the RI to provide, where applicable, for

sampling and analysis of soils and sediments. The soil/sediment sampling program has produced a data base which was used during the RI to determine the extent and nature of soil/sediment contamination at NSWCWODET. At site locations where no remedial action is selected, the correlation of data obtained from future sampling and analysis will help to track the spread of contamination and to identify the point at which further action may be necessary. The no-action response would leave source materials, such as drums containing hazardous wastes, in place and potentially could continue to allow discharge of contaminants to the environment.

3.7.2 Containment

Containment is a method of soil/sediment control which reduces the possibility of further physical contact with contaminated media and the potential of groundwater contamination. Containment includes covering the contaminated area with an impermeable barrier to prevent infiltration and leachate formation. In addition, capping is a very effective option to prevent migration of contaminated dust particles or sediment in storm water runoff.

3.7.2.1 Capping

Capping is discussed in Section 3.6.2.1. Containment of the contaminated soils/sediments, especially at landfills such as Sites 2 and 3, could sufficiently mitigate most environmental risk from a site. Capping could also be appropriate at other sites (Sites 4, 7, and 8) where wastes are left in place. Historically, capping is a less expensive alternative compared to other technologies and would be effective at any site with surficial soil contamination.

3.7.2.2 Surface Water Diversion

Diversion channels are used to intercept runoff or reduce slope length and to collect and transfer diverted water off-site. Channels could be lined with concrete or half round pipes to prevent sediment migration. Types of surface water diversion channels include: earthen channels, corrugated metal pipe (CMP), and concrete channels. CMP channels can be constructed by placing half-round pipe below grade. Half-round pipe channels are easier to install and have lower maintenance costs than earthen channels. Additionally, infiltration into the site is minimized. As with earthen channels, half-round channels may be

constructed on the perimeter of a waste site and moved as needed to protect other portions of the waste site.

Stream sediments could be contained by the use of surface water diversion channels. Surface water diversion channels could reroute storm water away from contaminated areas and would prevent runoff from transporting contaminants to streams and would reduce further increase in contaminant levels in sediments. Water diversion channels are effective options at sites that have contaminated stream sediments that are migrating. The sediment in the stream at Site 2 is the only contaminated stream sediment requiring remedial action. However, because the contamination requiring remedial action is limited to a very small area, this technology would not be cost effective and will not be developed further.

3.7.3 Collection: Excavation and Removal

Excavation and removal of contaminated soils, sediments, and source materials is effective and implementable at almost all RI sites. Application of this technology can be accomplished with conventional heavy construction equipment and would be followed by treatment and/or disposal of the contaminated media. The excavated areas would next be backfilled with clean or treated materials, regraded, and revegetated. The untreated soil, sediment or buried waste materials could be transported to an approved treatment facility in accordance with applicable federal, state, and local regulations, policy and standards, or treated on-site. Following excavation, remaining contaminated media could be remediated using other technologies.

Environmental and public health risks that may be encountered during excavation and removal activities include:

- Potential worker exposure via inhalation and contact to source materials and contaminated soils/sediments during excavation.
- Spillage of source materials and contaminated soils/sediments during transport.
- Migration of contaminants off-site by volatilization during excavation.
- Spillage resulting from contact of storm water runoff with exposed soils/sediments during excavation.
- Spillage resulting from exposure of unstable decomposed refuse during excavation operations.

- Spillage of source materials and contaminated soils/sediments during excavation and (i.e., puncturing a container containing a hazardous material).
- Migration of contaminants through contamination of vehicles removing and transporting wastes.

Proper excavation techniques, environmental controls, and monitoring programs could mitigate many of the risks created during excavation and removal activities. Collection and removal of contaminated materials followed by an appropriate treatment is an effective remedial action for most of the RI sites. From a cost consideration, it is also an inexpensive option. Excavation and removal is effective in most cases where contaminated soils and sediments are present.

3.7.4 Direct Treatment

Treatment technologies considered for soil, sediment, and hazardous substance remediation are described in this section. Only proven technologies for the types of contaminated materials at NSWCWODET were evaluated. The waste at NSWCWODET is a combination of municipal and industrial waste consisting of a wide variety of materials, including solid objects (i.e., torpedo casings, scrap metal, etc.) which may require decontamination and disposal. Available technologies providing the greatest degree of treatment possible have been given priority as outlined in SARA. Excavation, consolidation, and transportation would be required for off-site treatment of solids.

3.7.4.1 Thermal Treatment

Thermal treatment can be implemented either at high (exceeding 200°F) or low (below 200°F) temperatures. Since the organics found at the NSWCWODET site have a relatively low boiling point, it would be possible to decontaminate the soil using a low temperature thermal desorption process. Mobile desorption units can be easily transported and set up at a site, this technology will be considered in conjunction with on- or off-site disposal.

<u>Low Temperature Thermal Treatment</u>

Low temperature thermal desorption uses heaters to raise the temperature of the soil to volatilize the contaminants. This technology is a significant improvement on kiln-based incinerators, providing better control of residence time, soil temperature, as well as

minimization of fines carryover. As opposed to incineration, thermal desorption does not thermally oxidize (burn) the contaminants, but instead heats them only to the temperature necessary to drive them into the vapor phase and out of the soil. By minimizing both the maximum process temperatures and the temperature that must be achieved by the soil, this technology minimizes the chance of forming toxic by-products and maximizes equipment reliability. Removal efficiencies typically exceed 99 percent.

This process typically involves feeding the contaminated soil on a belt feet through the thermal desorption unit where volatilization occurs and then vaporized contaminants are condensed and captured. Water removed from the soil is typically treated and used as dust control.

Little reduction in volume occurs when using low temperature thermal desorption on soils. Residues could be used on-site as fill, depending on the waste classification or reprocessed to make asphalt.

Incineration

Thermal treatment at high temperatures, defined as incineration, generally is the only thermal treatment option offered at off-site incineration facilities. Incineration is an effective treatment for much of the solid waste materials at the NSWCWODET sites. Incineration offers essentially complete destruction of the original organic waste. The destruction and removal efficiency achieved for waste streams often exceeds 99.99 percent. Incineration also offers the additional benefit of volume reduction, thus reducing the amount of material that must ultimately be disposed. Off-site incineration involves excavation of the contaminated soils or sediments and source materials with transport to the nearest RCRA approved facility. The implementability of off-site incineration is limited by the availability of the approved incineration facilities and could be very costly.

A mobile on-site incinerator is an option for reducing the volume of excavated soils and destruction of the organics present. On-site thermal treatment involves a potentially high operation and maintenance cost associated with developing an incinerator to handle the type and volume of solid waste present. Testing of the residual ash would be required to determine if an approved landfill would be necessary for disposal. However, it is very unlikely that approval of an on-site incinerator could be obtained due to permitting restrictions and expected community opposition.

Summary of Thermal Treatment Technologies

On-site low temperature thermal desorption and off-site incineration are acceptable and common practices for soil and sediment treatment and may be practical for the NSWCWODET sites and will be evaluated further. However, because of the lack of previous studies on the efficiency of thermal treatment of soils containing explosive residuals, this technology will not be evaluated for Site 7.

3.7.4.2 Biological Treatment

Biological treatment utilizes bacteria which can be used to degrade a wide range of organic waste constituents. Bacterial growth or inhibition is influenced by moisture, available oxygen, temperature, pH, organic matter content, and inorganic nutrient supply. Listed below are summaries of several biological treatment methods for soils and sediments.

Land Farming

Land farming consists of the excavation and controlled application of hazardous waste onto or into the surface horizon of the soil, accompanied by continued monitoring and management. Properly designed and managed land farming should accomplish treatment without contaminating runoff water, leachate water, or the atmosphere. A pilot study or treatment demonstration is required to establish that the combination of operating practices at the unit (given the natural constraints at the site, such as oil and climate) can be used to completely degrade, transform or immobilize the hazardous constituents of the wastes managed at the site.

In the land farming process, waste, soil, climate and biological activity interact as a system to degrade or immobilize the contaminants in the soil. The soil provides a suitable habitat for a diverse range or organisms which help to render a waste less hazardous. Biological action accounts for approximately 80 percent of waste degradation in soil. The type, amount and variety of decomposer organisms present in a waste amended soil are dependent on the soil moisture content, available oxygen and nutrient composition. If any of these are deficient, the land farming would require watering and/or oxygen and nutrient application at the soil surface level.

Activated Sludge

The modified activated sludge process is being adapted from conventional sewage treatment technology to treat sludges or soil slurries. This process recirculates the biomass

which allows the organisms to adapt to changes in the waste, shortening the acclimation processes.

In-situ Bioremediation

In-situ bioremediation involves the introduction of bacterial organisms to the subsurface to degrade the contaminants. The rate of bacterial degradation is affected by factors such as moisture content and organic content in the soil. This technology has become effective in the remediation of various types of contaminants to include PCBs. However, because PCB contamination is present in surface soils and shallow stream sediment, this method would not be the most effective method for PCB treatment or remediation.

Composting

Composting is a process whereby the waste is first mixed with nutrients to enhance the naturally occurring organisms. This seed material can be agricultural waste or sludge from a sewage treatment plant. The resulting mixture is placed into lined containers which may include aeration and leachate collection equipment. Air emissions containment and control may be required as well.

None of these alternatives are particularly well-proven at this time. Because of the wide variety of contaminants present at each of the sites, it may be difficult to find a method that is not hampered by some other contaminant. In addition, these methods lack the predictability required for determining effectiveness. For this reason bioremediation will not be given further consideration during the development of remedial alternatives in Section 4.0.

3.7.4.3 Physical/Chemical Treatment

This section describes the applications and restrictions of physical/chemical treatment technologies for the cleanup of hazardous waste sites. These treatment technologies are widely used in industrial waste treatment and pretreatment.

Physical treatment processes separate the waste stream by either applying physical force or changing the physical form of the waste, while chemical treatment processes alter the chemical structure of the constituents to produce a waste residue that is less hazardous than the original waste. Further, the altered constituents may be easier to remove from the waste stream. The physical/chemical treatment processes presented in this section are:

- Chemical extraction
- Soil washing
- In-situ soil flushing
- In-situ vacuum extraction
- Glycolate dechlorination
- Fixation and Immobilization

Chemical Extraction

The chemical extraction processes are used to separate contaminated sludges and soils into their respective phase fractions: organics, water and particulate solids. One demonstrated process, Basic Extraction Sludge Treatment (BEST), developed by Resources Conservation Company, has been used primarily to treat oily sludges containing hydrocarbons and other high-molecular weight organics. The process has not been used to treat soils. Another process that is available to treat aqueous waste and sludges is known as solvent extraction with liquified gas. Due to the unknown effectiveness of this method, this technology will not be developed as an alternative for the sites at NSWCWODET.

Soil Washing

The soil washing process extracts contaminants from sludge or soil matrices using a liquid medium, such as water, as the washing solution. This process can be used on excavated soils that are fed into a washing unit. The washing fluid may be composed of water, organic solvents, water/chelating agents, water/surfactants, acids, or bases, depending on the contaminant to be removed. Soil washing requires excavating the contaminated medium and washing it in a mobile treatment unit. Mobile soil washing units are commercially available, and EPA currently operates an experimental unit. Generally, this process is more effective and faster than the in-situ application (soil flushing), since greater contact and control of the soil and washing solution are achieved. This technology could potentially be utilized for treatment of volatile organic-contaminated soils at various sites at NSWCWODET.

Solvents for the washing of contaminants may include acidic aqueous solutions (e.g., sulfuric and hydrochloric acid), basic solutions (e.g., sodium hydroxide), water, and surfactants. Acidic and basic solutions are both used for metal recovery. Water can be used

to extract water soluble or water mobile volatile organics. Surfactants are used to emulsify non-soluble organics and enhance the removal of hydrophobic organic compounds. Their use to date, however, has been primarily restricted to laboratory research. The level of treatment achieved is variable and depends on the contact of the washing solution with the waste, the use of an appropriate solvent and the hydraulic conductivity of the soil.

Solvents for the washing of organics from a contaminated medium may include water or surfactants. Following contact with the medium, the washing solution must be treated and/or regenerated. Treatment of the solution usually generates a chemical sludge which also must be treated or disposed of in a proper and acceptable manner. Depending on the characteristics and volume of the sludge, it may be disposed of in landfill (RCRA or municipal), stabilized on-site or encapsulated. The washing solution could be recycled following treatment resulting in no liquid discharge. If recycling is not possible, discharge to the groundwater, surface water or local wastewater treatment plant (WWTP) would be necessary after proper treatment. Prior to any discharge, the solution would be treated to appropriate water quality discharge levels. Various contaminants at the site could potentially require the use of several solvents to ensure thorough treatment.

In-situ Soil Flushing

In contrast to soil washing, soil flushing is performed in-situ on unexcavated soils and consists of injecting a solvent or surfactant solution to enhance the contaminant solubility, resulting in increased transfer of contaminants to leachate or groundwater. The system includes extraction wells drilled in the contaminated soils zone, re-injection wells upgradient of the contaminated area, and a wastewater treatment system. The technology is often used for removal of volatile organics from permeable soils. More aggressive soil flushing involves construction of ponds or sprinklers over the contaminated zone to accelerate migration of contaminants. The off-site migration of contaminants must be prevented by incorporating proper control measures. In situ soil flushing is both innovative and contaminant-specific. It has the greatest potential for success on soils contaminated with only a few specific chemicals. For soils and sludges that are contaminated with a variety of contaminants, the effectiveness is limited, and pretreatment or post-treatment may be necessary.

Soil flushing can be utilized to wash contaminants from landfills. Water or an aqueous solution would be injected into the area of contamination and the contaminated elutriate pumped to the surface for treatment. During elutriation, sorbed contaminants are mobilized into solution by increasing the solubility, forming an emulsion, or by chemical

reaction with the flushing solution. For the contaminants found at the NSWCWODET site, the flushing solutions which may have potential use are water, surfactants, and complexing and chelating agents. In-situ soil flushing can be used in combination with other technologies such as ex-situ soil washing and thermal treatment to expedite clean-up of contaminated soils.

In-situ Vacuum Extraction

Vacuum extraction involves the removal of volatile organics from soil by a process of forced ventilation with recovery of the resulting volatile gases and vapors. Typically, injection wells extending through the vadose zone above the groundwater table are installed around and within the volatile organic-contaminated soils. Ambient air is then forced through the vadose zone by means of a high capacity blower or compressor. The volatile organics transfer from the soil to the air, and a series of recovery wells connected to a vacuum retrieve the gases. The gases are typically passed through an air-water separator to remove residual moisture and condensate, and both the resulting liquid and gaseous phases are post-treated. In some cases, groundwater pumping to achieve a cone of depression (thereby exposing a larger fraction of the vadose zone) is performed concurrently with vacuum extraction in order to remove a larger percentage of the volatile organic contamination. Vacuum extraction relies on moderate to high soil permeability to effectively conduct soil vapors toward the extraction wells.

The permeability of the soil at NSWCWODET is sufficient to allow adequate influence from a vapor extraction system. However, due to the widespread location of source areas for most of the sites, vacuum extraction will not be effective for any site.

Glycolate Dechlorination

Potassium polyethylene glycolate (KPEG) dechlorination is an innovative process used to dehalogenate certain classes of chlorinated organics in contaminated organic liquids, sludges, and soils. For example, KPEG is used on waste oils containing dioxins and diesel fuel containing PCBs, dioxins, and chlorobenzenes, and used to convert these materials into lower toxicity, water-soluble materials. The KPEG solution reacts with the chlorinated organic and displaces a chlorine molecule. This technology, developed by General Electric, uses a glycol reagent and has been demonstrated to destroy PCBs in contaminated soil to levels required by the regulations. For example, in soils containing PCBs in the range of less than 10 to 70 ppm, the contamination was reduced to meet the regulatory standard in within 1.25 to 6.25 hours. Although KPEG reduces the toxicity of the waste, it increases the

volume of waste that must be further treated. Wastewaters containing reaction materials similar to those created as a residual by the KPEG process are commonly treated by chemical oxidation, biodegradation, carbon adsorption, or incineration.

Fixation and Immobilization

Fixation and immobilization (i.e., solidification and stabilization) technologies are potentially applicable to the NSWCWODET sites in regard to their use to stabilize and/or solidify contaminants in a matrix, thereby reducing their mobility. Potentially applicable technologies include portland cement solidification and the use of other pozzolanic materials. Immobilization includes a wide range of on-site treatment techniques designed to reduce the rate of release of contaminants from the soils so that resultant concentrations are held within acceptable levels. The primary immobilization methods are solidification/stabilization, adsorption, and vitrification (crystallization).

- Solidification/Stabilization - Solidification/stabilization (S/S) processes make use of a chemical reagent to stabilize organic or inorganic waste materials. Among the reagents available for S/S, lime-pozzolan based and cement based materials have proven to be the most versatile and cost effective.

  The lime-pozzolan solidification technique involves mixing wastes with hydrated lime and pozzolanic materials (siliceous or alumino-siliceous materials). Fly ash is the most common artificial pozzolan used for solidification. The resultant waste-lime-fly ash mixture sets into a solid product with reduced permeability. The materials and equipment required are readily available and are relatively low in cost.

  The disadvantages of lime-based and cement-based techniques include: (1) increased weight and volume of the final products, (2) lack of effectiveness in immobilizing certain organics, and (3) possible leaching of exposed lime and cement based products that would then require secondary containment measures.

- Vitrification (crystallization) - Vitrification is an emerging technology being developed to vitrify contaminated material into a stable glass and crystalline waste form that has chemical durability properties similar to granite. The waste is melted thermoelectrically, and any hazardous elements that escape the molten soil undergo combustion and are collected by an off-gas hood placed over the setting. This process offers numerous advantages, such as long-term stabilization (>10,000 years), applicability to varying soils and conditions, minimal occupational exposure to the waste during processing. However, because it is very costly, this technology will not be evaluated further.

Several remedial contractors have developed and implemented in-situ stabilization/ solidification processes for soils. The process uses proprietary additives delivered by innovative drilling and injection equipment. A deep soil mixing system is used for delivery of the solidifying agents.

Summary of Direct Treatment Technologies

Direct treatment could be expected to be utilized for the soil, sediments, or wastes at some of the NSWCWODET sites. Direct treatment technologies such as incineration, thermal treatment, in-situ soil flushing, soil washing, glycolate dechlorination and fixation/immobilization will be developed further in Sections 4.0 and 5.0 of the report.

3.8 DESCRIPTION OF DISPOSAL ALTERNATIVES

Three options have been identified as being potentially applicable for disposal of treated groundwater at the NSWCWODET sites. These include:

- Groundwater Reinjection
- Surface water discharge
- Discharge to POTW

Two options have been identified as being potentially applicable for disposal of treated/untreated soils and sediments. These include:

- Land Disposal (On- and off-site)
- Process Use

Each of these is described further below and developed along with the remedial alternatives in Sections 4.0 and 5.0 of this report.

3.8.1 Groundwater Reinjection

Injection wells are a potential option for the disposal of treated groundwater. Injection wells have been used with success at other contaminated sites. However, careful well design and operation and maintenance (O&M) would be critical.

The chemistry of the injection zone is of great importance when designing and operating injection wells. The potential for precipitation of iron, which will clog the well screen and surrounding aquifer zone, is high if the oxidizing states and other chemical properties of the injection zone and the treated water are different. The net result of this reaction is reduced performance of the injection well. Successful injection may require a chemical balancing of the treated water to match the in-situ groundwater and aquifer materials. Chemical comparability with the subsurface materials is another significant concern. Under certain conditions, clays may swell and reduce the permeability of the injection zone. Injection wells also require frequent redevelopment. To keep the system operational, redundant wells must be installed to accept water from any injection well which is being redeveloped. Prior to operation, each of the redundant wells must be tested in the same manner as the primary injection wells to determine their capacity to accept treated water.

Improper selection of the well location injection zone and well construction could conceivably cause the continued and exacerbated migration of contaminated groundwater. The effect of injecting water on the site cannot be evaluated or calculated without specific testing and a more in-depth characterization of the aquifer properties at each site. Testing would include pump testing each well to access its capacity for accepting treated water. Those analyses would form the basis for determining the number of injection wells required.

At this time, there are insufficient data to fully evaluate injection wells as an alternative for disposal of treated water on site. Numerous issues surround the implementation, effectiveness and cost and would have to be resolved during design and pilot testing phases of work. In addition, capital and O&M costs associated with injection wells are, in general, very high.

3.8.2 Surface Water

There are four streams located at the NSWCWODET facility that could potentially be used as discharge points for treated groundwater. A description of each of these streams is provided as follows:

- Paint Branch Creek flows through the central part of NSWCWODET. It enters the facility on the north property boundary and exits the property on the south boundary.

- An unnamed tributary of Paint Branch Creek flows south of and adjacent to site, then exits the facility at the north end of the facility and joins Paint Branch Creek approximately 1000 feet north of the facility. It appears that the majority of the water in this stream results from the discharge of process/storm water from the 100 Area industrial portion of the facility.

- An unnamed tributary to Paint Branch Creek enters along the northern facility boundary and flows west and adjacent to Sites 3 and 9. This stream exits the facility property along the southern boundary of NSWCWODET and joins Paint Branch Creek 1000 feet south of the facility.

- An intermittent stream is present along the eastern boundary of Site 9 and connects with the unnamed Paint Branch Creek tributary that flows along the western boundary of Site 9.

It is assumed that the treated groundwater, if discharged to surface water, would be discharged on the NSWCWODET property. A discharge permit (NPDES) would be required for the discharge(s) to surface water. The Maryland discharge program is regulated pursuant to the provisions of Title 9 of the Environmental Article, Annotated Code of Maryland, and regulations promulgated thereunder, and the provisions of the Clean Water Act and implementing regulations 40 CFR §122, 123, 124, and 125. The State of Maryland, Department of the Environment, is the responsible regulatory organization for the implementation of the NPDES/Maryland discharge permit program for the facility.

Discharge requirements of the NPDES/Maryland discharge permit program would be determined during design. It is assumed, for further analysis in the FS, that the best available technology would be required for treatment of the contaminated groundwater prior to surface water discharge. Discharge to the surface water would be an effective means of disposing of treated groundwater. Moderate costs would be associated with monitoring and ensuring compliance with NPDES/Maryland discharge permit requirements.

3.8.3 Discharge to POTW

The NSWCWODET facility currently discharges its industrial and sanitary wastewater to the Blue Plains Wastewater Treatment Plant, the local Publicly Owned Treatment Works (POTW). Based upon information provided by the Washington Suburban Sanitary Commission (WSSC), the governing body for all wastewater discharges in the metropolitan Washington, D.C. area, conveyance of the treated groundwater is not a practical alternative. WSSC stated that they have not accepted the discharge of treated waters from Superfund-

type operations or programs in the past and would not expect to approve a discharge of treated groundwater at the NSWCWODET facility. The discharge of treated groundwater to the POTW will not be evaluated further because implementability of this disposal option is not likely.

3.8.4 Land Disposal

On-Site

EPA guidance for on-site landfills under CERCLA requires that on-site landfills "attain or exceed applicable and relevant standards of (all) federal public health and environmental laws, unless specific circumstances dictate otherwise" (FR 29:5862-5932, 1985). With on-site disposal, contaminated soils and wastes are secured on-site. Excavated areas would be filled, regraded, and revegetated. Disposal of treated soil on-site would be the most cost effective means of disposal.

However, if wastes are determined to be hazardous wastes, RCRA requirements will serve as guidance for location, design, construction, operation and maintenance of landfill facilities. These requirements preclude landfilling of liquids and highly mobile or toxic wastes, and stipulate the use of impermeable liners. Land disposal prohibitions under RCRA may also apply to on-site landfilling of hazardous waste depending on the waste. Other factors to consider are costs of monitoring the groundwater, collection and possible treatment of any accumulated leachate, and implementation of further corrective actions if the liner fails. In addition, an on-site RCRA landfill facility will have significant institutional, environmental and economic constraints.

Off-site Landfill

The off-site disposal technology, allows source areas to be completely removed from the site by excavation, consolidation, and transportation to an approved facility. Off-site disposal includes landfilling or incineration at an approved facility. Landfilling of hazardous wastes must comply with RCRA and state regulations. The increasing regulatory control over landfilling is causing this technology to become increasingly more expensive. The 1984 Hazardous and Solid Waste Amendments to RCRA also established a schedule for banning the landfilling of several classes of RCRA wastes. This schedule has been published in 40 CFR 268 and requires an evaluation of each RCRA waste to determine if land disposal prohibition are appropriate. The application of these land disposal prohibitions is expected to significantly affect the ability to utilize off-site RCRA facilities for disposal of waste at

Superfund sites. Off-site transport and disposal of untreated wastes is the least preferred alternative under SARA where practicable treatment technologies are available. SARA requires that priority be given to remedial action alternatives in which treatment permanently or significantly reduces volume, toxicity or mobility of hazardous substances. In addition, the costs associated with off-site disposal/rehandling of contaminated wastes could be very high. Therefore, off-site disposal of untreated wastes should be regarded as the least attractive alternative for a site cleanup. At the NSWCWODET sites, disposal of untreated contaminated soils and waste is a feasible option only if an acceptable permitted treatment facility can be identified with the capacity to accept them. However, if soils and sediments are treated on-site (i.e., thermal treatment or soil washing), off-site disposal at a RCRA Subtitle C or D landfill could become a more costly and impractical remedial alternative.

3.8.5 Process Use

Some treated/untreated soils and sediments could potentially be used in a process such as using soil contaminated with low levels of hydrocarbons to make asphalt or in cement kilns. However, based on the types of contaminants present in the soils and sediments (i.e., metals, PCBs, nitroaromatics and volatile organics), it is not feasible to assume that there will be much of a market or use for these soils. This disposal option will not be evaluated further.

3.9 SUMMARY OF PRELIMINARY SCREENING

Preliminary technologies were evaluated based on effectiveness, implementability, and cost. A summary of these evaluations is provided in Table 3-8. Only those technologies that have site applicability (listed in last column of table) will be evaluated further in Section 4.0 during the development of remedial alternatives for each site.

TABLE 3-8

SUMMARY OF REMEDIAL TECHNOLOGIES SCREENING

MEDIA	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGIES	PRELIMINARY EVALUATION CRITERIA			SITE APPLICABILITY
			EFFECTIVENESS	IMPLEMENTABILITY	COST (Capital/O&M)	
Ground Water	No Action	No action	Does not restrict plume	Is implementable	Low/Low	All Sites
	Containment	Caps or surface seals	Effective for reducing rainwater infiltration	Is implementable	Mod/Low	2,3,4,8
		Sheet piling, grouting, and slurry walls	Ineffective because system will not control contaminant migration	Is implementable	High/Low	None
	Collection	Extraction and pumping wells	Effective for collection of groundwater contaminants	Is implementable	Mod/Mod	3,4,7,8,9,11
		Leachate collection system	Effective for leachate collection however efficiency is reduced when cap is installed.	Is implementable	Mod/Low	None
	Treatment	Extraction with sedimentation	Effective for metals only	Is implementable	Mod/Mod	None
		Precipitation/flocculation	Effective for suspended solids and metals only	Is implementable	Mod/High	None
		Coagulation	Effective for suspended solids only	Is implementable	Mod/Mod	None
		Activated Carbon	Effective for volatiles and nitroaromatics	Is implementable	Mod/High	3,4,7,8,9,11
		Air stripping	Effective for volatiles	Is implementable but may require an air permit	Mod/Mod	3,4,8,9,11
		Air sparging	Effective for volatiles	Is implementable	Mod/Mod	None
		Filtration	Effective for suspended solids only	Is implementable	Mod/Mod	None
		Biological Organisms	Not effective for contaminants	Is implementable	Mod/Mod	None
		Neutralization	Not effective for contaminants	Is implementable	Mod/Mod	None
		Oxidation/reduction	Not effective for contaminants	Is implementable	High/High	None
		Ion exchange	Not effective for all contaminants	Is implementable	High/High	None
		Ozonation	Not effective for all contaminants	Is implementable	High/High	None

TABLE 3-8
(Continued)

MEDIA	GENERAL RESPONSE	REMEDIAL TECHNOLOGIES	PRELIMINARY EVALUATION CRITERIA			SITE APPLICABILITY
			EFFECTIVENESS	IMPLEMENTABILITY	COST (Capital/O&M)	
Sediment and soil	No Action	No Action	Does not control soil contaminants	Is implementable	Low/Low	All sites
	Containment	Landfill caps and surface seals	Effective for reducing infiltration	Is implementable	Mod/Low	2,3,4,7,8
		Diversion channels and pipes	Effective for reducing migration	Is implementable	Low/Low	None
	Collection	Excavation	Effective for contaminant control	Is implementable	Mod/Low	2,4,7,8,9,11
	Treatment	Soil thermal treatment/incineration	Effective for most soil contaminants	Is implementable	High/Mod	2,4,8,9,11
		In-situ vacuum extraction	Effective for volatiles	Is implementable	Mod/Mod	None
		Chemical extraction	Uncertain of effectiveness	Is implementable	Mod/Mod	None
		Soil washing	Effective for organics	Is implementable	Mod/Mod	2,4,7,8,9,11
		In-situ soil flushing	Effective for organics	Is implementable	Mod/Mod	7
		Chemical and silicate fixatives	Effective for most contaminants	Is implementable	Mod/Mod	7
		Vitrification	Not proven technology	Is implementable	High/Low	None
		Glycolate dechlorination	May be effective for PCB treatment	Is implementable	High/Low	2
		In-situ bioremediation	Uncertain of effectiveness	Is implementable	Mod/Low	None
Sources	No Action	No Action	Does not control source	Is implementable	Low/Low	All sites
	Containment	Landfill caps and surface seals	Effective for reducing migration	Is implementable	Mod/Low	2,3,4,7,8
	Collection	Excavation	Effective for source control	Is implementable	High/Low	4,7,8,9,11
Treated Ground Water	Disposal	Groundwater Reinjection	Effective	Is implementable but state approval difficult	High/High	None
		Surface Water Discharge	Effective	Is implementable with NPDES permit	Mod/Low	3,4,7,8,9,11
		Discharge to POTW	Effective	WSSC will not approve	Low/Low	None
Treated/ Untreated Soil	Disposal	On-site land disposal	Effective, but treatment may be required	Is implementable	Low/Low	2,4,7,8,9,11
		Off-site Landfill	Effective, but treatment may be required	Is implementable	High/Low	2,4,7,8,9,11
		Process	Not effective for certain contaminants	Not implementable	Mod/Mod	None

4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

4.1 INTRODUCTION

In this section, the technologies identified and qualitatively screened according to their effectiveness, implementability and cost in Section 3.0 will be assembled and developed into alternatives on a site-specific basis and then screened based on their effectiveness, implementability and cost. The applicability of the technologies to each site was discussed in the previous section and summarized in Table 3-6. The development of remedial alternatives is based on the site conditions and human health and environmental concerns discussed in the preceding section and in the Remedial Investigation (RI) Report and risk assessment. The intent of the development of alternatives is to satisfy the remedial action objectives developed from the risk assessment analyses.

4.2 SITE 2 - APPLE ORCHARD LANDFILL

The nature and extent of contamination and the fate and transport mechanisms of contaminants in the environment were investigated during the RI. Based on data obtained during the RI, the following findings regarding contaminant transport were noted:

- Polychlorinated Biphenyl (PCB)-contaminated soil is migrating via surface runoff from the landfill surface area to the adjacent stream especially in the area to the west of the landfill. Runoff has contaminated the landfill surface, landfill face surrounding the landfill and the stream sediment adjacent to the landfill.

- PCB-contaminated sediment is migrating in the stream via sediment transport in a downstream pattern. Migration is thought to occur during heavy rain events as a result of increased velocity and turbulence during storm events.

Due to the complexity of this site, many technologies may be effective and implementable. Based on the applicability of technologies presented in Section 3.0, the following technologies will be considered for development into alternatives for Site 2. These technologies will be evaluated based on their effectiveness, implementability and cost.

General Response Action	Technology
No action	No action with continued monitoring
Soil/buried waste containment	Topsoil cover Clay cap Synthetic/soil cover
Sediment collection	Excavation
Sediment treatment	Incineration Thermal treatment Soil washing Glycolate dechlorination
Treatment residue disposal	On-site Off-site chemical waste landfill
Sediment disposal (no treatment)	Off-site chemical waste landfill

4.2.1 Soil/Buried Waste Remediation Alternatives

4.2.1.1 No Action

As required by the National Contingency Plan (NCP), no action for the site will be considered as an alternative. The No Action alternative involves baseline and periodic monitoring of selected media. Continued monitoring permits tracking of contaminant migration; however, it does not control migration of contaminants in the soil, prevent surface runoff which carries PCB-contaminated soil particles, or reduce leachate generation through infiltration prevention.

Under a No Action scenario, monitoring would be conducted on a periodic basis to evaluate the concentration of contaminants in the soil. Samples would be collected from numerous locations from the landfill surface and face on a semi-annual basis to determine any additional migration of PCB contaminants through surface runoff. Soil samples will be analyzed for PCBs since they are the only chemicals of concern in this media.

Capital costs of implementing the No Action alternative are $11,000 and would be limited to developing a detailed sampling and analysis plan. Annual operation and maintenance (O&M) costs are estimated to be $5,000 per year and include labor to obtain samples and analytical costs associated with sampling the surface soils. Total present worth

costs for this alternative are estimated at $62,000. Cost estimates and key assumptions used to conduct the cost estimating for each site are provided in Appendix A.

4.2.1.2 Containment

Containment may involve various capping/covering technologies. Covering typically constitutes placing one or more layers of clean material over the contaminated soils/fill to either reduce infiltration of precipitation and/or prevent direct contact, and to prevent the erosion and transport of contaminated particles. Because Site 2 is a landfill, this technology will be considered for this site. Evaluation of various cover technologies is presented in the following subsections. The area of the landfill surface and face to be capped is estimated at 57,000 square feet. However, because the face of the landfill has a steep slope that is not acceptable for capping, regrading with potential relocation of some material may be required so that a cap can be installed. The surface area to be capped is expected to increase to approximately 67,000 square feet.

Topsoil Cover

A topsoil cover would consist of an approximate 6-inch thick layer of topsoil which would be placed over the contaminated soils and landfill and seeded to promote vegetative growth for erosion control and evapotranspiration. Site preparation for the cap would include significant grading efforts to reduce the steep slopes on several sides of the landfill. Additional fill material may be require to develop acceptable grades on all sides of the landfill. Removal of trees and brush would be required along the landfill face for construction of the cap. During this stage of construction, erosion and sediment control measures would be maintained to prevent further migration of PCB-contaminated soils due to runoff. The topsoil cover will be constructed over the surface area of the landfill and around the face of the landfill. After the landfill is graded for installation of the cap, a topsoil cover will be installed.

Effectiveness

A topsoil cover placed over the landfill would be effective in preventing direct human contact with PCB-contaminated surface soils and in preventing the surface runoff of contaminated particles to the adjacent stream. However, infiltration of precipitation would not be prevented, potentially resulting in leachate generation with discharge of contaminants to groundwater or surface water. The effectiveness of a topsoil cover is only maintained if the integrity of the cover can be well maintained.

Implementability

Placement of a topsoil cover following clearing and grading would pose no substantial difficulties. Although the topsoil cover meets most of the needs for containment of contaminated soils, it does not prevent leachate which could be generated at the site and further impact groundwater quality. Therefore, this technology does not pass the initial screening and will not be retained for further detailed analysis.

Cost

Capital and engineering costs for construction of the topsoil cover over the entire landfill surface and face is estimated at $300,000. Annual O&M costs are estimated at $5,000 per year. Total present worth costs for this alternative are estimated at $351,000. Cost estimates for completion of the cover are provided in Appendix A.

Clay Cap

This cap is typically used for non-hazardous waste landfills where a clay source is available. A description of the layer composition is presented in Section 3.6.2.1. Site preparation would be the same as described for the topsoil cover. The clay cover will be constructed over the surface area of the landfill and around the face of the landfill. After the landfill is graded for installation of the cap, a clay cover will be installed.

Effectiveness

A clay cover placed over the landfill would be effective in preventing direct human contact with PCB-contaminated surface soils and in preventing the surface runoff of contaminated particles to the adjacent stream. However, infiltration of precipitation would be decreased but not prevented potentially resulting in leachate generation with discharge of contaminants to groundwater or surface water.

Implementability

Placement of a clay cover following clearing and grading would pose no substantial difficulties. Although the clay cover meets most of the needs for containment of contaminated soils, it does not prevent leachate which could be generated at the site and further impact groundwater quality. Therefore, this technology does not pass the initial screening and will not be retained for further detailed analysis.

Cost

Capital and engineering costs for construction of the clay cover over the entire landfill surface and face is estimated at $292,000. Annual O&M costs are estimated at $5,000 per year. Total present worth costs for this alternative are estimated at $343,000. Cost

estimates for completion of the cover are provided in Appendix A.

Synthetic Membrane/Soil Cover System

A synthetic membrane/soil cover system consists of a synthetic membrane barrier layer, typically 30 to 40 millimeters thick, sandwiched between layers of synthetic fabric and geogrid synthetic drainage material. The synthetic fabric functions to protect the plastic sheeting from perforation due to rocks or sharp objects. The top layer of synthetic fabric is then covered with a 6- to 12-inch layer of topsoil and is seeded to promote vegetative growth for erosion control purposes.

The purposes of the impermeable cap are to reduce human exposure to PCBs in the soils on the landfill, to eliminate infiltration from rainfall that could impact groundwater quality and reduce the amount of PCB-contaminated runoff that enters the adjacent stream. The cap will be designed and constructed to promote drainage and minimize erosion of the cover. Long-term O&M will be conducted to ensure the integrity of the cap.

Site preparation for the cap would include significant grading efforts due to the steep slopes on several sides of the landfill. Additional fill material may be require to develop acceptable grades on all sides of the landfill. Removal of trees and brush would be required along the landfill face for construction of the cap. During this stage of construction, erosion and sediment control measures would be maintained to prevent further migration of PCB-contaminated soils due to runoff. The cap will be constructed over the surface area of the landfill and around the face of the landfill.

The PCB concentration in the surface soils were less than 10 mg/kg. The USEPA guidance, "A Guide on Remedial Actions at Superfund Sites With PCB Contamination," suggests that for PCB concentrations of 1 to 10 mg/kg, long term management controls should be implemented for low levels of contamination left on-site. This management control should be in the form of a cover system to be installed to control migration and runoff. A synthetic/soil cap would meet these requirements.

Effectiveness

The synthetic/soil cover is effective in preventing erosion and contact with contaminated soils, and limiting infiltration to the buried wastes with potential discharge to groundwater or surface water. The cap will prevent further transport of contaminated runoff to the adjacent stream with PCB deposition in the sediment. Capping alone does not address the human health and environmental impacts associated with exposure to PCB in the stream sediment, and does not prevent migration of existing contaminants.

Implementability

Construction of the synthetic/soil cover could be completed without substantial implementation difficulties. Some trees and other brush may have to be removed for installation of the landfill cover. The synthetic cover passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for construction of the synthetic/soil cover over the entire landfill surface and face is estimated at $506,000. Annual O&M costs are estimated at $5,000 per year. Total present worth costs for this alternative are estimated at $557,000. Cost estimates for completion of the cover are provided in Appendix A.

4.2.2 Sediment Remediation Alternatives

These technologies include no action and excavation of PCB-contaminated sediment from the stream that flows adjacent to the landfill. The initial screening of these alternatives is as follows.

4.2.2.1 No Action

As required by the NCP, no action for the site will be considered as an alternative. The No Action alternative involves baseline and periodic monitoring of selected media. Continued monitoring permits tracking of contaminant migration; however, it does not control migration of contaminants in the sediment.

Under a No Action scenario, monitoring would be conducted on a periodic basis to evaluate the movement and concentration of contaminants in the stream sediment. Samples would be collected from numerous sediment locations along the stream on a semi-annual basis. Stream sediment samples will be analyzed for PCBs since it is the only chemical of concern in this media.

Capital costs of implementing the no action alternative would be limited to developing a detailed sampling and analysis plan (detailed costs and assumptions are provided in Appendix A) and are $11,000. Annual O&M costs include labor to obtain samples and analytical costs associated with sampling the stream sediment and are estimated to be $5,000 per year. Total present worth costs for this alternative are estimated at $62,000.

4.2.2.2 Excavation

Sediment Removal

The purpose of the sediment excavation is to reduce the amount of PCB-contaminated sediment that could migrate on- and off-site and affect human health and aquatic life, and reduce the potential for on-site human exposure to PCBs in the stream sediment. An Interim Sediment Quality Criteria (SQC) for PCB-contaminated sediment has been set at 19 milligrams per kilogram (mg/kg). Pursuant to approval of this criteria as the cleanup level for sediment at Site 2, sediment only needs to be removed in the stream on the west end of the landfill between the Naval Surface Warfare Center, Dahlgran Division Detachment, White Oak (NSWCWODET) property boundary and the confluence of the stream and the process water ditch. It should be noted that this portion of the stream is dry except during heavy rains. Shallow subsurface water is present during most of the year. To achieve cleanup to the 19 mg/kg level, it is estimated that sediment will be removed to a depth of approximately 3 feet and a width of 5 feet in the stream bed. The amount of sediment to be excavated is estimated at approximately 167 cubic yards. However, confirmation sampling will be performed to document that cleanup to the 19 mg/kg level has been accomplished. If residual contamination is at levels higher than the cleanup level, then additional excavation will be accomplished until this cleanup level is reached.

Effectiveness

Sediment removal will be effective in reducing the amount of PCB contamination that can be transported downstream, preventing human exposure to significant levels of PCBs and reducing impacts to aquatic life. Low levels of PCBs in the sediment adjacent to and downstream from the landfill will remain; however, no adverse human health or ecological impacts are expected.

Implementability

Sediment removal could be implemented with no substantial difficulties. Sediment excavation passes the initial screening and will be developed further in the detailed analysis section.

Cost

Costs for excavation of the PCB-contaminated sediment is estimated at $7,000. Cost estimates for sediment removal are provided in Appendix A.

4.2.3 Sediment Treatment Alternatives

As discussed above, approximately 167 cubic yards of PCB-contaminated sediment is estimated to require treatment on- or off-site.

4.2.3.1 Thermal Treatment/Incineration

Thermal treatment involves heating the contaminated sediment to the point where the PCBs will experience combustion, thus fully or partially oxidizing the organic contaminants. Gases and/or particulate emitted during the combustion process are typically quenched, then scrubbed or absorbed such that they can be discharged to the atmosphere. Thermal treatment may involve the use of high temperature steam to thermally destruct contaminants. Thermal treatment will be considered as an on-site treatment option. Thermal treatment at high temperatures using an oven or kiln is defined as incineration and is generally only feasible as an off-site treatment option.

<u>On-site Thermal Treatment</u>

Soils would be staged at the treatment unit prior to and after treatment. Disposal of treatment residuals could be on-site on the landfill surface or off-site in a chemical waste landfill. Disposal alternatives are discussed in Section 4.2.4.

Effectiveness

Following excavation, the contaminated sediment would be thermally treated to minimize the human health and environmental risks associated with the excavated sediment. Reduction in organic concentration can be as high as 99 percent; therefore, thermal treatment is an effective treatment method for PCB contamination.

Implementability

Equipment required for the thermal treatment of PCB-contaminated sediment would be supplied by a thermal treatment vendor. Electrical power and possibly a fuel source would need to be supplied to the process. Extensive mobilization and installation of equipment would be required. The implementation of on-site thermal treatment is technically feasible. Approval of on-site treatment (permit may be required) will be the most difficult implementation facet of this remedial action. Based on the effectiveness and implementability of thermal treatment, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Costs for on-site thermal treatment of the PCB-contaminated sediment is estimated at $31,000. Cost estimates for sediment thermal treatment are provided in Appendix A.

Off-site Incineration

Off-site treatment with incineration would involve transport of contaminated sediment to the off-site treatment facility.

Effectiveness

Following excavation, contaminated sediment would be transported to an off-site facility for treatment by incineration. Transport of untreated contaminated sediment may increase the risks to human health and the environment due to the potential release of the soils to the environment via accidental spillage. The effectiveness of incineration was previously discussed.

Implementability

The implementability of excavation has been previously discussed. The implementation of off-site incineration is technically feasible. Off-site transport may required proper manifesting (hazardous or special waste).

Cost

Costs for off-site incineration of the PCB-contaminated sediment is estimated at $776,000. Cost estimates for sediment incineration are provided in Appendix A. Based on the extremely high costs of incineration, this technology does not pass the initial screening and will not be retained for further detailed analysis.

4.2.3.2 Soil Washing

Soil washing requires excavating contaminated sediment and washing it in a mobile washing unit. The washing fluid can be water, organic solvents, surfactants, etc. More detailed description on operation of the unit can be found in Section 3.7.4.3.

On-site Soil Washing

Excavated sediment would require staging at the treatment unit prior to and after soil washing awaiting final disposition.

Effectiveness

Following excavation, the contaminated sediment would receive soil washing to minimize the human health and environmental risks associated with the excavated sediment. Reduction in PCB concentration can be as high as 90 percent; therefore, soil washing is an

effective treatment method for PCB contamination.

Implementability

Mobile equipment required for the washing of PCB-contaminated sediment would be supplied by a vendor. Electrical power and possibly a fuel source would need to be supplied to the process. Extensive mobilization and installation of equipment would be required. The implementation of on-site soil washing is technically feasible. Approval of on-site treatment (permit may be required) will be the most difficult implementation facet of this remedial action. Based on the effectiveness and implementability of soil washing, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Costs for on-site soil washing of the PCB-contaminated sediment is estimated at $88,000. Cost estimates for sediment washing are provided in Appendix A.

Off-Site Soil Washing

Off-site treatment with soil washing would involve transport of sediment to the off-site treatment facility.

Effectiveness

Following excavation, contaminated sediment would be transported to an off-site facility for treatment by soil washing. Transport of untreated contaminated sediment may increase the risks to human health and the environment due to the potential release of the soils to the environment via accidental spillage. The effectiveness of soil washing was previously discussed.

Implementability

The implementability of excavation has been previously discussed. The implementation of off-site soil washing is technically feasible. Off-site transport may required proper manifesting (hazardous or special waste). Based on the effectiveness and implementability of soil washing, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Costs for off-site soil washing of the PCB-contaminated sediment is estimated at $104,000. Cost estimates for sediment washing are provided in Appendix A.

4.2.3.3 Glycolate Dechlorination

Potassium polyethylene glycolate (KEPG) dechlorination is an innovative process used to dehalogenate certain classes of chlorinated organics include PCBs. This technology has been demonstrated to destroy PCBs in contaminated soil. Further details on this process are presented in Section 3.7.4.3.

On-site Dechlorination

Excavated sediment would require staging at the treatment unit prior to and after glycolate dechlorination.

Effectiveness

Following excavation, the contaminated sediment would be placed in a mobile unit to dechlorinate the PCBs to minimize the human health and environmental risks associated with the excavated sediment. Reduction in PCB concentration can be as high as 90 percent; therefore, KEPG dechlorination is an effective treatment method for PCB contamination.

Implementability

Mobile equipment required for the dechlorination of PCB-contaminated sediment would be supplied by a vendor. However, due to the extensive amount of mobilization and equipment installation requirements in conjunction with the small amount of sediments that require treatment, this technology is not feasible for this site. Based on the implementability problems, this technology does not pass the initial screening and will not be retained for further detailed analysis.

Cost

Costs for on-site dechlorination of the PCB-contaminated sediment is estimated at $101,000. Cost estimates for sediment dechlorination are provided in Appendix A.

Off-site Glycolate Dechlorination

Off-site treatment with glycolate dechlorination would involve transport of contaminated sediment to the off-site treatment facility.

Effectiveness

Following excavation, contaminated sediment would be transported to an off-site facility for treatment by dechlorination. Transport of untreated contaminated sediment may increase the risks to human health and the environment due to the potential release of the soils to the environment via accidental spillage. The effectiveness of dechlorination was previously discussed.

Implementability

Due to the lack of permanent off-site dechlorination facilities, this technology is not feasible for this site. This technology does not pass the initial screening and will not be retained for further detailed analysis.

Cost

Costs for off-site glycolate dechlorination of the PCB-contaminated sediment were not estimated due to the lack of permanent off-site dechlorination facilities to conduct the treatment.

4.2.4 Sediment Disposal Alternatives

On-site Treatment Residue Disposal

The PCB concentration in the residue would be expected to be less than 10 mg/kg for all of the treatment processes discussed above. All treatment processes will generate a waste stream that contains the majority of the PCB contamination that was removed from the sediment during the treatment process. These wastes will be further treated or disposed of properly off-site. Only the residual ash or sediment from the treatment process will be evaluated for disposal in this section. Approximately 167 cubic yards of treatment residue is expected to require disposal. The USEPA guidance, "A Guide on Remedial Actions at Superfund Sites With PCB Contamination", suggests that for PCB residues of concentration 1 to 10 mg/kg a cover system be installed to control migration and runoff. The placement of the treatment residues on the landfill surface prior to capping would be consistent with these recommendations.

Effectiveness

On-site disposal onto the surface of the landfill (landfill to be capped) would be an effective method of PCB treatment residue disposal. The PCB concentration of the residue would be less than existing in-situ PCB contamination. Human health exposure to treatment residue would be eliminated. Even with the absence of a leachate collection system for the landfill, there is little potential for subsurface migration of PCBs due to their sorption characteristics and the presence of an impermeable cap.

Implementability

The disposal of treatment residue on the landfill surface could be implemented with no substantial difficulties. Approval of on-site disposal (permit may be required) will be the most difficult implementation facet of this remedial action. Based on the effectiveness and

implementability of disposal of treatment residue on the landfill surface prior to capping, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Costs for on-site disposal of the treatment residuals are estimated at $5,000. Cost estimates are provided in Appendix A.

Off-site Treatment Residue Disposal

The PCB concentration in the residue would be expected to be less than 10 mg/kg for all of the treatment processes discussed above. Approximately 167 cubic yards of treatment residue will require disposal. The USEPA guidance, "A Guide on Remedial Actions at Superfund Sites With PCB Contamination," suggests that for PCB residues of concentration 1 to 10 mg/kg a cover system be installed to control migration and runoff. The placement of the treatment residues in an industrial waste or RCRA landfill would be consistent with these recommendations.

Effectiveness

Off-site disposal in an approved landfill would be an effective method of PCB treatment residue disposal. Human health exposure to treatment residue would be eliminated. There is little potential for subsurface migration of PCBs due to their sorption characteristics and the presence of an impermeable cap on the approved landfill.

Implementability

The disposal of treatment residue in an approved landfill could be implemented with no substantial difficulties. Based on the effectiveness and implementability of disposal of treatment residue in an approved landfill, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Costs for off-site disposal of the treatment residuals are estimated at $101,000. Cost estimates are provided in Appendix A.

Off-site Sediment Disposal

The average PCB concentration in the sediment is expected to be approximately 50 mg/kg. Approximately 167 cubic yards of sediment will require disposal. The USEPA guidance, "A Guide on Remedial Actions at Superfund Sites With PCB Contamination," suggests that PCB-contaminated sediment can be placed in a chemical waste landfill. Pursuant to TSCA regulations (40 CFR 761.60(a)(4)), PCB-contaminated soil with concentrations greater than 50 mg/kg can be disposed of in a chemical waste landfill.

Effectiveness

Off-site disposal in an approved landfill would be an effective method of PCB - contaminated soil disposal. Human health exposure to contaminated sediment would be eliminated. There is little potential for subsurface migration of PCBs due to their sorption characteristics and the presence of an impermeable cap and leachate collection system on the chemical waste landfill.

Implementability

The disposal of PCB-contaminated sediment in an approved landfill could be implemented with no substantial difficulties. Based on the effectiveness and implementability of disposal of sediment in a chemical waste landfill, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Costs for off-site disposal of the contaminated sediment is estimated at $111,000. Cost estimates are provided in Appendix A.

4.2.5 Summary

A range of alternatives was developed for this site using the technology type evaluations previously described. These alternatives are listed below and will be further evaluated in the detailed analysis section.

Soil Remediation Alternatives

Alternative 1 - No Action with continued monitoring

Alternative 2 - Synthetic/soil cap with regrading and revegetation

Sediment Remediation Alternatives

Alternative 1 - No Action with continued monitoring

Alternative 2 - Excavation with off-site sediment disposal in landfill

Alternative 3 - Excavation with on-site thermal treatment and on-site disposal

Alternative 4 - Excavation with on-site thermal treatment and off-site disposal

Alternative 5 - Excavation with on-site soil washing and on-site disposal

Alternative 6 - Excavation with on-site soil washing and off-site disposal

Alternative 7 - Excavation with off-site soil washing and off-site disposal

4.3 SITE 3 - PISTOL RANGE LANDFILL

The nature and extent of contamination and the fate and transport mechanisms of contaminants in the environment were investigated during the RI. Based on data obtained to date, the following findings regarding contaminant transport were noted:

- The shallow groundwater quality has been impacted through leachate generation from the landfill. Trans-1,2-dichloroethene and trichloroethene were identified as chemicals of potential concern in the groundwater that potentially may have adverse effects in humans.
- Metal contamination was detected in surface soils on the face of the landfill which could impact stream sediment and surface water quality. However, significant levels of these metals were not detected in the stream.

Due to the complexity of this site, many technologies may be effective and implementable. Based on the applicability of technologies presented in Section 3.0, the following technologies will be considered for development into alternatives for Site 3. These technologies will be evaluated based on their effectiveness, implementability and cost.

General Response Action	Technology
No action	No action with continued monitoring
Soil/buried waste containment	Topsoil cover Clay cap Synthetic/soil cover
Groundwater collection	Extraction wells
Groundwater treatment	Air stripping Activated carbon
Treated groundwater disposal	Discharge to surface water

4.3.1 Soil/Buried Waste Remediation Alternatives

4.3.1.1 No Action

As required by the NCP, no action for the site will be considered as an alternative. The No Action alternative involves baseline and periodic monitoring of selected media. Continued monitoring permits tracking of contaminant migration; however, it does not control migration of contaminants in the soil, prevent surface runoff which carries contaminated soil particles or eliminate leachate generation through prevention of infiltration.

Under a No Action scenario, monitoring would be conducted on a periodic basis to evaluate the concentration of contaminants in the soil. Samples would be collected from numerous locations from the landfill surface/face and adjacent stream sediment on a semi-annual basis to determine any additional migration of contaminants through surface runoff. Soil samples will be analyzed for metals (cadmium, copper, lead, mercury and zinc) since they are the chemicals of concern in this media.

Capital costs of implementing the no action alternative would be limited to developing a detailed sampling and analysis plan (detailed costs and assumptions are provided in Appendix A) and are $11,000. Annual O&M costs include labor to obtain samples and analytical costs associated with sampling the surface soils and are estimated to be $5,000 per year. Total present worth costs for this alternative are estimated at $72,000.

4.3.1.2 Containment

Containment may involve various capping/covering technologies. Covering typically constitutes placing one or more layers of clean material over the contaminated soils/fill to either reduce infiltration of precipitation and/or prevent direct contact, and prevent the erosion and transport of contaminated particles. Because Site 3 is a landfill, this technology will be considered for this site and evaluation of various cover technologies is presented in the following subsections. The area of the landfill surface and face to be capped is estimated at 40,000 square feet. However, because the face of the landfill has a steep slope that is not acceptable for capping, regrading with potential relocation of some material may be required so that a cap can be installed. The surface area to be capped is expected to increase to an estimated 52,000 square feet.

Topsoil Cover

A topsoil cover would consist of an approximate 6-inch thick layer of topsoil which would be placed over the contaminated soils and landfill and seeded to promote vegetative growth for erosion control and evapotranspiration. Site preparation for the cap would include significant grading efforts due to the steep slopes on several sides of the landfill. Additional fill material may be require to develop acceptable grades on all sides of the landfill. Removal of trees and brush would be required along the landfill face for construction of the cap. During this stage of construction, erosion and sediment control measures would be maintained to prevent further migration of metal-contaminated soils due to runoff. The topsoil cover will be constructed over the surface area of the landfill and around the face of the landfill. After the landfill is graded for installation of the cap, a topsoil cover will be installed.

Effectiveness

A topsoil cover placed over the landfill would be effective in preventing direct human contact with contaminated surface soils and in preventing the surface runoff of contaminated particles to the adjacent stream. However, infiltration of precipitation would not be prevented, resulting in leachate generation with discharge of contaminants to groundwater or surface water. The effectiveness of a topsoil cover is only maintained if the integrity of the cover can be well maintained.

Implementability

Placement of a topsoil cover following clearing and grading would pose no substantial difficulties. Although the topsoil cover meets most of the needs for containment of contaminated soils, it does not prevent leachate which has been generated at the site and greatly impacted groundwater quality. Therefore, this technology does not pass the initial screening and will not be retained for further detailed analysis.

Cost

Capital and engineering costs for construction of the topsoil cover over the entire landfill surface and face is estimated at $230,000. Annual O&M costs are estimated at $5,000 per year. Total present worth costs for this alternative are estimated at $291,000. Cost estimates for completion of the cover are provided in Appendix A.

Clay Cap

This cap is typically used for non-hazardous waste landfills where a clay source is available. A description of the layer composition is presented in Section 3.6.2.1. Site

preparation would be the same as described for the topsoil cover. The clay cover will be constructed over the surface area of the landfill and around the face of the landfill. After the landfill is graded for installation of the cap, a clay cover will be installed.

Effectiveness

A clay cover placed over the landfill would be effective in preventing direct human contact with contaminated surface soils and in preventing the surface runoff of contaminated particles to the adjacent stream. However, infiltration of precipitation would be decreased but not prevented potentially resulting in leachate generation with discharge of contaminants to groundwater or surface water.

Implementability

Placement of a clay cover following clearing and grading would pose no substantial difficulties. Although the clay cover meets most of the needs for containment of contaminated soils, it does not prevent leachate which has been generated at the site and impacted groundwater quality. Therefore, this technology does not pass the initial screening and will not be retained for further detailed analysis.

Cost

Capital and engineering costs for construction of the clay cover over the entire landfill surface and face is estimated at $224,000. Annual O&M costs are estimated at $5,000 per year. Total present worth costs for this alternative are estimated at $285,000. Cost estimates for completion of the cover are provided in Appendix A.

Synthetic Membrane/Soil Cover System

A synthetic membrane/soil cover system consists of a synthetic membrane barrier layer, typically 30 to 40 millimeters thick, sandwiched between layers of synthetic fabric and geogrid synthetic drainage material. The synthetic fabric functions to protect the plastic sheeting from perforation due to rocks or sharp objects. The top layer of synthetic fabric is then covered with a 6- to 12-inch layer of topsoil and is seeded to promote vegetative growth for erosion control purposes.

The purposes of the impermeable cap are to reduce the amount of infiltration from rainfall that could impact groundwater quality and reduce the amount of metal-contaminated runoff that potentially could enter the adjacent stream. The cap will be designed and constructed to promote drainage and minimize erosion of the cover. Long-term O&M will be conducted to ensure the integrity of the cap.

Site preparation for the cap would include significant grading efforts due to the steep slopes on several sides of the landfill. Additional fill material may be require to develop acceptable grades on all sides of the landfill. Removal of trees and brush would be required along the landfill face for construction of the cap. During this stage of construction, erosion and sediment control measures would be maintained to prevent further migration of contaminated soils due to runoff. The cap will be constructed over the surface area of the landfill and around the face of the landfill.

Effectiveness

The synthetic/soil cover is effective in preventing erosion and contact with contaminated soils, and limiting infiltration to the buried wastes with potential discharge to groundwater or surface water. The cap will prevent further transport of contaminated runoff to the adjacent stream with potential metal deposition in the sediment.

Implementability

Construction of the synthetic/soil cover could be completed without substantial implementation difficulties. Some trees and other brush may have to be removed for installation of the landfill cover. The synthetic cover passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for construction of the synthetic/soil cover over the entire landfill surface and face is estimated at $388,000. Annual O&M costs are estimated at $5,000 per year. Total present worth costs for this alternative are estimated at $449,000. Cost estimates for completion of the cover are provided in Appendix A.

4.3.2 Groundwater Collection Alternatives

These technologies include no action and collection of contaminated groundwater that has migrated in the groundwater in the shallow overburden to the south from the landfill area. The initial screening of these alternatives is as follows.

4.3.2.1 No Action

As required by the NCP, no action for the site will be considered as an alternative. The No Action alternative involves baseline and periodic monitoring of selected media. Continued monitoring permits tracking of contaminant migration; however, it does not control migration of contaminants in the groundwater.

Under a No Action scenario, monitoring would be conducted on a periodic basis to evaluate the movement and concentration of contaminants in the groundwater. Samples would be collected from the existing and any additional groundwater monitoring wells on a quarterly basis. Two additional downgradient monitoring wells need to be installed to determine the complete downgradient extent of contamination in the overburden and shallow bedrock. Groundwater samples will be analyzed for certain metals (cadmium, copper, lead, mercury, and zinc; total and dissolved) and volatile organics. The no action alternative will be retained through the preliminary screening and detailed analysis section.

Capital costs of implementing the no action alternative would be include installation of two additional groundwater monitoring wells and development of a detailed sampling and analysis plan (detailed costs and assumptions are provided in Appendix A) and are $11,000. Annual O&M costs include labor to obtain samples and analytical costs associated with sampling the groundwater and are estimated to be $8,000 per year. Total present worth costs are estimated at $98,000.

4.3.2.2 Collection

Extraction Wells

The purpose of groundwater collection is to reduce the amount of volatile organic contamination that could migrate and affect human health and aquatic life through ingestion and dermal contact. Because extraction wells have been used successfully to control groundwater flow on various other similar contaminated sites within EPA Region III, the technology for implementing extraction wells is highly developed and the contaminants are potentially located in the shallow fractured bedrock (trench system would not be cost effective or technically feasible), it is the only collection technology that will be evaluated for Site 3.

Groundwater will be collected using extraction wells located within the plume and at the leading edge of the contaminant plume to capture contaminated groundwater and prevent further migration of contamination. It is estimated that properly located extraction wells will be able to capture sufficient groundwater flow to restrict off-site migration of contaminants in the overburden and shallow bedrock groundwater zones. The groundwater extraction wells will be screened in the overburden and in the shallow bedrock fractures to collect contamination from these areas. Based on hydrogeologic investigations performed during the RI, groundwater at the leading edge of the contaminant plume is located in the

overburden and approximately 2 feet into the fractured bedrock. There are no water-bearing fractures located at this site below approximately 14 feet below grade.

The development of extraction wells has been limited to the overburden and in the shallow fractured bedrock to a depth of 15 feet in order to restrict groundwater movement in the most contaminated zones. Based upon data (drawdown and recovery data collected from on-site monitoring wells) reported in the RI report, it is estimated that the each extraction well located in the overburden and shallow bedrock zone should yield about 2 gallons per minute (gpm). The actual withdrawal rate will have to be confirmed by testing during design of the system.

The conceptual design of the extraction wells includes an 8-inch diameter borehole to a depth of 15 feet, the wells will be constructed of 6-inch polyvinyl chloride (PVC) pipe with a continuous-slotted screen at 5 to 15 feet below the surface. The wells will be equipped with submersible pumps constructed of PVC pipe with PVC fittings. The pumps should be equipped with low water cutoffs to avoid damaging the pump in the event that the pumping water level declines to the depth of the pump. The discharge piping should be constructed of PVC pipe to reduce corrosion.

For cost estimating purposes, it was assumed that three extraction wells could adequately collect the contaminated groundwater located downgradient from the landfill. The groundwater contamination plume is estimated to be 32,500 square feet in area and has a vertical thickness of 10 feet resulting in a volume of 325,000 cubic feet. Using an effective porosity of 0.261 for this site results in an estimated volume of contaminated groundwater of 635,000 gallons. It will be assumed that five times that volume will have to be removed to reduce the groundwater contaminant concentration to acceptable clean-up levels.

Effectiveness

Groundwater extraction is effective in reducing the amount of volatile organic contamination that can be transported downgradient, preventing human exposure to significant levels of organics through ingestion or dermal contact and reducing impacts to aquatic life if the groundwater discharged to a surface water body. Collection via extraction wells is an effective means for mitigating migration of contaminants in the overburden groundwater. However, extraction of contaminated groundwater from bedrock fractures would be a much more difficult task. This collection alternative passes the initial screening and will be retained for further development in the detailed analysis section.

Implementability

Collection via extraction wells could be implemented without substantial difficulties. Implementation of the extraction wells would consist of using a drilling contractor to install the wells into the overburden and bedrock.

Cost

Capital and engineering costs for collection of contaminated groundwater is estimated at $121,000. Annual O&M costs are estimated at $27,000 per year. Total present worth costs for this alternative are estimated at $148,000. Cost estimates for groundwater collection are provided in Appendix A.

4.3.3 Groundwater Treatment Alternatives

Air Stripping

Air stripping is a commonly used technique for removing volatile organic compounds from groundwater. Air stripping is particularly effective for removal of low molecular weight chlorinated solvents such as dichloroethenes and trichloroethene. Various air stripping methods are available. The implementability of each is discussed in the evaluation criteria sections.

After the stripping the groundwater, the air stream may require emissions controls to meet Maryland air emissions regulations. This is typically performed by use of a post-treatment scrubber using a granular carbon packed absorber. Spent carbon is typically regenerated off-site.

Effectiveness

Air stripping will be effective in removing those volatile organic compounds detected in the groundwater at Site 3. Expected removal rate should be as high as 99 percent. This degree of removal will allow the air stripper effluent to meet the Maryland surface water quality criteria for volatile organics.

Implementability

Air stripping is generally a readily implementable method for remediation of contaminated groundwater. The shallow tray and bubble diffusion strippers are available as skid-mounted units with process controls and alarms supplied by the manufacturer. Unlike packed towers, these units can typically be quickly cleaned of mild scale/fouling with a pressure sprayer. In addition, the shallow tray unit consists of a series of removable trays, and the unit can be increased or decreased in size by adding or removing trays if flow or

volatile organic concentrations change. An air permit may be required for the discharge to the atmosphere.

On the basis of ease of O&M, the shallow tray unit is considered the most implementable air stripper for the site and will be the assumed process for the air stripping alternative. Physical treatment through air stripping passes the initial screening and shall be retained for further detailed analysis.

Cost

Capital and engineering costs for treatment of contaminated groundwater using a shallow tray air stripper are estimated at $145,000. Annual O&M costs are estimated at $31,000 per year. Total present worth costs are estimated at $176,000. Cost estimates for groundwater treatment are provided in Appendix A.

Activated Carbon

Activated carbon removes organics from aqueous streams by adsorbing the compounds onto the pore surface area of granular activated carbon (GAC). Activated carbon can be used in a flow-through packed treatment column or by adding powdered activated carbon (PAC) directly to contaminated water. Direct addition of PAC to water requires separation of the carbon particles from the waste stream prior to discharge of the treated waste, and is generally not implemented in cases where the treatment system is automated. Therefore, activated carbon adsorption as discussed here will assume a flow-through GAC column or bed. Activated carbon treatment would likely require pre-filtration to remove incidental solids from the water which might blind the column.

Effectiveness

Groundwater flow through a GAC column or bed would be an effective means of volatile organic removal. Expected removal rate should be as high as 99 percent. This degree of removal will allow the GAC unit effluent to meet the Maryland surface water quality criteria for volatile organics.

Implementability

GAC treatment columns or beds are typically skid-mounted units which are relatively simple to install or replace. Activated carbon is readily available from firms nationwide. Installation of a pre-filtration unit is also readily implementable.

Cost

Capital and engineering costs for treatment of contaminated groundwater using GAC columns or beds are estimated at $121,000. Annual O&M costs are estimated at $29,000 per year. Total present worth costs are estimated at $150,000. Cost estimates for groundwater treatment are provided in Appendix A.

4.3.4 Treated Groundwater Disposal Alternatives

Discharge of Treated Groundwater

Treated groundwater will be discharged to the stream that flows adjacent to the landfill. This tributary of Paint Branch Creek flows from north to south across the NSWCWODET facility.

Effectiveness

Discharge of treated groundwater to the stream would be an effective means of disposal. Due to the low levels of inorganics found at the site, it is expected that MCLs would be achieved prior to surface water discharge. It is expected that the treatment process would decrease the volatile organic concentrations to levels less than the Maryland surface water quality criteria.

Implementability

Disposal of treated groundwater in the stream adjacent to the landfill is very implementable. The treatment system would be located adjacent to the stream making discharge of the treated water technically feasible. Approval of a Maryland discharge permit would have to be secured prior to discharge of the treated groundwater but approval is expected to be obtained.

Cost

Capital and engineering costs for disposal of treated groundwater is estimated at $147,000. Annual O&M costs are estimated at $23,000 per year. Total present worth costs are estimated at $170,000. Cost estimates for the disposal of treated groundwater are provided in Appendix A.

4.3.5 Summary

A range of alternatives was developed for this site using the technology type evaluations previously described. These alternatives are listed below and will be further evaluated in the detailed analysis section.

Soil Remediation Alternatives

Alternative 1 - No action with continued monitoring

Alternative 2 - Synthetic/soil cap with regrading and revegetation

Groundwater Remediation Alternatives

Alternative 1 - No action with continued monitoring

Alternative 2 - Extraction wells with air stripping and discharge to surface water

Alternative 3 - Extraction wells with GAC treatment and discharge to surface water

4.4 SITE 4 - CHEMICAL BURIAL SITE

The nature and extent of contamination and the fate and transport mechanisms of contaminants in the environment were investigated during the RI. Based on data obtained to date, the following findings regarding contaminant transport were noted:

- Groundwater quality has been impacted through leachate generation from the burial sites. Numerous volatile organic compounds (benzene, trans-1,2-dichloroethene, 1,1,2,2-tetrachloroethane, toluene, vinyl chloride and trichloroethene) and bis(2-ethylhexyl)phthalate were identified as chemicals of potential concern in the groundwater that potentially may have adverse effects in humans.

- Although subsurface soils at and beneath the burial sites were not sampled, they probably have been impacted and will require remedial action as well.

Due to the complexity of this site, many technologies may be effective and implementable. Based on the applicability of technologies presented in Section 3.0, the following technologies will be considered for development into alternatives for Site 4. These technologies will be evaluated based on their effectiveness, implementability and cost.

General Response Action	Technology
No action	No action with continued monitoring
Soil/buried wastes containment or collection	Topsoil cover Clay cap Synthetic/soil cover Excavation
Soil treatment	Soil washing Soil thermal treatment Soil incineration
Treated soil disposal	On-site Off-site landfill
Excavated material disposal	Off-site landfill
Groundwater collection	Extraction wells
Groundwater treatment	Air stripping Activated carbon
Treated groundwater disposal	Discharge to surface water

4.4.1 Soil/Buried Waste Remediation Alternatives

4.4.1.1 No Action

As required by the NCP, no action for the site will be considered as an alternative. The No Action alternative involves baseline and periodic monitoring of selected media. Continued monitoring permits tracking of contaminant migration; however, it does not control migration of contaminants in the soil and does not control leachate generation with further impacts on groundwater quality.

Under a No Action scenario, monitoring would be conducted on a periodic basis to evaluate the concentration of contaminants in the soil. Samples would be collected from numerous subsurface locations within and on the perimeter of the burial sites on a semi-annual basis to determine any surface migration of contaminants from surface runoff. Soil samples will be analyzed for volatile and semivolatile organic compounds since they are the chemicals of concern in this media.

Capital costs of implementing the No Action alternative would be limited to developing a detailed sampling and analysis plan (detailed costs and assumptions are provided in Appendix A) and are $11,000. Annual O&M costs include labor to obtain samples and analytical costs associated with sampling the subsurface soils and are estimated to be $5,000 per year. Total present worth costs are estimated at $72,000.

4.4.1.2 Containment

Containment of contaminated soil and buried wastes may involve various capping/covering technologies. Covering typically constitutes placing one or more layers of clean material over the contaminated burial areas to either reduce infiltration of precipitation and/or prevent direct contact. Because Site 4 is a burial site, this technology will be considered and evaluation of various cover technologies is presented in the following subsections. The area of the burial sites to be capped is estimated at 60,000 square feet.

Topsoil Cover

A topsoil cover would consist of an approximate 6-inch thick layer of topsoil which would be placed over the contaminated soils and seeded to promote vegetative growth for erosion control and evapotranspiration. The topsoil cover will be constructed over the surface area of the burial areas. After the site is graded for installation of the cap, a topsoil cover will be installed.

Effectiveness

A topsoil cover placed over the burial areas would be effective in preventing direct human contact with contaminated surface soils. However, infiltration of precipitation would not be prevented, potentially resulting in leachate generation with discharge of contaminants to groundwater. The effectiveness of a topsoil cover is only maintained if the integrity of the cover can be well maintained.

Implementability

Placement of a topsoil cover following clearing and grading would pose no substantial difficulties. Although the topsoil cover meets most of the needs for containment of contaminated soils, it does not prevent leachate which has been generated at the site and impacted groundwater quality. Therefore, this technology does not pass the initial screening and will not be retained for further detailed analysis.

Cost

Capital and engineering costs for construction of the topsoil cover over the entire the burial areas are estimated at $138,000. Annual O&M costs are estimated at $5,000 per year. Total present worth costs for this alternative are estimated at $199,000. Cost estimates for completion of the cover are provided in Appendix A.

Clay Cap

This cap is typically used for non-hazardous waste landfills where a clay source is available. A description of the layer composition is presented in Section 3.6.2.1. Site preparation would be the same as described for the topsoil cover. The clay cover will be constructed over the entire surface area of the site to ensure that the four burial areas are covered. After the site is graded for installation of the cap, a clay cover will be installed.

Effectiveness

A clay cover placed over the site would be effective in preventing direct human contact with contaminated surface soils. However, because waste materials will remain in the subsurface, infiltration of precipitation must be eliminated to prevent leachate generation not just decrease it.

Implementability

Placement of a clay cover would pose no substantial difficulties. Although the clay cover meets most of the needs for containment of contaminated soils, it does not prevent leachate which has been generated at the site and impacted groundwater quality. Therefore, this technology does not pass the initial screening and will not be retained for further detailed analysis.

Cost

Capital and engineering costs for construction of the clay cover over the entire the burial areas are estimated at $132,000. Annual O&M costs are estimated at $5,000 per year. Total present worth costs for this alternative are estimated at $193,000. Cost estimates for completion of the cover are provided in Appendix A.

Synthetic Membrane/Soil Cover System

A synthetic membrane/soil cover system consists of a synthetic membrane barrier layer, typically 30 to 40 millimeters thick, sandwiched between layers of synthetic fabric and geogrid synthetic drainage material. The synthetic fabric functions to protect the plastic sheeting from perforation due to rocks or sharp objects. The top layer of synthetic fabric is then covered with a 6- to 12-inch layer of topsoil and is seeded to promote vegetative

growth for erosion control purposes.

The purposes of the impermeable cap are to reduce human exposure to contaminated soils and to reduce the amount of infiltration from rainfall that could impact groundwater quality. The cap will be designed and constructed to promote drainage and minimize erosion of the cover. Long-term O&M will be conducted to ensure the integrity of the cap.

Effectiveness

The synthetic/soil cover is effective in preventing erosion and contact with contaminated soils, and limiting infiltration to the buried wastes with potential discharge to groundwater. Capping alone does not address the human health and environmental impacts associated with exposure to contaminated groundwater, and does not prevent migration of existing groundwater contamination.

Implementability

Construction of the synthetic/soil cover could be completed without substantial implementation difficulties. The synthetic cover passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for construction of the synthetic/soil cover over the entire the burial areas are estimated at $341,000. Annual O&M costs are estimated at $5,000 per year. Total present worth costs for this alternative are estimated at $402,000. Cost estimates for completion of the cover are provided in Appendix A.

4.4.1.3 Excavation

The purpose of the soil and buried waste excavation is to reduce the amount of leachate generation that could impact groundwater and eventually affect human health and aquatic life. The four burial areas including all contaminated soil and buried wastes will be excavated with subsequent treatment and/or disposal. The amount of soil and buried wastes to be excavated is expected to be approximately 5,200 cubic yards. For the purposes of cost estimating, 5,000 cubic yards of the excavated material are considered to be contaminated soil with the remaining 200 cubic yards considered as buried waste materials such as drums, metal containers, scrap metal and other solid waste.

Effectiveness

Contaminated soil and buried waste removal would be effective in preventing leachate generation while reducing the impacts to groundwater. Thus, reducing the potential risks

from exposure to contaminated groundwater.

Implementability

Contaminated soil and buried waste removal could be implemented with no substantial difficulties. Excavation passes the initial screening and will be developed further in the detailed analysis section.

Cost

Capital and engineering costs for excavation of the burial areas are estimated at $71,000. Cost estimates for removal are provided in Appendix A.

4.4.2 Soil Treatment Alternatives

Although no subsurface soil sampling has been conducted to determine the levels of contamination for organics at the burial sites, based on the high concentrations of organics detected in the groundwater at the site, it is assumed that treatment of contaminated soils will be required. As discussed above, approximately 5,000 cubic yards of contaminated soil are estimated to be excavated from the burial areas that require treatment.

4.4.2.1 Thermal Treatment/Incineration

Thermal treatment involves heating the contaminated soil to the point where the contaminants will experience combustion, thus fully or partially oxidizing the organic contaminants. Gases and/or particulate emitted during the combustion process are typically quenched, then scrubbed or absorbed such that they can be discharged to the atmosphere. Thermal treatment may involve the use of high temperature steam to thermally destruct contaminants. Thermal treatment will be considered as an on-site treatment option.

Thermal treatment at high temperatures using an oven or kiln is defined as incineration and is generally only feasible as an off-site treatment option.

<u>On-site Thermal Treatment</u>

Soils would be staged at the treatment unit prior to and after treatment. Disposal of treatment residuals would be used as "clean fill" or sent off-site to a chemical waste landfill. Treatment residual disposal alternatives are discussed in Section 4.4.4.

Effectiveness

Following excavation, the contaminated soil would receive thermal treatment to minimize the human health and environmental risks associated with the excavated sediment. Reduction in organic concentration can be as high as 99 percent; therefore, thermal

treatment is an effective treatment method for volatile and semivolatile organic contamination.

Implementability

Equipment required for the thermal treatment of contaminated soil would be supplied by a thermal treatment vendor. Electrical power and possibly a fuel source would need to be supplied to the process. Extensive mobilization and installation of equipment would be required. The implementation of on-site thermal treatment is technically feasible. Approval of on-site treatment (permit may be required) will be the most difficult implementation facet of this remedial action. Based on the effectiveness and implementability of thermal treatment, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for on-site thermal treatment of the contaminated soil is estimated at $759,000. Cost estimates for soil thermal treatment are provided in Appendix A.

Off-site Incineration

Off-site treatment with incineration would involve transport of contaminated soil to the off-site treatment facility.

Effectiveness

Following excavation, contaminated soil would be transported to an off-site facility for treatment by incineration. Transport of untreated contaminated soil may increase the risks to human health and the environment due to the potential release of the soils to the environment via accidental spillage. The effectiveness of incineration was previously discussed.

Implementability

The implementability of excavation has been previously discussed. The implementation of off-site incineration is technically feasible. Off-site transport may required proper manifesting (hazardous or special waste).

Cost

Capital and engineering costs for off-site incineration of the contaminated soil is estimated at $23,115,000. Cost estimates for soil incineration are provided in Appendix A. Based on high cost of incineration, this technology does not pass the initial screening and will not be retained for further detailed analysis.

4.4.2.2 Soil Washing

Soil washing requires excavating contaminated soil and washing it in a mobile washing unit. The washing fluid can be water, organic solvents, surfactants, etc. More detailed description on operation of the unit can be found in Section 3.7.4.3.

On-site Soil Washing

Excavated soil would require staging at the treatment unit prior to and after soil washing.

Effectiveness

Following excavation, the contaminated soil would receive soil washing to minimize the human health and environmental risks associated with the excavated soil. Reduction in organic concentration can be as high as 90 percent; therefore, soil washing is an effective treatment method for volatile and semivolatile organic contamination.

Implementability

Mobile equipment required for the washing of contaminated soil would be supplied by a vendor. Electrical power and possibly a fuel source would need to be supplied to the process. Extensive mobilization and installation of equipment would be required. The implementation of on-site soil washing is technically feasible. Approval of on-site treatment (permit may be required) will be the most difficult implementation facet of this remedial action. Based on the effectiveness and implementability of soil washing, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for on-site soil washing of the contaminated soil is estimated at $1,540,000. Cost estimates for soil washing are provided in Appendix A.

Off-Site Soil Washing

Off-site treatment with soil washing would involve transport of soil to the off-site treatment facility.

Effectiveness

Following excavation, contaminated soil would be transported to an off-site facility for treatment by soil washing. Transport of untreated contaminated soil may increase the risks to human health and the environment due to the potential release of the soils to the environment via accidental spillage. The effectiveness of soil washing was previously discussed.

Implementability

The implementability of excavation has been previously discussed. The implementation of off-site soil washing is technically feasible. Off-site transport may required proper manifesting (hazardous or special waste). Based on the effectiveness and implementability of soil washing, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for off-site soil washing of the contaminated soil is estimated at $2,490,000. Cost estimates for soil washing are provided in Appendix A.

4.4.3 Soil Disposal Alternatives

As stated in Section 4.4.2, it is assumed that treatment prior to disposal will be required. Therefore, disposal of untreated soils will not be evaluated in this section.

On-site Treatment Residue Disposal

A 90 percent reduction in concentration of organics in the residue would be expected for all of the treatment processes discussed above. All treatment processes will generate a waste stream that contains the majority of the organic contamination that was removed from the soil during the treatment process. These wastes will be further treated or disposed of properly off-site. Only the residual ash or soil from the treatment process will be evaluated for disposal in this section. Approximately 5,000 cubic yards of treatment residue is expected to require disposal.

Effectiveness

On-site disposal as "clean fill" back into the excavated areas would be an effective method of treatment residue disposal. Human health exposure to treatment residue would be eliminated. Residual contamination would not generate a leachate that would further impact groundwater quality.

Implementability

The disposal of treatment residue in the excavated areas could be implemented with no substantial difficulties. Approval of on-site disposal (permit may be required) will be the most difficult implementation facet of this remedial action. Based on the effectiveness and implementability of disposal of treatment residue in the excavated areas, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for on-site disposal of the treatment residuals is estimated at $38,000. Cost estimates are provided in Appendix A.

Off-site Treatment Residue Disposal

As previously stated, treatment of the contaminated soils would occur prior to disposal of the treatment residuals. Approximately 5,000 cubic yards of soil will require disposal.

Effectiveness

Off-site disposal in an approved landfill would be an effective method of PCB treatment residue disposal. Human health exposure to treatment residue would be eliminated.

Implementability

The disposal of treatment residue in an approved landfill could be implemented with no substantial difficulties. Based on the effectiveness and implementability of disposal of treatment residue in an approved landfill, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for off-site disposal of the treatment residuals is estimated at $3,013,000. Cost estimates are provided in Appendix A.

4.4.4 Buried Waste Disposal Alternatives

As previously stated in Section 4.4.1.3, approximately 200 cubic yards of buried solid material (i.e., empty drums, metal containers and other scrap) will require off-site disposal. The only alternative to be discussed and evaluated will be the disposal of this material in a solid or hazardous waste landfill. Additional effort and costs would be required if the containers still contained signficant quantities of chemicals.

Off-site Waste Disposal

Effectiveness

Off-site disposal in an approved landfill would be an effective method of excavated material disposal. Human health exposure to these potentially contaminated materials would be eliminated.

Implementability

The disposal of these materials in an approved landfill could be implemented with no substantial difficulties. Based on the effectiveness and implementability of disposal of solid wastes in an approved landfill, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for off-site disposal of the these materials is estimated at $133,000. Cost estimates are provided in Appendix A.

4.4.5 Groundwater Collection Alternatives

These technologies include no action and collection of contaminated groundwater that has migrated in the groundwater in the overburden and upper saprolite units to the southeast from the burial areas. The initial screening of these alternatives is as follows.

4.4.5.1 No Action

As required by the NCP, no action for the site will be considered as an alternative. The No Action alternative involves baseline and periodic monitoring of selected media. Continued monitoring permits tracking of contaminant migration; however, it does not control migration of contaminants in the groundwater.

Under a No Action scenario, monitoring would be conducted on a periodic basis to evaluate the movement and concentration of contaminants in the groundwater. Samples would be collected from the existing groundwater monitoring wells on a quarterly basis. Groundwater samples will be analyzed for volatile and semivolatile organics. The no action alternative will be retained through the preliminary screening and detailed analysis section.

Capital costs of implementing the no action alternative would be include development of a detailed sampling and analysis plan (detailed costs and assumptions are provided in Appendix A) and are $11,000. Annual O&M costs include labor to obtain samples and analytical costs associated with sampling the groundwater and are estimated to be $8,000 per year. Total present worth costs are estimated at $98,000.

4.4.5.2 Collection

Extraction Wells

The purpose of groundwater collection is to reduce the amount of volatile and semivolatile organic contamination that could migrate and affect human health and aquatic life through ingestion and dermal contact. Because extraction wells have been used successfully to control groundwater flow on various other similar contaminated sites within EPA Region III, the technology for implementing extraction wells is highly developed and the contaminants are located at depths and in a saprolite unit where a trench system would not be cost effective or technically feasible, it is the only collection technology that will be evaluated for Site 4.

Groundwater will be collected using extraction wells located within the plume and at the leading edge of the contaminant plume to capture contaminated groundwater and prevent further migration of contamination. It is estimated that properly located extraction wells will be able to capture sufficient groundwater flow to restrict on- and off-site migration of contaminants in the overburden and saprolite. The groundwater extraction wells will be screened in the overburden and upper saprolite unit. Based on hydrogeologic investigations performed during the RI, groundwater at the leading edge of the contaminant plume is located in the overburden and saprolite units.

The development of extraction wells has been limited to the overburden and in the upper saprolite to a depth of 80 feet in order to restrict groundwater movement in the most contaminated zones. Based upon data (drawdown and recovery data collected from on-site monitoring wells) reported in the RI report, it is estimated that the each extraction well should yield about 6 gpm. The actual withdrawal rate will have to be confirmed by testing during design of the system.

The conceptual design for the extraction wells includes an 8-inch diameter borehole to a depth of 80 feet, the wells will be constructed of 6-inch PVC pipe with a continuous-slotted screen at 40 to 80 feet below the surface. The wells will be equipped with submersible pumps constructed of PVC pipe with PVC fittings. The pumps should be equipped with low water cutoffs to avoid damaging the pump in the event that the pumping water level declines to the depth of the pump. The discharge piping should be constructed of PVC pipe to reduce corrosion.

For cost estimating purposes, it was assumed that eight extraction wells could adequately collect the contaminated groundwater located downgradient from the burial areas. The groundwater contamination plume is estimated to be 840,000 square feet in area and has an average vertical thickness of 20 feet resulting in a volume of 16,800,000 cubic feet. Using an effective porosity of 0.40 for this site results in an estimated volume of contaminated groundwater of 50,265,000 gallons. It will be assumed that five times that volume will have to be removed to reduce the groundwater contaminant concentration to acceptable clean-up levels.

Effectiveness

Groundwater extraction is effective in reducing the amount of volatile organic contamination that can be transported downgradient, preventing human exposure to significant levels of organics through ingestion or dermal contact and reducing impacts to aquatic life if the groundwater discharged to a surface water body. Collection via extraction wells is an effective means for mitigating migration of contaminants in the overburden and saprolite groundwater. This collection alternative passes the initial screening and will be retained for further development in the detailed analysis section.

Implementability

Collection via extraction wells could be implemented without substantial difficulties. Implementation of the extraction wells would consist of using a drilling contractor to install the wells into the overburden and saprolite units.

Cost

Capital and engineering costs for collection of contaminated groundwater is estimated at $509,000. Annual O&M costs are estimated at $45,000. Total present worth costs for this alternative are estimated at $811,000. Cost estimates for groundwater collection are provided in Appendix A.

4.4.6 Groundwater Treatment Alternatives

Air Stripping

Air stripping is a commonly used technique for removing volatile organic compounds from groundwater. Air stripping is particularly effective for removal of low molecular weight chlorinated solvents such as dichloroethenes and trichloroethene. Various air stripping methods are available. The implementability of each is discussed in the evaluation criteria sections.

After the stripping the groundwater, the air stream may require emissions controls to meet Maryland air emissions regulations. This is typically performed by use of a post-treatment scrubber using a granular carbon packed absorber. Spent carbon is typically regenerated off-site.

Effectiveness

Air stripping will be effective in removing those volatile organic compounds detected in the groundwater at Site 4. However, air stripping may not be effective in reducing the levels of semivolatile organics to acceptable levels. Expected volatile organic removal rate should be as high as 99 percent. This degree of removal will allow the air stripper effluent to meet the Maryland surface water quality criteria for volatile organics.

Implementability

Air stripping is generally a readily implementable method for remediation of contaminated groundwater. The shallow tray and bubble diffusion strippers are available as skid-mounted units with process controls and alarms supplied by the manufacturer. Unlike packed towers, these units can typically be quickly cleaned of mild scale/fouling with a pressure sprayer. In addition, the shallow tray unit consists of a series of removable trays, and the unit can be increased or decreased in size by adding or removing trays if flow or volatile organic concentrations change. On the basis of ease of O&M, the shallow tray unit is considered the most implementable air stripper for the site and will be the assumed process for the air stripping alternative.

Physical treatment through air stripping passes the initial screening and shall be retained for further detailed analysis.

Cost

Capital and engineering costs for treatment of contaminated groundwater using a shallow tray air stripper is estimated at $387,000. Annual O&M costs are estimated at $51,000. Total present worth is estimated at $730,000. Cost estimates for groundwater treatment are provided in Appendix A.

<u>Activated Carbon</u>

Activated carbon removes organics from aqueous streams by adsorbing the compounds onto the pore surface area of granular activated carbon (GAC). Activated carbon can be used in a flow-through packed treatment column or by adding powdered activated carbon (PAC) directly to contaminated water. Direct addition of PAC to water requires separation of the carbon particles from the waste stream prior to discharge of the

treated waste, and is generally not implemented in cases where the treatment system is automated. Therefore, activated carbon adsorption as discussed here will assume a flow-through GAC column or bed. Activated carbon treatment would likely require pre-filtration to remove incidental solids from the water which might blind the column.

Effectiveness

Groundwater flow through a GAC column or bed would be an effective means of volatile and semivolatile organic removal. Expected removal rate should be as high as 99 percent. This degree of removal will allow the GAC unit effluent to meet the Maryland surface water quality criteria for volatile organics.

Implementability

GAC treatment columns or beds are typically skid-mounted units which are relatively simple to install or replace. Activated carbon is readily available from firms nationwide. Installation of a pre-filtration unit is also readily implementable.

Cost

Capital and engineering costs for treatment of contaminated groundwater using a GAC columns or beds is estimated at $301,000. Annual O&M costs are estimated at $49,000. Total present worth is estimated at $630,000. Cost estimates for groundwater treatment are provided in Appendix A.

4.4.7 Treated Groundwater Disposal Alternatives

Discharge of Treated Groundwater

Treated groundwater will be discharged to the stream that is located just south of Dahlgren Road and flows from north to south across the NSWCWODET facility to the east of Site 9.

Effectiveness

Discharge of treated groundwater to the stream would be an effective means of disposal. Due to the low levels of inorganics found at the site, it is expected that Maximum Contaminant Levels (MCLs) would be achieved prior to surface water discharge. It is expected that the treatment process would decrease the volatile and semivolatile organic concentrations to levels less than the Maryland surface water quality criteria.

Implementability

Disposal of treated groundwater in the stream is very implementable. The treatment system would be located adjacent to the stream making discharge of the treated water technically feasible. Approval of a Maryland discharge permit would have to be secured prior to discharge of the treated groundwater but approval is expected to be obtained.

Cost

Capital and engineering costs for disposal of treated groundwater is estimated at $172,000. Annual O&M costs are estimated at $23,000. Total present worth costs are estimated at $339,000. Cost estimates for the disposal of treated groundwater are provided in Appendix A.

4.4.8 Summary

A range of alternatives was developed for this site using the technology type evaluations previously described. These alternatives are listed below and will be further evaluated in the detailed analysis section.

Soil Remediation Alternatives

Alternative 1 - No action with continued monitoring

Alternative 2 - Synthetic/soil cap with regrading and revegetation

Alternative 3 - Excavation with on-site thermal treatment and on-site disposal

Alternative 4 - Excavation with on-site thermal treatment and off-site disposal

Alternative 5 - Excavation with on-site soil washing and on-site disposal

Alternative 6 - Excavation with on-site soil washing and off-site disposal

Alternative 7 - Excavation with off-site soil washing and off-site disposal

Buried Waste Material Disposal Alternatives

Alternative 1 - Off-site landfill

Groundwater Remediation

Alternative 1 - No action with continued monitoring

Alternative 2 - Extraction wells with air stripping and discharge to surface water

Alternative 3 - Extraction wells with GAC treatment and discharge to surface water

4.5 SITE 7 - ORDNANCE BURN AREA

The nature and extent of contamination and the fate and transport mechanisms of contaminants in the environment were investigated during the RI. Based on data obtained to date, the following findings regarding contaminant transport were noted:

- Groundwater quality has been impacted through leachate generation from the burn area. Numerous nitroaromatic compounds such as 2,4-dinitrotoluene (2,4-DNT), 2,6-dinitrotoluene (2,6-DNT), cyclotetramethylenetetranitramine (HMX), cyclotrimethylenetrinitramine (RDX), 1,3,5-trinitrobenzene (1,3,5-TNB) and 2,4,6-trinitrotoluene (TNT) were identified as chemicals of potential concern in the groundwater that potentially may have adverse effects in humans.

- Surface soils have been impacted (nitroaromatic contamination) due to the past practice of ordnance burning and exposure to these contaminants could impact human health.

- Subsurface soils at the site have been impacted due to contaminant migration and will require remedial action as well.

Due to the complexity of this site, many technologies may be effective and implementable. Based on the applicability of technologies presented in Section 3.0, the following technologies will be considered for development into alternatives for Site 7. These technologies will be evaluated based on their effectiveness, implementability and cost.

General Response Action	Technology
No action	No action with continued monitoring
Soil containment/ collection	Topsoil cover Clay cap Synthetic/soil cover Excavation
In-situ soil treatment	Soil flushing Soil fixation
Ex-situ soil treatment	Soil washing
Treated soil disposal	On-site Off-site landfill
Groundwater collection	Extraction wells
Groundwater treatment	Air stripping Activated carbon
Treated groundwater	Discharge to surface water disposal

4.5.1 In-situ Soil Remediation Alternatives

4.5.1.1 No Action

As required by the NCP, no action for the site will be considered as an alternative. The No Action alternative involves baseline and periodic monitoring of selected media. Continued monitoring permits tracking of contaminant migration; however, it does not control migration of contaminants in the soil and does not control leachate generation with further impacts on groundwater quality.

Under a No Action scenario, monitoring would be conducted on a periodic basis to evaluate the concentration of contaminants in the soil. Samples would be collected from numerous surface and subsurface locations within and on the perimeter of the burn area on a semi-annual basis to determine additional surface and subsurface migration of nitroaromatics. Soil samples will be analyzed for nitroaromatic compounds since they are the chemicals of concern in this media.

Capital costs of implementing the No Action alternative would be limited to developing a detailed sampling and analysis plan (detailed costs and assumptions are

provided in Appendix A) and are $11,000. Annual O&M costs include labor to obtain samples and analytical costs associated with sampling the surface and subsurface soils and are estimated to be $9,000 per year. Total present worth costs are estimated at $117,000.

4.5.1.2 Containment

Containment of contaminated soil may involve various capping/covering technologies. Covering typically constitutes placing one or more layers of clean material over the contaminated soils to either reduce infiltration of precipitation and/or prevent direct contact. Because Site 7 has deep subsurface contamination in the unsaturated zone, this technology will be considered and evaluation of various cover technologies is presented in the following subsections. The area of the burn area to be capped is estimated at 15,000 square feet.

Topsoil Cover

A topsoil cover would consist of an approximate 6-inch thick layer of topsoil which would be placed over the contaminated soils and seeded to promote vegetative growth for erosion control and evapotranspiration. The topsoil cover will be constructed over the surface of the burn area. After the site is graded for installation of the cap, a topsoil cover will be installed.

Effectiveness

A topsoil cover placed over the burn area would be effective in preventing direct human contact with contaminated surface soils. However, infiltration of precipitation would not be prevented, potentially resulting in leachate generation with discharge of contaminants to groundwater. The effectiveness of a topsoil cover is only maintained if the integrity of the cover can be well maintained.

Implementability

Placement of a topsoil cover following clearing and grading would pose no substantial difficulties. Although the topsoil cover meets most of the needs for containment of contaminated soils, it does not prevent leachate which has been generated at the site and impacted groundwater quality. Therefore, this technology does not pass the initial screening and will not be retained for further detailed analysis.

Cost

Capital and engineering costs for construction of the topsoil cover over the entire site are estimated at $87,000. Annual O&M costs are estimated at $8,000 per year. Total present worth costs for this alternative are estimated at $177,000. Cost estimates for completion of the cover are provided in Appendix A.

Clay Cap

This cap is typically used for non-hazardous waste landfills where a clay source is available. A description of the layer composition is presented in Section 3.6.2.1. Site preparation would be the same as described for the topsoil cover. The clay cover will be constructed over the entire surface area of the site to ensure that the burn area is covered. After the site is graded for installation of the cap, a clay cover will be installed.

Effectiveness

A clay cover placed over the site would be effective in preventing direct human contact with contaminated surface soils. However, prevention of infiltration, not just a decrease in infiltration, is needed to prevent leachate generation and further impacts to groundwater quality.

Implementability

Placement of a clay cover would pose no substantial difficulties. Although the clay cover meets most of the needs for containment of contaminated soils, it does not prevent leachate which has been generated at the site and impacted groundwater quality. Therefore, this technology does not pass the initial screening and will not be retained for further detailed analysis.

Cost

Capital and engineering costs for construction of the clay cover over the entire site are estimated at $86,000. Annual O&M costs are estimated at $8,000 per year. Total present worth costs for this alternative are estimated at $176,000. Cost estimates for completion of the cover are provided in Appendix A.

Synthetic Membrane/Soil Cover System

A synthetic membrane/soil cover system consists of a synthetic membrane barrier layer, typically 30 to 40 millimeters thick, sandwiched between layers of synthetic fabric and geogrid synthetic drainage material. The synthetic fabric functions to protect the plastic sheeting from perforation due to rocks or sharp objects. The top layer of synthetic fabric is then covered with a 6- to 12-inch layer of topsoil and is seeded to promote vegetative

growth for erosion control purposes.

The purposes of the impermeable cap are to reduce human exposure to contaminated soils and to reduce the amount of infiltration from rainfall that could impact groundwater quality. The cap will be designed and constructed to promote drainage and minimize erosion of the cover. Long-term O&M will be conducted to ensure the integrity of the cap.

Effectiveness

The synthetic/soil cover is effective in preventing erosion and contact with contaminated soils, and limiting infiltration and leachate generation with discharge to groundwater. Capping alone does not address the human health and environmental impacts associated with exposure to contaminated groundwater, and does not prevent migration of existing groundwater contamination.

Implementability

Construction of the synthetic/soil cover could be completed without substantial implementation difficulties. The synthetic cover passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for construction of the synthetic/soil cover over the entire site are estimated at $133,000. Annual O&M costs are estimated at $8,000 per year. Total present worth costs for this alternative are estimated at $223,000. Cost estimates for completion of the cover are provided in Appendix A.

4.5.1.3 Excavation

The purpose of soil excavation is to reduce the amount of leachate generation that could impact groundwater and eventually affect human health and aquatic life. The burn area including all contaminated soil will be excavated with subsequent treatment and/or disposal. The amount of soil to be excavated is expected to be approximately 3,400 cubic yards. Soil would be removed to a depth of 10 feet because the highest concentrations of nitroaromatics are present in this upper unsaturated zone.

<u>Contaminated Soil Removal</u>

Effectiveness

Contaminated soil removal would be effective in preventing significant leachate generation which reduces the impacts to groundwater. However, because not all of the contaminated soils in the subsurface would be removed (only those soils with the highest

concentrations of nitroaromatics), there still will be some contaminated leachate generated which could continue to impact groundwater quality.

Implementability

Contaminated soil removal could be implemented with no substantial difficulties. Excavation passes the initial screening and will be developed further in the detailed analysis section.

Cost

Capital and engineering costs for excavation of the soils is estimated at $55,000. Cost estimates for removal are provided in Appendix A.

4.5.1.4 In-situ Soil Flushing

In-situ soil flushing involves injecting of a solvent or surfactant to enhance contaminant mobility in permeable soils resulting in increased recovery of contaminants in leachate or groundwater. The resulting leachate can be collected or allowed to discharge to groundwater where extraction wells can remove the contaminated groundwater for further treatment. Subsurface soil and groundwater data indicate that the nitroaromatics have migrated through the unsaturated zone and, therefore, because of the high permeability sand and gravel unit, removal through soil flushing is a potential feasible technology.

A 9,000-square foot area to a depth of approximately 30 feet will require in-situ soil flushing to enhance contaminant mobility in the unsaturated zone. The total volume of soil to be treated is approximately 10,000 cubic yards.

Contaminated Soil Flushing

Effectiveness

A significant reduction in nitroaromatic concentration would be expected but the actual removal rates are unknown. In-situ soil flushing could be an effective treatment method for nitroaromatic contamination. However, groundwater or leachate control measures would be required to contain or capture the resulting contaminated solvent or surfactant from the flushing process.

Implementability

Equipment required for the flushing of contaminated soil would be supplied by a vendor. Electrical power and possibly a fuel source would need to be supplied to the process. Extensive mobilization and installation of equipment would be required. The implementation of in-situ soil flushing is technically feasible. Based on the effectiveness and

implementability of in-situ soil flushing, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for in-situ soil flushing of the contaminated soil at Site 7 is estimated at $2,539,000. Cost estimates for in-situ soil flushing are provided in Appendix A.

4.5.1.5 In-situ Soil Fixation

The purpose of in-situ fixation (i.e., solidification or stabilization) is to prevent contaminant mobility or leachate generation that could further impact groundwater quality. In-situ fixation involves augering through the subsurface soils and adding a stabilization compound such as lime-pozzolan and cement to immobilize the contaminants in the unsaturated soils, therefore, prevent leachate generation.

A 9,000-square foot area to a depth of approximately 30 feet will require in-situ soil fixation to reduce contaminant mobility in the unsaturated zone.

Contaminated Soil Fixation

Effectiveness

A significant reduction in the mobility of the nitroaromatic concentration would be expected but leachate generation may still be possible to some extent. In-situ fixation would be an effective method for control of nitroaromatic contamination in subsurface soils. However, some leachate could continue to be generated and potentially impact groundwater.

Implementability

Equipment required for the fixation of contaminated soil would be supplied by a vendor. Electrical power and possibly a fuel source would need to be supplied to the process. Extensive mobilization and installation of equipment would be required. The implementation of in-situ soil fixation is technically feasible. Based on the effectiveness and implementability of in-situ soil fixation, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for in-situ soil fixation of the contaminated soil is estimated at $4,387,000. Cost estimates for in-situ fixation are provided in Appendix A.

4.5.2 Ex-situ Soil Treatment Alternatives

Treatment of contaminated soils will be required. As discussed above, approximately 3,400 cubic yards of contaminated soil are estimated to be excavated from the burn area that require treatment. The only treatment technology to be evaluated for this site will be soil washing.

4.5.2.1 Soil Washing

Soil washing requires excavating contaminated soil and washing it in a mobile washing unit. The washing fluid can be water, organic solvents, surfactants, etc. More detailed description on operation of the unit can be found in Section 3.7.4.3.

On-site Soil Washing

Excavated soil would require staging at the treatment unit prior to and after soil washing.

Effectiveness

Following excavation, the contaminated soil would receive soil washing to minimize the human health and environmental risks associated with the excavated soil. Reduction in nitroaromatic concentration would be significant; therefore, soil washing is an effective treatment method for nitroaromatic contamination.

Implementability

Mobile equipment required for the washing of contaminated soil would be supplied by a vendor. Electrical power and possibly a fuel source would need to be supplied to the process. Extensive mobilization and installation of equipment would be required. The implementation of on-site soil washing is technically feasible. Approval of on-site treatment (permit may be required) will be the most difficult implementation facet of this remedial action. Based on the effectiveness and implementability of soil washing, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for on-site soil washing of the contaminated soil is estimated at $1,051,000. Cost estimates for soil washing are provided in Appendix A.

Off-Site Soil Washing

Off-site treatment with soil washing would involve transport of soil to the off-site treatment facility.

Effectiveness

Following excavation, contaminated soil would be transported to an off-site facility for treatment by soil washing. Transport of untreated contaminated soil may increase the risks to human health and the environment due to the potential release of the soils to the environment via accidental spillage. The effectiveness of soil washing was previously discussed.

Implementability

The implementability of excavation has been previously discussed. The implementation of off-site soil washing is technically feasible. Off-site transport may required proper manifesting (hazardous or special waste). Based on the effectiveness and implementability of soil washing, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for off-site soil washing of the contaminated soil is estimated at $1,697,000. Cost estimates for soil washing are provided in Appendix A.

4.5.3 Soil Disposal Alternatives

As stated in Section 4.5.2, it is assumed that treatment prior to disposal will be required. Therefore, disposal of untreated soils will not be evaluated in this section.

On-site Treatment Residue Disposal

A 90 percent reduction in concentration of nitroaromatics in the residue would be expected for all of the treatment processes discussed above. All treatment processes will generate a waste stream that contains the majority of the nitroaromatic contamination that was removed from the soil during the treatment process. These wastes will be further treated or disposed of properly off-site. Only the residual soil from the treatment process will be evaluated for disposal in this section. Approximately 3,400 cubic yards of residual soil is expected to require disposal.

Effectiveness

On-site disposal back into the excavated areas would be an effective method of treatment residual disposal. Human health exposure to treatment residue would be eliminated. Residual contamination would not generate a leachate that would further impact groundwater quality.

Implementability

The disposal of treatment residue in the excavated areas could be implemented with no substantial difficulties. Approval of on-site disposal will be the most difficult implementation facet of this remedial action. Based on the effectiveness and implementability of disposal of treatment residue in the excavated areas, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for on-site disposal of the treatment residuals is estimated at $26,000. Cost estimates are provided in Appendix A.

Off-site Treatment Residue Disposal

As previously stated, treatment of the contaminated soils would occur prior to disposal of the treatment residuals. Approximately 3,400 cubic yards of soil will require disposal.

Effectiveness

Off-site disposal in an approved landfill would be an effective method of PCB treatment residue disposal. Human health exposure to treatment residue would be eliminated.

Implementability

The disposal of treatment residue in an approved landfill could be implemented with no substantial difficulties. Based on the effectiveness and implementability of disposal of treatment residue in an approved landfill, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for off-site disposal of the treatment residuals is estimated at $2,049,000. Cost estimates are provided in Appendix A.

4.5.4 Groundwater Collection Alternatives

These technologies include no action and collection of contaminated groundwater that has migrated in the groundwater in the overburden and upper saprolite units to the south from the burn area. The initial screening of these alternatives is as follows.

4.5.4.1 No Action

As required by the NCP, no action for the site will be considered as an alternative. The No Action alternative involves baseline and periodic monitoring of selected media. Continued monitoring permits tracking of contaminant migration; however, it does not control migration of contaminants in the groundwater.

Under a No Action scenario, monitoring would be conducted on a periodic basis to evaluate the movement and concentration of contaminants in the groundwater. Samples would be collected from the existing groundwater monitoring wells on a quarterly basis. Groundwater samples will be analyzed for nitroaromatics. The no action alternative will be retained through the preliminary screening and detailed analysis section.

Capital costs of implementing the no action alternative would be include development of a detailed sampling and analysis plan (detailed costs and assumptions are provided in Appendix A) and are $11,000. Annual O&M costs include labor to obtain samples and analytical costs associated with sampling the groundwater and are estimated to be $9,000 per year. Total present worth costs estimated for this alternative are $117,000.

4.5.4.2 Collection

The purpose of groundwater collection is to reduce the amount of nitroaromatic contamination that could migrate and affect human health and aquatic life through ingestion and dermal contact. Because extraction wells have been used successfully to control groundwater flow on various other similar contaminated sites within EPA Region III, the technology for implementing extraction wells is highly developed and the contaminants are located at depths and in a saprolite unit where a trench system would not be cost effective or technically feasible, it is the only collection technology that will be evaluated for Site 7.

Groundwater will be collected using extraction wells located within the plume and at the leading edge of the contaminant plume to capture contaminated groundwater and prevent further migration of contamination. It is estimated that properly located extraction wells will be able to capture sufficient groundwater flow to restrict on- and off-site migration of contaminants in the overburden and saprolite. The groundwater extraction wells will be screened in the overburden and upper saprolite unit. Based on hydrogeologic investigations performed during the RI, groundwater at the leading edge of the contaminant plume is located in the overburden and saprolite units.

The development of extraction wells has been limited to the overburden and in the upper saprolite to a depth of 60 feet in order to restrict groundwater movement in the most contaminated zones. Based upon data (drawdown and recovery data collected from on-site monitoring wells) reported in the RI report, it is estimated that the each extraction well should yield about 6 gpm. The actual withdrawal rate will have to be confirmed by testing during design of the system.

The conceptual design for the extraction wells includes an 8-inch diameter borehole to a depth of 60 feet, the wells will be constructed of 6-inch PVC pipe with a continuous-slotted screen at 40 to 60 feet below the surface. The wells will be equipped with submersible pumps constructed of PVC pipe with PVC fittings. The pumps should be equipped with low water cutoffs to avoid damaging the pump in the event that the pumping water level declines to the depth of the pump. The discharge piping should be constructed of PVC pipe to reduce corrosion.

For cost estimating purposes, it was assumed that 3 extraction wells could adequately collect the contaminated groundwater located downgradient from the burn area. The groundwater contamination plume is estimated to be 40,000 square feet in area and has an average vertical thickness of 20 feet resulting in a volume of 800,000 cubic feet. Using an effective porosity of 0.40 for this site results in an estimated volume of contaminated groundwater of 2,400,000 gallons. It will be assumed that five times that volume will have to be removed to reduce the groundwater contaminant concentration to acceptable clean-up levels.

Effectiveness

Groundwater extraction is effective in reducing the amount of nitroaromatic contamination that can be transported downgradient, preventing human exposure to significant levels of nitroaromatics through ingestion or dermal contact and reducing impacts to aquatic life if the groundwater discharged to a surface water body. Collection via extraction wells is an effective means for mitigating migration of contaminants in the overburden and saprolite groundwater. This collection alternative passes the initial screening and will be retained for further development in the detailed analysis section.

Implementability

Collection via extraction wells could be implemented without substantial difficulties. Implementation of the extraction wells would consist of using a drilling contractor to install the wells into the overburden and saprolite units.

Cost

Capital and engineering costs for collection of contaminated groundwater is estimated at 131,000. Annual O&M costs are estimated at $27,000. Total present worth is estimated at $169,000. Cost estimates for groundwater collection are provided in Appendix A.

4.5.5 Groundwater Treatment Alternatives

Air Stripping

Air stripping is a commonly used technique for removing organic compounds from groundwater. Various air stripping methods are available. The implementability of each is discussed in the evaluation criteria sections.

After the stripping the groundwater, the air stream may require emissions controls to meet Maryland air emissions regulations. This is typically performed by use of a post-treatment scrubber using a granular carbon packed absorber. Spent carbon is typically regenerated off-site.

Effectiveness

Air stripping will not be effective in removing those nitroaromatic compounds detected in the groundwater at Site 7. Air stripping may not reduce nitroaromatics to acceptable levels.

Implementability

Air stripping is generally a readily implementable method for remediation of contaminated groundwater. The shallow tray and bubble diffusion strippers are available as skid-mounted units with process controls and alarms supplied by the manufacturer. Unlike packed towers, these units can typically be quickly cleaned of mild scale/fouling with a pressure sprayer. In addition, the shallow tray unit consists of a series of removable trays, and the unit can be increased or decreased in size by adding or removing trays if flow or volatile organic concentrations change. On the basis of ease of O&M, the shallow tray unit is considered the most implementable air stripper for the site and will be the assumed process for the air stripping alternative. Because this treatment will not effectively remove nitroaromatics from groundwater, air stripping does not pass the initial screening and will not be retained for further detailed analysis.

Cost

Capital and engineering costs for treatment of contaminated groundwater using a shallow tray air stripper is estimated at $187,000. Annual O&M costs are estimated at

$32,000 per year. Total present worth costs are estimated at $232,000. Cost estimates for groundwater treatment are provided in Appendix A.

Activated Carbon

Activated carbon removes organics and other compounds from aqueous streams by adsorbing the compounds onto the pore surface area of granular activated carbon (GAC). Activated carbon can be used in a flow-through packed treatment column or by adding powdered activated carbon (PAC) directly to contaminated water. Direct addition of PAC to water requires separation of the carbon particles from the waste stream prior to discharge of the treated waste, and is generally not implemented in cases where the treatment system is automated. Therefore, activated carbon adsorption as discussed here will assume a flow-through GAC column or bed. Activated carbon treatment would likely require pre-filtration to remove incidental solids from the water which might blind the column.

Effectiveness

Groundwater flow through a GAC column or bed would be an effective means of nitroaromatic removal. Expected removal rate should be as high as 90 percent. This degree of removal will allow the GAC unit effluent to meet the Maryland surface water quality criteria for nitroaromatics.

Implementability

GAC treatment columns or beds are typically skid-mounted units which are relatively simple to install or replace. Activated carbon is readily available from firms nationwide. Installation of a pre-filtration unit is also readily implementable.

Cost

Capital and engineering costs for treatment of contaminated groundwater using a GAC columns or beds is estimated at $161,000. Annual O&M costs are estimated at $30,000 per year with total present worth estimated at $203,000. Cost estimates for groundwater treatment are provided in Appendix A.

4.5.6 Treated Groundwater Disposal Alternatives

Discharge of Treated Groundwater

Treated groundwater will be discharged to the stream that is located just south of Dahlgren Road and flows from north to south across the NSWCWODET facility to the east of Site 9.

Effectiveness

Discharge of treated groundwater to the stream would be an effective means of disposal. Due to the low levels of inorganics found at the site, it is expected that MCLs would be achieved prior to surface water discharge. It is expected that the treatment process would decrease the nitroaromatic compounds concentrations to levels less than the NPDES permit requirements.

Implementability

Disposal of treated groundwater in the stream is very implementable. The treatment system would be located adjacent to the stream making discharge of the treated water technically feasible. Approval of a Maryland discharge permit would have to be secured prior to discharge of the treated groundwater but approval is expected to be obtained.

Cost

Capital and engineering costs for disposal of treated groundwater is estimated at $172,000. Annual O&M costs are estimated to be $43,000 with total present worth estimated at $232,000 for this alternative. Cost estimates for the disposal of treated groundwater are provided in Appendix A.

4.5.7 Summary

A range of alternatives was developed for this site using the technology type evaluations previously described. These alternatives are listed below and will be further evaluated in the detailed analysis section.

Soil Remediation Alternatives

Alternative 1 - No action with continued monitoring

Alternative 2 - Synthetic/soil cap with regrading and revegetation

Alternative 3 - In-situ soil flushing

Alternative 4 - In-situ soil fixation

Alternative 5 - Excavation with on-site soil washing and on-site disposal

Alternative 6 - Excavation with on-site soil washing and off-site disposal

Alternative 7 - Excavation with off-site soil washing and off-site disposal

Alternative 8 - Limited excavation with on-site soil washing, on-site disposal and in-situ soil flushing

Groundwater Remediation Alternatives

Alternative 1 - No action with continued monitoring

Alternative 2 - Extraction wells with GAC treatment and discharge to surface water

4.6 SITE 8 - ABANDONED CHEMICAL DISPOSAL PIT

The nature and extent of contamination and the fate and transport mechanisms of contaminants in the environment were investigated during the RI. Based on data obtained to date, the following findings regarding contaminant transport were noted:

- Groundwater quality has been impacted through leachate generation from the disposal pit. 1,1,2-trichloroethane and bis(2-ethylhexyl)phthalate were identified as chemicals of potential concern in the groundwater that potentially may have adverse effects in humans.
- Although subsurface soils at and beneath the disposal pit were not sampled, they probably have been impacted and will require remedial action as well.

Due to the complexity of this site, many technologies may be effective and implementable. Based on the applicability of technologies presented in Section 3.0, the following technologies will be considered for development into alternatives for Site 8. These technologies will be evaluated based on their effectiveness, implementability and cost.

General Response Action	Technology
No action	No action with continued monitoring
Soil/buried wastes containment or collection	Topsoil cover Clay cap Synthetic/soil cover Excavation

Soil treatment	Soil washing Soil thermal treatment Soil incineration
Treated soil disposal	On-site Off-site landfill
Excavated material disposal	Off-site landfill
Groundwater collection	Extraction wells
Groundwater treatment	Air stripping Activated carbon
Treated groundwater disposal	Discharge to surface water

4.6.1 Soil/Buried Waste Remediation Alternatives

4.6.1.1 No Action

As required by the NCP, no action for the site will be considered as an alternative. The No Action alternative involves baseline and periodic monitoring of selected media. Continued monitoring permits tracking of contaminant migration; however, it does not control migration of contaminants in the soil and does not control leachate generation with further impacts on groundwater quality.

Under a No Action scenario, monitoring would be conducted on a periodic basis to evaluate the concentration of contaminants in the soil. Samples would be collected from numerous subsurface locations within and on the perimeter of the disposal pit on a semi-annual basis to identify any migration of contaminants from surface runoff. Soil samples will be analyzed for volatile and semivolatile organic compounds since they are the chemicals of concern in this media.

Capital costs of implementing the No Action alternative would be limited to developing a detailed sampling and analysis plan (detailed costs and assumptions are provided in Appendix A) and are $11,000. Annual O&M costs include labor to obtain samples and analytical costs associated with sampling the subsurface soils and are estimated to be $5,000 per year. Total present worth costs are estimated at $62,000.

4.6.1.2 Containment

Containment of contaminated soil and buried wastes may involve various capping/covering technologies. Covering typically constitutes placing one or more layers of clean material over the contaminated site to either reduce infiltration of precipitation and/or prevent direct contact. Because Site 8 is a disposal site, this technology will be considered and evaluation of various cover technologies is presented in the following subsections. Due to regrading of the area, the total area to be capped is estimated to be approximately 5,200 square feet.

Topsoil Cover

A topsoil cover would consist of an approximate 6-inch thick layer of topsoil which would be placed over the disposal pit and seeded to promote vegetative growth for erosion control and evapotranspiration. The topsoil cover will be constructed over the surface area of the disposal pit. After the site is graded for installation of the cap, a topsoil cover will be installed.

Effectiveness

A topsoil cover placed over the disposal pit would be effective in preventing direct human contact with contaminated surface soils. However, infiltration of precipitation would not be prevented, potentially resulting in leachate generation with discharge of contaminants to groundwater. The effectiveness of a topsoil cover is only maintained if the integrity of the cover can be well maintained.

Implementability

Placement of a topsoil cover following clearing and grading would pose no substantial difficulties. Although the topsoil cover meets most of the needs for containment of contaminated soils, it does not prevent leachate which has been generated at the site and impacted groundwater quality. Therefore, this technology does not pass the initial screening and will not be retained for further detailed analysis.

Cost

Capital and engineering costs for construction of the topsoil cover over the site is estimated at $48,000. Annual O&M costs are estimated at $3,000 with total present worth costs estimated at $85,000. Cost estimates for completion of the cover are provided in Appendix A.

Clay Cap

This cap is typically used for non-hazardous waste landfills where a clay source is available. A description of the layer composition is presented in Section 3.6.2.1. Site preparation would be the same as described for the topsoil cover.

The clay cover will be constructed over the entire surface area of the site to ensure that the disposal pit is covered. After the site is graded for installation of the cap, a clay cover will be installed.

Effectiveness

A clay cover placed over the site would be effective in preventing direct human contact with contaminated surface soils. However, because of the presence of buried waste material, infiltration of precipitation needs to be prevented not decreased so that there are no further impacts to groundwater quality.

Implementability

Placement of a clay cover would pose no substantial difficulties. Although the clay cover meets most of the needs for containment of contaminated soils, it does not prevent leachate which has been generated at the site and impacted groundwater quality. Therefore, this technology does not pass the initial screening and will not be retained for further detailed analysis.

Cost

Capital and engineering costs for construction of the clay cover over the site is estimated at $48,000. Annual O&M costs are estimated at $3,000 per year with total present worth costs estimated at $85,000. Cost estimates for completion of the cover are provided in Appendix A.

Synthetic Membrane/Soil Cover System

A synthetic membrane/soil cover system consists of a synthetic membrane barrier layer, typically 30 to 40 millimeters thick, sandwiched between layers of synthetic fabric and geogrid synthetic drainage material. The synthetic fabric functions to protect the plastic sheeting from perforation due to rocks or sharp objects. The top layer of synthetic fabric is then covered with a 6- to 12-inch layer of topsoil and is seeded to promote vegetative growth for erosion control purposes.

The purposes of the impermeable cap are to reduce human exposure to contaminated soils and to reduce the amount of infiltration from rainfall that could impact groundwater quality. The cap will be designed and constructed to promote drainage and minimize

erosion of the cover. Long-term O&M will be conducted to ensure the integrity of the cap.

Effectiveness

The synthetic/soil cover is effective in preventing erosion and contact with contaminated soils, and limiting infiltration to the buried wastes with potential discharge to groundwater. Capping alone does not address the human health and environmental impacts associated with exposure to contaminated groundwater, and does not prevent migration of existing groundwater contamination.

Implementability

Construction of the synthetic/soil cover could be completed without substantial implementation difficulties. The synthetic cover passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for construction of the synthetic/soil cover over the disposal pit is estimated at $64,000. Annual O&M costs are estimated at $3,000 per year. Total present worth costs are estimated at $101,000. Cost estimates for completion of the cap are provided in Appendix A.

4.6.1.3 Excavation

Contaminated Soil/Buried Waste Removal

The purpose of the soil and buried waste excavation is to reduce the amount of leachate generation that could impact groundwater and eventually affect human health and aquatic life. The disposal pit including all contaminated soil and buried wastes will be excavated with subsequent treatment and/or disposal. The amount of soil and buried wastes to be excavated is expected to be approximately 1,600 cubic yards. For the purposes of cost estimating, 1,400 cubic yards of the excavated material are considered to be contaminated soil with the remaining 200 cubic yards considered as buried waste materials such as drums, metal containers, scrap metal and other solid waste.

Effectiveness

Contaminated soil and buried waste removal would be effective in preventing leachate generation while reducing the impacts to groundwater. Thus, reducing the potential risks from exposure to contaminated groundwater.

Implementability

Contaminated soil and buried waste removal could be implemented with no

substantial difficulties. Excavation passes the initial screening and will be developed further in the detailed analysis section.

Cost

Capital and engineering costs for excavation of the disposal pit is estimated at $23,000. Cost estimates for removal are provided in Appendix A.

4.6.2 Soil Treatment Alternatives

Although no subsurface soil sampling has been conducted to determine the levels of contamination for organics at the disposal pit, based on the concentrations of organics detected in the groundwater at the site, it is assumed that treatment of contaminated soils will be required. As discussed above, approximately 1,400 cubic yards of contaminated soil are estimated to be excavated from the disposal pit that require treatment.

4.6.2.1 Thermal Treatment/Incineration

Thermal treatment involves heating the contaminated soil to the point where the contaminants will experience combustion, thus fully or partially oxidizing the organic contaminants. Gases and/or particulate emitted during the combustion process are typically quenched, then scrubbed or absorbed such that they can be discharged to the atmosphere. Thermal treatment may involve the use of high temperature steam to thermally destruct contaminants. Thermal treatment will be considered as an on-site treatment option.

Thermal treatment at high temperatures using an oven or kiln is defined as incineration and is generally only feasible as an off-site treatment option.

<u>On-site Thermal Treatment</u>

Soils would be staged at the treatment unit prior to and after treatment. Disposal of treatment residuals would be used as "clean fill" or sent off-site to a chemical waste landfill. Treatment residual disposal alternatives are discussed in Section 4.6.4.

Effectiveness

Following excavation, the contaminated soil would receive thermal treatment to minimize the human health and environmental risks associated with the excavated sediment. Reduction in organic concentration can be as high as 99 percent; therefore, thermal treatment is an effective treatment method for volatile and semivolatile organic contamination.

Implementability

Equipment required for the thermal treatment of contaminated soil would be supplied by a thermal treatment vendor. Electrical power and possibly a fuel source would need to be supplied to the process. Extensive mobilization and installation of equipment would be required. The implementation of on-site thermal treatment is technically feasible. Approval of on-site treatment (permit may be required) will be the most difficult implementation facet of this remedial action. Based on the effectiveness and implementability of thermal treatment, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for on-site thermal treatment of the contaminated soil is estimated at $214,000. Cost estimates for soil thermal treatment are provided in Appendix A.

Off-site Incineration

Off-site treatment with incineration would involve transport of contaminated soil to the off-site treatment facility.

Effectiveness

Following excavation, contaminated soil would be transported to an off-site facility for treatment by incineration. Transport of untreated contaminated soil may increase the risks to human health and the environment due to the potential release of the soils to the environment via accidental spillage. The effectiveness of incineration was previously discussed.

Implementability

The implementability of excavation has been previously discussed. The implementation of off-site incineration is technically feasible. Off-site transport may required proper manifesting (hazardous or special waste).

Cost

Capital and engineering costs for off-site incineration of the contaminated soil is estimated at $6,474,000. Cost estimates for soil incineration are provided in Appendix A. Based on the extremely high costs of incineration, this technology does not pass the initial screening and will not be retained for further detailed analysis.

4.6.2.2 Soil Washing

Soil washing requires excavating contaminated soil and washing it in a mobile washing unit. The washing fluid can be water, organic solvents, surfactants, etc. More detailed description on operation of the unit can be found in Section 3.7.4.3.

On-site Soil Washing

Excavated soil would require staging at the treatment unit prior to and after soil washing.

Effectiveness

Following excavation, the contaminated soil would receive soil washing to minimize the human health and environmental risks associated with the excavated soil. Reduction in organic concentration can be as high as 90 percent; therefore, soil washing is an effective treatment method for volatile and semivolatile organic contamination.

Implementability

Mobile equipment required for the washing of contaminated soil would be supplied by a vendor. Electrical power and possibly a fuel source would need to be supplied to the process. Extensive mobilization and installation of equipment would be required. The implementation of on-site soil washing is technically feasible. Approval of on-site treatment (permit may be required) will be the most difficult implementation facet of this remedial action. Based on the effectiveness and implementability of soil washing, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for on-site soil washing of the contaminated soil is estimated at $433,000. Cost estimates for soil washing are provided in Appendix A.

Off-Site Soil Washing

Off-site treatment with soil washing would involve transport of soil to the off-site treatment facility.

Effectiveness

Following excavation, contaminated soil would be transported to an off-site facility for treatment by soil washing. Transport of untreated contaminated soil may increase the risks to human health and the environment due to the potential release of the soils to the environment via accidental spillage. The effectiveness of soil washing was previously discussed.

Implementability

The implementability of excavation has been previously discussed. The implementation of off-site soil washing is technically feasible. Off-site transport may required proper manifesting (hazardous or special waste). Based on the effectiveness and implementability of soil washing, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for off-site soil washing of the contaminated soil is estimated at $699,000. Cost estimates for soil washing are provided in Appendix A.

4.6.3 Soil Disposal Alternatives

As stated in Section 4.6.2, it is assumed that treatment prior to disposal will be required. Therefore, disposal of untreated soils will not be evaluated in this section.

On-site Treatment Residue Disposal

A 90 percent reduction in concentration of organics in the residue would be expected for all of the treatment processes discussed above. All treatment processes will generate a waste stream that contains the majority of the organic contamination that was removed from the soil during the treatment process. These wastes will be further treated or disposed of properly off-site. Only the residual ash or soil from the treatment process will be evaluated for disposal in this section. Approximately 1,400 cubic yards of treatment residue is expected to require disposal.

Effectiveness

On-site disposal as "clean fill" back into the excavated areas would be an effective method of treatment residue disposal. Human health exposure to treatment residue would be eliminated. Residual contamination would not generate a leachate that would further impact groundwater quality.

Implementability

The disposal of treatment residue in the excavated areas could be implemented with no substantial difficulties. Approval of on-site disposal (permit may be required) will be the most difficult implementation facet of this remedial action. Based on the effectiveness and implementability of disposal of treatment residue in the excavated areas, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for on-site disposal of the treatment residuals is estimated at $13,000. Cost estimates are provided in Appendix A.

Off-site Treatment Residue Disposal

As previously stated, treatment of the contaminated soils would occur prior to disposal of the treatment residuals. Approximately 1,400 cubic yards of soil will require disposal.

Effectiveness

Off-site disposal in an approved landfill would be an effective method of PCB treatment residue disposal. Human health exposure to treatment residue would be eliminated.

Implementability

The disposal of treatment residue in an approved landfill could be implemented with no substantial difficulties. Based on the effectiveness and implementability of disposal of treatment residue in an approved landfill, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for off-site disposal of the treatment residuals is estimated at $844,000. Cost estimates are provided in Appendix A.

4.6.4 Buried Waste Disposal Alternatives

As previously stated in Section 4.6.1.3, approximately 200 cubic yards of buried solid material (i.e., drums, metal containers and other scrap) will require off-site disposal. The only alternative to be discussed and evaluated will be the disposal of this material in a solid or hazardous waste landfill.

Off-site Waste Disposal

Effectiveness

Off-site disposal in an approved landfill would be an effective method of excavated material disposal. Human health exposure to these potentially contaminated materials would be eliminated.

Implementability

The disposal of these materials in an approved landfill could be implemented with no substantial difficulties. Based on the effectiveness and implementability of disposal of solid

wastes in an approved landfill, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for off-site disposal of the these materials is estimated at $133,000. Cost estimates are provided in Appendix A.

4.6.5 Groundwater Collection Alternatives

These technologies include no action and collection of contaminated groundwater that has migrated in the groundwater in the overburden and upper saprolite units in a radial area around the disposal pit. The initial screening of these alternatives is as follows.

4.6.5.1 No Action

As required by the NCP, no action for the site will be considered as an alternative. The No Action alternative involves baseline and periodic monitoring of selected media. Continued monitoring permits tracking of contaminant migration; however, it does not control migration of contaminants in the groundwater.

Under a No Action scenario, monitoring would be conducted on a periodic basis to evaluate the movement and concentration of contaminants in the groundwater. Samples would be collected from the existing and any additional groundwater monitoring wells on a quarterly basis. Groundwater samples will be analyzed for volatile and semivolatile organics. The no action alternative will be retained through the preliminary screening and detailed analysis section.

Capital costs of implementing the no action alternative would be include the installation of additional groundwater monitoring wells, development of a detailed sampling and analysis plan (detailed costs and assumptions are provided in Appendix A) and are $11,000. Annual O&M costs include labor to obtain samples and analytical costs associated with sampling the groundwater and are estimated to be $5,000 per year. Total present worth costs are estimated at $72,000.

4.6.5.2 Collection

Extraction Wells

The purpose of groundwater collection is to reduce the amount of volatile and semivolatile organic contamination that could migrate and affect human health and aquatic

life through ingestion and dermal contact. Because extraction wells have been used successfully to control groundwater flow on various other similar contaminated sites within EPA Region III, the technology for implementing extraction wells is highly developed and the contaminants are located at depths and in a saprolite unit where a trench system would not be cost effective or technically feasible, it is the only collection technology that will be evaluated for Site 8.

Groundwater will be collected using extraction wells located within the plume and at the leading edge of the contaminant plume to capture contaminated groundwater and prevent further migration of contamination. It is estimated that properly located extraction wells will be able to capture sufficient groundwater flow to restrict on- and off-site migration of contaminants in the overburden and saprolite. The groundwater extraction wells will be screened in the overburden and upper saprolite unit. Based on hydrogeologic investigations performed during the RI, groundwater at the leading edge of the contaminant plume is located in the overburden and saprolite units.

The development of extraction wells has been limited to the overburden and in the upper saprolite to a depth of 55 feet in order to restrict groundwater movement in the most contaminated zones. Based upon data (drawdown and recovery data collected from on-site monitoring wells) reported in the RI report, it is estimated that the each extraction well should yield about 2 gpm. The actual withdrawal rate will have to be confirmed by testing during design of the system.

The conceptual design for the extraction wells includes an 8-inch diameter borehole to a depth of 55 feet, the wells will be constructed of 6-inch PVC pipe with a continuous-slotted screen at 35 to 55 feet below the surface. The wells will be equipped with submersible pumps constructed of PVC pipe with PVC fittings. The pumps should be equipped with low water cutoffs to avoid damaging the pump in the event that the pumping water level declines to the depth of the pump. The discharge piping should be constructed of PVC pipe to reduce corrosion.

For cost estimating purposes, it was assumed that four extraction wells could adequately collect the contaminated groundwater located radially around the disposal pit. The groundwater contamination plume is estimated to be 31,500 square feet in area and has an average vertical thickness of 20 feet resulting in a volume of 63,000 cubic feet. Using an effective porosity of 0.40 for this site results in an estimated volume of contaminated groundwater of 188,500 gallons. It will be assumed that five times that volume will have to

be removed to reduce the groundwater contaminant concentration to acceptable clean-up levels.

Effectiveness

Groundwater extraction is effective in reducing the amount of volatile organic contamination that can be transported downgradient, preventing human exposure to significant levels of organics through ingestion or dermal contact and reducing impacts to aquatic life if the groundwater discharged to a surface water body. Collection via extraction wells is an effective means for mitigating migration of contaminants in the overburden and saprolite groundwater. This collection alternative passes the initial screening and will be retained for further development in the detailed analysis section.

Implementability

Collection via extraction wells could be implemented without substantial difficulties. Implementation of the extraction wells would consist of using a drilling contractor to install the wells into the overburden and saprolite units.

Cost

Capital and engineering costs for collection of contaminated groundwater is estimated at $143,000. Annual O&M costs are estimated at $18,000. Total present worth costs for this alternative are estimated at $161,000. Cost estimates for groundwater collection are provided in Appendix A.

4.6.6 Groundwater Treatment Alternatives

Air Stripping

Air stripping is a commonly used technique for removing organic compounds from groundwater. Air stripping is particularly effective for removal of low molecular weight chlorinated solvents such as 1,1,2-trichloroethane. Various air stripping methods are available. The implementability of each is discussed in the evaluation criteria sections.

After the stripping the groundwater, the air stream may require emissions controls to meet Maryland air emissions regulations. This is typically performed by use of a post-treatment scrubber using a granular carbon packed absorber. Spent carbon is typically regenerated off-site.

Effectiveness

Air stripping will be effective in removing those volatile organic compounds detected in the groundwater at Site 8. However, air stripping may not be effective in reducing the

levels of semivolatile organics to acceptable levels. Expected volatile organic removal rate should be as high as 90 percent with 99 percent removal potentially attainable. This degree of removal will allow the air stripper effluent to meet the Maryland surface water quality criteria for volatile organics.

Implementability

Air stripping is generally a readily implementable method for remediation of contaminated groundwater. The shallow tray and bubble diffusion strippers are available as skid-mounted units with process controls and alarms supplied by the manufacturer. Unlike packed towers, these units can typically be quickly cleaned of mild scale/fouling with a pressure sprayer. In addition, the shallow tray unit consists of a series of removable trays, and the unit can be increased or decreased in size by adding or removing trays if flow or volatile organic concentrations change. On the basis of ease of O&M, the shallow tray unit is considered the most implementable air stripper for the site and will be the assumed process for the air stripping alternative.

Physical treatment through air stripping passes the initial screening and shall be retained for further detailed analysis.

Cost

Capital and engineering costs for treatment of contaminated groundwater using a shallow tray air stripper is estimated at $145,000. Annual O&M costs are estimated at $20,000 per year. Total present worth costs are estimated at $165,000. Cost estimates for groundwater treatment are provided in Appendix A.

Activated Carbon

Activated carbon removes organics from aqueous streams by adsorbing the compounds onto the pore surface area of granular activated carbon (GAC). Activated carbon can be used in a flow-through packed treatment column or by adding powdered activated carbon (PAC) directly to contaminated water. Direct addition of PAC to water requires separation of the carbon particles from the waste stream prior to discharge of the treated waste, and is generally not implemented in cases where the treatment system is automated. Therefore, activated carbon adsorption as discussed here will assume a flow-through GAC column or bed. Activated carbon treatment would likely require pre-filtration to remove incidental solids from the water which might blind the column.

Effectiveness

Groundwater flow through a GAC column or bed would be an effective means of volatile and semivolatile organic removal. Expected removal rate should be as high as 90 percent with 99 percent removal potentially attainable. This degree of removal will allow the GAC unit effluent to meet the Maryland surface water quality criteria for volatile organics.

Implementability

GAC treatment columns or beds are typically skid-mounted units which are relatively simple to install or replace. Activated carbon is readily available from firms nationwide. Installation of a pre-filtration unit is also readily implementable. Activated carbon treatment passes the initial screening process and will be retained for further detailed analysis.

Cost

Capital and engineering costs for treatment of contaminated groundwater using a GAC columns or beds is estimated at $121,000. Annual O&M costs are estimated at $19,000 per year. Total present worth costs are estimated at $140,000 for this alternative. Cost estimates for groundwater treatment are provided in Appendix A.

4.6.7 Treated Groundwater Disposal Alternatives

Discharge of Treated Groundwater

Treated groundwater will be discharged to the stream that flows from north to south to the east of the site.

Effectiveness

Discharge of treated groundwater to the stream would be an effective means of disposal. Due to the low levels of inorganics found at the site, it is expected that MCLs would be achieved prior to surface water discharge. It is expected that the treatment process would decrease the volatile and semivolatile organic concentrations to levels less than the Maryland surface water quality criteria.

Implementability

Disposal of treated groundwater in the stream is very implementable. The treatment system would be located adjacent to the stream making discharge of the treated water technically feasible. Approval of a Maryland discharge permit would have to be secured prior to discharge of the treated groundwater but approval is expected to be obtained.

Cost

Capital and engineering costs for disposal of treated groundwater is estimated at $180,000. Annual O&M costs are estimated at $12,000 with total present worth costs estimated at $192,000. Cost estimates for the disposal of treated groundwater are provided in Appendix A.

4.6.8 Summary

A range of alternatives was developed for this site using the technology type evaluations previously described. These alternatives are listed below and will be further evaluated in the detailed analysis section.

Soil Remediation Alternatives

Alternative 1 - No action with continued monitoring

Alternative 2 - Synthetic/soil cap with regrading and revegetation

Alternative 3 - Excavation with on-site thermal treatment and on-site disposal

Alternative 4 - Excavation with on-site thermal treatment and off-site disposal

Alternative 5 - Excavation with on-site soil washing and on-site disposal

Alternative 6 - Excavation with on-site soil washing and off-site disposal

Alternative 7 - Excavation with off-site soil washing and off-site disposal

Buried Waste Material Disposal Alternatives

Alternative 1 - Off-site landfill

Groundwater Remediation Alternatives

Alternative 1 - No action with continued monitoring

Alternative 2 - Extraction wells with air stripping and discharge to surface water

Alternative 3 - Extraction wells with GAC treatment and discharge to surface water

4.7 SITE 9 - INDUSTRIAL WASTEWATER DISPOSAL AREA 300

The nature and extent of contamination and the fate and transport mechanisms of contaminants in the environment were investigated during the RI. Based on data obtained to date, the following findings regarding contaminant transport were noted:

- Groundwater quality in several areas of the site has been impacted through leachate generation from seven leaching wells and fields. Several volatile organic compounds (tetrachloroethene and trichloroethene) and RDX were identified as chemicals of potential concern in the groundwater that potentially may have adverse effects in humans.
- Although subsurface soils at and beneath the leaching wells and fields were not sampled, they probably have been impacted and will require remedial action as well.

Due to the complexity of this site, many technologies may be effective and implementable. Based on the applicability of technologies presented in Section 3.0, the following technologies will be considered for development into alternatives for Site 9. These technologies will be evaluated based on their effectiveness, implementability and cost.

General Response Action	Technology
No action	No action with continued monitoring
Soil/leaching well and field material collection	Excavation
Soil treatment	Soil washing Soil thermal treatment Soil incineration
Treated soil disposal	On-site Off-site landfill
Excavated material disposal	Off-site landfill
Groundwater collection	Extraction wells

Groundwater treatment	Air stripping Activated carbon
Treated groundwater disposal	Discharge to surface water

4.7.1 Soil/Buried Waste Remediation Alternatives

4.7.1.1 No Action

As required by the NCP, no action for the site will be considered as an alternative. The No Action alternative involves baseline and periodic monitoring of selected media. Continued monitoring permits tracking of contaminant migration; however, it does not control migration of contaminants in the soil and does not control leachate generation with further impacts on groundwater quality.

Under a No Action scenario, monitoring would be conducted on a periodic basis to evaluate the concentration of contaminants in the soil to determine any migration of contaminants through surface runoff. Samples would be collected from numerous subsurface locations within the perimeter of the leaching wells and fields on a semi-annual basis. Soil samples will be analyzed for volatile organic and nitroaromatic compounds since they are the chemicals of concern in this media.

Capital costs of implementing the No Action alternative would be limited to developing a detailed sampling and analysis plan (detailed costs and assumptions are provided in Appendix A) and are $11,000. Annual O&M costs include labor to obtain samples and analytical costs associated with sampling the subsurface soils and are estimated to be $18,000 per year. Total present worth is estimated at $209,000.

4.7.1.2 Excavation

Contaminated Soil/Buried Material Removal

The purpose of the soil and buried materials (i.e., wastes or solid materials located in the leaching wells) excavation is to reduce the amount of leachate generation that could impact groundwater and eventually affect human health and aquatic life. The seven identified leaching wells and fields including all contaminated soil and buried wastes will be excavated with subsequent treatment and/or disposal. The amount of soil and buried materials to be excavated is expected to be approximately 1,050 cubic yards for seven locations. For the purposes of cost estimating, 1,000 cubic yards of the excavated material

are considered to be contaminated soil with the remaining 50 cubic yards considered as buried materials such as leaching well/field construction material (i.e., bricks, piping).

Effectiveness

Contaminated soil and buried material removal would be effective in preventing leachate generation while reducing the impacts to groundwater. Thus, reducing the potential risks from exposure to contaminated groundwater.

Implementability

Contaminated soil and buried material removal could be implemented with no substantial difficulties. Excavation passes the initial screening and will be developed further in the detailed analysis section.

Cost

Capital and engineering costs for excavation of the leaching wells and field is estimated at $24,000. Cost estimates for removal are provided in Appendix A.

4.7.2 Soil Treatment Alternatives

Although no subsurface soil sampling has been conducted to determine the levels of contamination for volatile organics and nitroaromatics at the site, based on the high concentrations of volatile organics and nitroaromatics detected in the groundwater at the site, it is assumed that treatment of contaminated soils will be required. As discussed above, approximately 1,000 cubic yards of contaminated soil are estimated to be excavated from the leaching wells and field that require treatment.

4.7.2.1 Thermal Treatment/Incineration

Thermal treatment involves heating the contaminated soil to the point where the contaminants will experience combustion, thus fully or partially oxidizing the organic contaminants. Gases and/or particulate emitted during the combustion process are typically quenched, then scrubbed or absorbed such that they can be discharged to the atmosphere. Thermal treatment may involve the use of high temperature steam to thermally destruct contaminants. Thermal treatment will be considered as an on-site treatment option.

Thermal treatment at high temperatures using an oven or kiln is defined as incineration and is generally only feasible as an off-site treatment option.

On-site Thermal Treatment

Soils would be staged at the treatment unit prior to and after treatment. Disposal of treatment residuals would be used as "clean fill" or sent off-site to a chemical waste landfill. Treatment residual disposal alternatives are discussed in Section 4.7.3.

Effectiveness

Following excavation, the contaminated soil would receive thermal treatment to minimize the human health and environmental risks associated with the excavated sediment. Reduction in organic concentration can be as high as 99 percent; therefore, thermal treatment is an effective treatment method for volatile organic and nitroaromatic contamination.

Implementability

Equipment required for the thermal treatment of contaminated soil would be supplied by a thermal treatment vendor. Electrical power and possibly a fuel source would need to be supplied to the process. Extensive mobilization and installation of equipment would be required. The implementation of on-site thermal treatment is technically feasible. Approval of on-site treatment (permit may be required) will be the most difficult implementation facet of this remedial action. Based on the effectiveness and implementability of thermal treatment, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for on-site thermal treatment of the contaminated soil is estimated at $161,000. Cost estimates for soil thermal treatment are provided in Appendix A.

Off-site Incineration

Off-site treatment with incineration would involve transport of contaminated soil to the off-site treatment facility.

Effectiveness

Following excavation, contaminated soil would be transported to an off-site facility for treatment by incineration. Transport of untreated contaminated soil may increase the risks to human health and the environment due to the potential release of the soils to the environment via accidental spillage. The effectiveness of incineration was previously discussed.

Implementability

The implementability of excavation has been previously discussed. The implementation of off-site incineration is technically feasible. Off-site transport may required proper manifesting (hazardous or special waste).

Cost

Capital and engineering costs for off-site incineration of the contaminated soil is estimated at $4,633,000. Cost estimates for soil incineration are provided in Appendix A. Based on the high cost of incineration, this technology does not pass the initial screening and will not be retained for further detailed analysis.

4.7.2.2 Soil Washing

Soil washing requires excavating contaminated soil and washing it in a mobile washing unit. The washing fluid can be water, organic solvents, surfactants, etc. More detailed description on operation of the unit can be found in Section 3.7.4.3.

On-site Soil Washing

Excavated soil would require staging at the treatment unit prior to and after soil washing.

Effectiveness

Following excavation, the contaminated soil would receive soil washing to minimize the human health and environmental risks associated with the excavated soil. Reduction in organic concentration can be as high as 90 percent; therefore, soil washing is an effective treatment method for volatile organic and nitroaromatic contamination.

Implementability

Mobile equipment required for the washing of contaminated soil would be supplied by a vendor. Electrical power and possibly a fuel source would need to be supplied to the process. Extensive mobilization and installation of equipment would be required. The implementation of on-site soil washing is technically feasible. Approval of on-site treatment (permit may be required) will be the most difficult implementation facet of this remedial action. Based on the effectiveness and implementability of soil washing, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for on-site soil washing of the contaminated soil is estimated at $318,000. Cost estimates for soil washing are provided in Appendix A.

Off-Site Soil Washing

Off-site treatment with soil washing would involve transport of soil to the off-site treatment facility.

Effectiveness

Following excavation, contaminated soil would be transported to an off-site facility for treatment by soil washing. Transport of untreated contaminated soil may increase the risks to human health and the environment due to the potential release of the soils to the environment via accidental spillage. The effectiveness of soil washing was previously discussed.

Implementability

The implementability of excavation has been previously discussed. The implementation of off-site soil washing is technically feasible. Off-site transport may required proper manifesting (hazardous or special waste). Based on the effectiveness and implementability of soil washing, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for off-site soil washing of the contaminated soil is estimated at $508,000. Cost estimates for soil washing are provided in Appendix A.

4.7.3 Soil Disposal Alternatives

As stated in Section 4.7.2, it is assumed that treatment prior to disposal will be required. Therefore, disposal of untreated soils will not be evaluated in this section.

On-site Treatment Residue Disposal

A 90 percent reduction in concentration of organics in the residue would be expected for all of the treatment processes discussed above. All treatment processes will generate a waste stream that contains the majority of the organic contamination that was removed from the soil during the treatment process. These wastes will be further treated or disposed of properly off-site. Only the residual ash or soil from the treatment process will be evaluated for disposal in this section. Approximately 1,000 cubic yards of treatment residue is expected to require disposal.

Effectiveness

On-site disposal as "clean fill" back into the excavated areas would be an effective method of treatment residue disposal. Human health exposure to treatment residue would

be eliminated. Residual contamination would not generate a leachate that would further impact groundwater quality.

Implementability

The disposal of treatment residue in the excavated areas could be implemented with no substantial difficulties. Approval of on-site disposal (permit may be required) will be the most difficult implementation facet of this remedial action. Based on the effectiveness and implementability of disposal of treatment residue in the excavated areas, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for on-site disposal of the treatment residuals is estimated at $17,000. Cost estimates are provided in Appendix A.

Off-site Treatment Residue Disposal

As previously stated, treatment of the contaminated soils would occur prior to disposal of the treatment residuals. Approximately 1,000 cubic yards of soil will require disposal.

Effectiveness

Off-site disposal in an approved landfill would be an effective method of PCB treatment residue disposal. Human health exposure to treatment residue would be eliminated.

Implementability

The disposal of treatment residue in an approved landfill could be implemented with no substantial difficulties. Based on the effectiveness and implementability of disposal of treatment residue in an approved landfill, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for off-site disposal of the treatment residuals is estimated at $603,000. Cost estimates are provided in Appendix A.

4.7.4 Buried Waste Disposal Alternatives

As previously stated in Section 4.7.1.2, approximately 50 cubic yards of buried leaching well material (i.e., bricks and piping) will require off-site disposal. The only alternative to be discussed and evaluated will be the disposal of this material in a solid or hazardous waste landfill.

Off-site Waste Disposal

Effectiveness

Off-site disposal in an approved landfill would be an effective method of excavated material disposal. Human health exposure to these potentially contaminated materials would be eliminated.

Implementability

The disposal of these materials in an approved landfill could be implemented with no substantial difficulties. Based on the effectiveness and implementability of disposal of solid wastes in an approved landfill, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for off-site disposal of the these materials is estimated at $33,000. Cost estimates are provided in Appendix A.

4.7.5 Groundwater Collection Alternatives

These technologies include no action and collection of contaminated groundwater that has migrated in the groundwater in the overburden and upper saprolite units to the southeast from the leaching wells and field. There are 3 distinct plumes located at the site. However, only 2 plumes will be addressed for remedial alternatives for this site. The plume located on the northern end of the site is the downgradient extent of contamination from Site 4 and will be cleaned up in accordance with the Site 4 alternatives. The initial screening of these alternatives is as follows.

4.7.5.1 No Action

As required by the NCP, no action for the site will be considered as an alternative. The No Action alternative involves baseline and periodic monitoring of selected media. Continued monitoring permits tracking of contaminant migration; however, it does not control migration of contaminants in the groundwater.

Under a No Action scenario, monitoring would be conducted on a periodic basis to evaluate the movement and concentration of contaminants in the groundwater. Samples would be collected from the existing groundwater monitoring wells on a quarterly basis. Groundwater samples will be analyzed for volatile organics and nitroaromatics. The no action alternative will be retained through the preliminary screening and detailed analysis section.

Capital costs of implementing the no action alternative would be include development of a detailed sampling and analysis plan (detailed costs and assumptions are provided in Appendix A) and are $11,000. Annual O&M costs include labor to obtain samples and analytical costs associated with sampling the groundwater and are estimated to be $18,000 per year. Total present worth is estimated at $209,000.

4.7.5.2 Collection

Extraction Wells

The purpose of groundwater collection is to reduce the amount of volatile organic and nitroaromatic contamination that could migrate and affect human health and aquatic life through ingestion and dermal contact. Because extraction wells have been used successfully to control groundwater flow on various other similar contaminated sites within EPA Region III, the technology for implementing extraction wells is highly developed and the contaminants are located at depths and in a saprolite unit where a trench system would not be cost effective or technically feasible, it is the only collection technology that will be evaluated for Site 9.

Groundwater will be collected using extraction wells located within the plume and at the leading edge of the contaminant plumes to capture contaminated groundwater and prevent further migration of contamination. It is estimated that properly located extraction wells will be able to capture sufficient groundwater flow to restrict on- and off-site migration of contaminants in the overburden and saprolite. The groundwater extraction wells will be screened in the overburden and upper saprolite unit. Based on hydrogeologic investigations performed during the RI, groundwater at the leading edge of the contaminant plumes is located in the overburden and saprolite units.

The development of extraction wells has been limited to the overburden and in the upper saprolite to a depth of 30 feet in order to restrict groundwater movement in the most contaminated zones. Based upon data (drawdown and recovery data collected from on-site monitoring wells) reported in the RI report, it is estimated that the each extraction well should yield about 2 gpm. The actual withdrawal rate will have to be confirmed by testing during design of the system.

The conceptual design for the deep extraction wells includes an 8-inch diameter borehole to a depth of 30 feet, the wells will be constructed of 6-inch PVC pipe with a continuous-slotted screen at 10 to 30 feet below the surface. Several extraction wells will

be shallow wells with depths of only 15 feet and a continuous-slotted screen at 5 to 15 feet below the surface. The wells will be equipped with submersible pumps constructed of PVC pipe with PVC fittings. The pumps should be equipped with low water cutoffs to avoid damaging the pump in the event that the pumping water level declines to the depth of the pump. The discharge piping should be constructed of PVC pipe to reduce corrosion.

For cost estimating purposes, it was assumed that eight extraction wells (five shallow, three deep) could adequately collect the contaminated groundwater located downgradient from the leaching wells and field. The groundwater contamination plumes are estimated to be 240,000 square feet in area and has an average vertical thickness of 20 feet resulting in a volume of 16,650,000 cubic feet. Using an effective porosity of 0.40 for this site results in an estimated volume of contaminated groundwater of 14,400,000 gallons. It will be assumed that five times that volume will have to be removed to reduce the groundwater contaminant concentration to acceptable clean-up levels.

Effectiveness

Groundwater extraction is effective in reducing the amount of volatile organic contamination that can be transported downgradient, preventing human exposure to significant levels of organics through ingestion or dermal contact and reducing impacts to aquatic life if the groundwater discharged to a surface water body. Collection via extraction wells is an effective means for mitigating migration of contaminants in the overburden and saprolite groundwater. This collection alternative passes the initial screening and will be retained for further development in the detailed analysis section.

Implementability

Collection via extraction wells could be implemented without substantial difficulties. Implementation of the extraction wells would consist of using a drilling contractor to install the wells into the overburden and saprolite units.

Cost

Capital and engineering costs for collection of contaminated groundwater is estimated at $296,000. Annual O&M costs are estimated at $44,000 per year. Total present worth is estimated at $576,000. Cost estimates for groundwater collection at this site are provided in Appendix A.

4.7.6 Groundwater Treatment Alternatives

Air Stripping

Air stripping is a commonly used technique for removing volatile organic compounds from groundwater. Air stripping is particularly effective for removal of low molecular weight chlorinated solvents such as tetrachloroethene and trichloroethene. Various air stripping methods are available. The implementability of each is discussed in the evaluation criteria sections.

After the stripping the groundwater, the air stream may require emissions controls to meet Maryland air emissions regulations. This is typically performed by use of a post-treatment scrubber using a granular carbon packed absorber. Spent carbon is typically regenerated off-site.

Effectiveness

Air stripping will be effective in removing those volatile organic compounds detected in the groundwater at Site 9. However, air stripping may not be effective in reducing the levels of nitroaromatics to acceptable levels. Expected volatile organic removal rate should be as high as 90 percent with 99 percent removal potentially attainable. This degree of removal will allow the air stripper effluent to meet the Maryland surface water quality criteria for volatile organics.

Implementability

Air stripping is generally a readily implementable method for remediation of contaminated groundwater. The shallow tray and bubble diffusion strippers are available as skid-mounted units with process controls and alarms supplied by the manufacturer. Unlike packed towers, these units can typically be quickly cleaned of mild scale/fouling with a pressure sprayer. In addition, the shallow tray unit consists of a series of removable trays, and the unit can be increased or decreased in size by adding or removing trays if flow or volatile organic concentrations change. On the basis of ease of O&M, the shallow tray unit is considered the most implementable air stripper for the site and will be the assumed process for the air stripping alternative.

Physical treatment through air stripping passes the initial screening and shall be retained for further detailed analysis.

Cost

Capital and engineering costs for treatment of contaminated groundwater using a shallow tray air stripper is estimated at $187,000. Annual O&M costs are estimated at

$48,000 per year. Total present worth is estimated at $490,000. Cost estimates for groundwater treatment are provided in Appendix A.

Activated Carbon

Activated carbon removes organics from aqueous streams by adsorbing the compounds onto the pore surface area of granular activated carbon (GAC). Activated carbon can be used in a flow-through packed treatment column or by adding powdered activated carbon (PAC) directly to contaminated water. Direct addition of PAC to water requires separation of the carbon particles from the waste stream prior to discharge of the treated waste, and is generally not implemented in cases where the treatment system is automated. Therefore, activated carbon adsorption as discussed here will assume a flow-through GAC column or bed. Activated carbon treatment would likely require pre-filtration to remove incidental solids from the water which might blind the column.

Effectiveness

Groundwater flow through a GAC column or bed would be an effective means of volatile organic and nitroaromatic removal. Expected removal rate should be as high as 90 percent with 99 percent removal potentially attainable. This degree of removal will allow the GAC unit effluent to meet the Maryland surface water quality criteria for volatile organics and nitroaromatics.

Implementability

GAC treatment columns or beds are typically skid-mounted units which are relatively simple to install or replace. Activated carbon is readily available from firms nationwide. Installation of a pre-filtration unit is also readily implementable.

Cost

Capital and engineering costs for treatment of contaminated groundwater using a GAC columns or beds is estimated at $161,000. Annual O&M costs are estimated at $46,000 per year. Total present worth is estimated at $451,000. Cost estimates for groundwater treatment are provided in Appendix A.

4.7.7 Treated Groundwater Disposal Alternatives

Discharge of Treated Groundwater

Treated groundwater will be discharged to the stream that is flows from north to south across the NSWCWODET facility to the west of Site 9 and flows into Paint Branch Creek just south of the NSWCWODET facility.

Effectiveness

Discharge of treated groundwater to the stream would be an effective means of disposal. Due to the low levels of inorganics found at the site, it is expected that MCLs would be achieved prior to surface water discharge. It is expected that the treatment process would decrease the volatile organic and nitroaromatic concentrations to levels less than the Maryland surface water quality criteria.

Implementability

Disposal of treated groundwater in the stream is very implementable. The treatment system would be located near the stream making discharge of the treated water technically feasible. Approval of a Maryland discharge permit would have to be secured prior to discharge of the treated groundwater but approval is expected to be obtained.

Cost

Capital and engineering costs for disposal of treated groundwater is estimated at $147,000. Annual O&M costs are estimated $56,000 per year. Total present worth is estimated at $497,000. Cost estimates for the disposal of treated groundwater are provided in Appendix A.

4.7.8 Summary

A range of alternatives was developed for this site using the technology type evaluations previously described. These alternatives are listed below and will be further evaluated in the detailed analysis section.

Soil Remediation Alternatives

Alternative 1 - No action with continued monitoring

Alternative 2 - Excavation with on-site thermal treatment and on-site disposal

Alternative 3 - Excavation with on-site thermal treatment and off-site disposal

Alternative 4 - Excavation with on-site soil washing and on-site disposal

Alternative 5 - Excavation with on-site soil washing and off-site disposal

Alternative 6 - Excavation with off-site soil washing and off-site disposal

Buried Material Disposal Alternatives

Alternative 1 - Off-site landfill

Groundwater Remediation Alternatives

Alternative 1 - No action with continued monitoring

Alternative 2 - Extraction wells with air stripping and discharge to surface water

Alternative 3 - Extraction wells with GAC treatment and discharge to surface water

4.8 SITE 11 - INDUSTRIAL WASTEWATER DISPOSAL AREA 100

The nature and extent of contamination and the fate and transport mechanisms of contaminants in the environment were investigated during the RI. Based on data obtained to date, the following findings regarding contaminant transport were noted:

- Groundwater quality in two areas of the site has been impacted through leachate generation from three leaching wells. Numerous volatile organic compounds (benzene, carbon tetrachloride, chloroform, 1,2-dichloroethane, trans 1,2-dichloroethene, tetrachloroethene and trichloroethene) were identified as chemicals of potential concern in the groundwater that potentially may have adverse effects in humans.
- Although subsurface soils at and beneath the leaching wells were not sampled, they probably have been impacted and will require remedial action as well.

Due to the complexity of this site, many technologies may be effective and implementable. Based on the applicability of technologies presented in Section 3.0, the following technologies will be considered for development into alternatives for Site 11. These technologies will be evaluated based on their effectiveness, implementability and cost.

General Response Action	Technology
No action	No action with continued monitoring

Soil/leaching well material collection	Excavation
Soil treatment	Soil washing Soil thermal treatment Soil incineration
Treated soil disposal	On-site Off-site landfill
Excavated material disposal	Off-site landfill
Groundwater collection	Extraction wells
Groundwater treatment	Air stripping Activated carbon
Treated groundwater disposal	Discharge to surface water

4.8.1 Soil/Buried Material Remediation Alternatives

4.8.1.1 No Action

As required by the NCP, no action for the site will be considered as an alternative. The No Action alternative involves baseline and periodic monitoring of selected media. Continued monitoring permits tracking of contaminant migration; however, it does not control migration of contaminants in the soil and does not control leachate generation with further impacts on groundwater quality.

Under a No Action scenario, monitoring would be conducted on a periodic basis to evaluate the concentration of contaminants in the soil to determine any migration of contaminants through surface runoff. Samples would be collected from numerous subsurface locations within the perimeter of the leaching wells on a semi-annual basis. Soil samples will be analyzed for volatile organic compounds since they are the chemicals of concern in this media.

Capital costs of implementing the No Action alternative would be limited to developing a detailed sampling and analysis plan (detailed costs and assumptions are provided in Appendix A) and are $11,000. Annual O&M costs include labor to obtain samples and analytical costs associated with sampling the subsurface soils and are estimated to be $7,000 per year. Total present worth is estimated at $88,000.

4.8.1.2 Excavation

Contaminated Soil/Buried Material Removal

The purpose of the soil and buried materials (i.e., wastes or solid materials located in the leaching wells) excavation is to reduce the amount of leachate generation that could impact groundwater and eventually affect human health and aquatic life. All 13 leaching wells identified at the site including all contaminated soil and buried wastes will be excavated with subsequent treatment and/or disposal. The amount of soil and buried materials to be excavated is expected to be approximately 500 cubic yards for seven locations. For the purposes of cost estimating, 450 cubic yards of the excavated material are considered to be contaminated soil with the remaining 50 cubic yards considered as buried materials such as leaching well construction material (i.e., bricks, piping).

Effectiveness

Contaminated soil and buried material removal would be effective in preventing leachate generation while reducing the impacts to groundwater. Thus, reducing the potential risks from exposure to contaminated groundwater.

Implementability

Contaminated soil and buried material removal could be implemented with no substantial difficulties. Excavation passes the initial screening and will be developed further in the detailed analysis section.

Cost

Capital and engineering costs for excavation of the leaching wells is estimated at $11,000. Cost estimates for removal are provided in Appendix A.

4.8.2 Soil Treatment Alternatives

Although no subsurface soil sampling has been conducted to determine the levels of contamination for volatile organics at the site, based on the high concentrations of volatile organics detected in the groundwater at the site, it is assumed that treatment of contaminated soils will be required. As discussed above, approximately 450 cubic yards of contaminated soil are estimated to be excavated from the leaching wells that require treatment.

4.8.2.1 Thermal Treatment/Incineration

Thermal treatment involves heating the contaminated soil to the point where the contaminants will experience combustion, thus fully or partially oxidizing the organic

contaminants. Gases and/or particulate emitted during the combustion process are typically quenched, then scrubbed or absorbed such that they can be discharged to the atmosphere. Thermal treatment may involve the use of high temperature steam to thermally destruct contaminants. Thermal treatment will be considered as an on-site treatment option.

Thermal treatment at high temperatures using an oven or kiln is defined as incineration and is generally only feasible as an off-site treatment option.

On-site Thermal Treatment

Soils would be staged at the treatment unit prior to and after treatment. Disposal of treatment residuals would be used as "clean fill" or sent off-site to a chemical waste landfill. Treatment residual disposal alternatives are discussed in Section 4.8.3.

Effectiveness

Following excavation, the contaminated soil would receive thermal treatment to minimize the human health and environmental risks associated with the excavated sediment. Reduction in organic concentration can be as high as 99 percent, and therefore, thermal treatment is an effective treatment method for volatile organic contamination.

Implementability

Equipment required for the thermal treatment of contaminated soil would be supplied by a thermal treatment vendor. Electrical power and possibly a fuel source would need to be supplied to the process. Extensive mobilization and installation of equipment would be required. The implementation of on-site thermal treatment is technically feasible. Approval of on-site treatment (permit may be required) will be the most difficult implementation facet of this remedial action. Based on the effectiveness and implementability of thermal treatment, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for on-site thermal treatment of the contaminated soil is estimated at $75,000. Cost estimates for soil thermal treatment at Site 11 are provided in Appendix A.

Off-site Incineration

Off-site treatment with incineration would involve transport of contaminated soil to the off-site treatment facility.

Effectiveness

Following excavation, contaminated soil would be transported to an off-site facility for treatment by incineration. Transport of untreated contaminated soil may increase the risks to human health and the environment due to the potential release of the soils to the environment via accidental spillage. The effectiveness of incineration was previously discussed.

Implementability

The implementability of excavation has been previously discussed. The implementation of off-site incineration is technically feasible. Off-site transport may required proper manifesting (hazardous or special waste).

Cost

Capital and engineering costs for off-site incineration of the contaminated soil is estimated at $2,085,000. Cost estimates for soil incineration are provided in Appendix A. Based on the high cost of incineration, this technology does not pass the initial screening and will not be retained for further detailed analysis.

4.8.2.2 Soil Washing

Soil washing requires excavating contaminated soil and washing it in a mobile washing unit. The washing fluid can be water, organic solvents, surfactants, etc. More detailed description on operation of the unit can be found in Section 3.7.4.3.

On-site Soil Washing

Excavated soil would require staging at the treatment unit prior to and after soil wa ;g.

Effectiveness

Following excavation, the contaminated soil would receive soil washing to minimize the human health and environmental risks associated with the excavated soil. Reduction in organic concentration can be as high as 90 percent, and therefore, soil washing is an effective treatment method for volatile organic contamination.

Implementability

Mobile equipment required for the washing of contaminated soil would be supplied by a vendor. Electrical power and possibly a fuel source would need to be supplied to the process. Extensive mobilization and installation of equipment would be required. The implementation of on-site soil washing is technically feasible. Approval of on-site treatment

(permit may be required) will be the most difficult implementation facet of this remedial action. Based on the effectiveness and implementability of soil washing, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for on-site soil washing of the contaminated soil is estimated at $230,000. Cost estimates for soil washing are provided in Appendix A.

Off-Site Soil Washing

Off-site treatment with soil washing would involve transport of soil to the off-site treatment facility.

Effectiveness

Following excavation, contaminated soil would be transported to an off-site facility for treatment by soil washing. Transport of untreated contaminated soil may increase the risks to human health and the environment due to the potential release of the soils to the environment via accidental spillage. The effectiveness of soil washing was previously discussed.

Implementability

The implementability of excavation has been previously discussed. The implementation of off-site soil washing is technically feasible. Off-site transport may required proper manifesting (hazardous or special waste). Based on the effectiveness and implementability of soil washing, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for off-site soil washing of the contaminated soil is estimated at $270,000. Cost estimates for soil washing are provided in Appendix A.

4.8.3 Soil Disposal Alternatives

As stated in Section 4.8.2, it is assumed that treatment prior to disposal will be required. Therefore, disposal of untreated soils will not be evaluated in this section.

On-site Treatment Residue Disposal

A 90 percent reduction in concentration of organics in the residue would be expected for all of the treatment processes discussed above. All treatment processes will generate a waste stream that contains the majority of the organic contamination that was removed from the soil during the treatment process. These wastes will be further treated or disposed of

properly off-site. Only the residual ash or soil from the treatment process will be evaluated for disposal in this section. Approximately 450 cubic yards of treatment residue is expected to require disposal.

Effectiveness

On-site disposal as "clean fill" back into the excavated areas would be an effective method of treatment residue disposal. Human health exposure to treatment residue would be eliminated. Residual contamination would not generate a leachate that would further impact groundwater quality.

Implementability

The disposal of treatment residue in the excavated areas could be implemented with no substantial difficulties. Approval of on-site disposal (permit may be required) will be the most difficult implementation facet of this remedial action. Based on the effectiveness and implementability of disposal of treatment residue in the excavated areas, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for on-site disposal of the treatment residuals is estimated at $12,000. Cost estimates are provided in Appendix A.

Off-site Treatment Residue Disposal

As previously stated, treatment of the contaminated soils would occur prior to disposal of the treatment residuals. Approximately 450 cubic yards of soil will require disposal.

Effectiveness

Off-site disposal in an approved landfill would be an effective method of PCB treatment residue disposal. Human health exposure to treatment residue would be eliminated.

Implementability

The disposal of treatment residue in an approved landfill could be implemented with no substantial difficulties. Based on the effectiveness and implementability of disposal of treatment residue in an approved landfill, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for off-site disposal of the treatment residuals is estimated at $271,000. Cost estimates are provided in Appendix A.

4.8.4 Buried Waste Disposal Alternatives

Off-site Waste Disposal

As previously stated in Section 4.8.1.2, approximately 50 cubic yards of buried leaching well material (i.e., bricks and piping) will require off-site disposal. The only alternative to be discussed and evaluated will be the disposal of this material in a solid or hazardous waste landfill.

Effectiveness

Off-site disposal in an approved landfill would be an effective method of excavated material disposal. Human health exposure to these potentially contaminated materials would be eliminated.

Implementability

The disposal of these materials in an approved landfill could be implemented with no substantial difficulties. Based on the effectiveness and implementability of disposal of solid wastes in an approved landfill, this technology passes the initial screening and will be retained for further detailed analysis.

Cost

Capital and engineering costs for off-site disposal of the these materials is estimated at $33,000. Cost estimates are provided in Appendix A.

4.8.5 Groundwater Collection Alternatives

These technologies include no action and collection of contaminated groundwater that has migrated in the groundwater in the overburden and upper saprolite units at the site. There are two plumes located at the site that will require remedial action. The initial screening of these alternatives is as follows.

4.8.5.1 No Action

As required by the NCP, no action for the site will be considered as an alternative. The No Action alternative involves baseline and periodic monitoring of selected media. Continued monitoring permits tracking of contaminant migration; however, it does not control migration of contaminants in the groundwater.

Under a No Action scenario, monitoring would be conducted on a periodic basis to evaluate the movement and concentration of contaminants in the groundwater. Samples would be collected from the existing groundwater monitoring wells on a quarterly basis.

Groundwater samples will be analyzed for volatile organics. The no action alternative will be retained through the preliminary screening and detailed analysis section.

Capital costs of implementing the no action alternative would be include development of a detailed sampling and analysis plan (detailed costs and assumptions are provided in Appendix A) and are $11,000. Annual O&M costs include labor to obtain samples and analytical costs associated with sampling the groundwater and are estimated to be $6,000 per year. Total present worth is estimated at $77,000.

4.8.5.2 Collection

Extraction Wells

The purpose of groundwater collection is to reduce the amount of volatile organic contamination that could migrate and affect human health and aquatic life through ingestion and dermal contact. Because extraction wells have been used successfully to control groundwater flow on various other similar contaminated sites within EPA Region III, the technology for implementing extraction wells is highly developed and the contaminants are located at depths and in a saprolite unit where a trench system would not be cost effective or technically feasible, it is the only collection technology that will be evaluated for Site 9.

Groundwater will be collected using extraction wells located at the leading edge of the contaminant plumes to prevent further migration of contamination. It is estimated that properly located extraction wells will be able to capture sufficient groundwater flow to restrict on- and off-site migration of contaminants in the overburden and saprolite. The groundwater extraction wells will be screened in the overburden and upper saprolite unit. Based on hydrogeologic investigations performed during the RI, groundwater at the leading edge of the contaminant plumes is located in the overburden and saprolite units.

The development of extraction wells has been limited to the overburden and in the upper saprolite to a depth of 60 feet in order to restrict groundwater movement in the most contaminated zones. Based upon data (drawdown and recovery data collected from on-site monitoring wells) reported in the RI report, it is estimated that the each extraction well should yield about 5 gpm from fractures within the saprolite. The actual withdrawal rate will have to be confirmed by testing during design of the system.

The conceptual design for the extraction wells includes an 8-inch diameter borehole to a depth of 50 feet, the wells will be constructed of 6-inch PVC pipe with a continuous-slotted screen at 30 to 50 feet below the surface. The wells will be equipped with

submersible pumps constructed of PVC pipe with PVC fittings. The pumps should be equipped with low water cutoffs to avoid damaging the pump in the event that the pumping water level declines to the depth of the pump. The discharge piping should be constructed of PVC pipe to reduce corrosion.

For cost estimating purposes, it was assumed that eight extraction wells could adequately collect the contaminated groundwater located downgradient from the leaching wells. The groundwater contamination plumes are estimated to be 605,000 square feet in area and has an average vertical thickness of 40 feet resulting in a volume of 12,100,000 cubic feet. Using an effective porosity of 0.26 for this site results in an estimated volume of contaminated groundwater of 23,530,000 gallons. It will be assumed that five times that volume will have to be removed to reduce the groundwater contaminant concentration to acceptable clean-up levels.

Effectiveness

Groundwater extraction is effective in reducing the amount of volatile organic contamination that can be transported downgradient, preventing human exposure to significant levels of organics through ingestion or dermal contact and reducing impacts to aquatic life if the groundwater discharged to a surface water body. Collection via extraction wells is an effective means for mitigating migration of contaminants in the overburden and saprolite groundwater. This collection alternative passes the initial screening and will be retained for further development in the detailed analysis section.

Implementability

Collection via extraction wells could be implemented without substantial difficulties. Implementation of the extraction wells would consist of using a drilling contractor to install the wells into the overburden and saprolite units.

Cost

Capital and engineering costs for collection of contaminated groundwater is estimated at $396,000. Annual O&M costs are estimated at $45,000 with total present worth estimated at $608,000. Cost estimates for groundwater collection are provided in Appendix A.

4.8.6 Groundwater Treatment Alternatives

Air Stripping

Air stripping is a commonly used technique for removing volatile organic compounds from groundwater. Air stripping is particularly effective for removal of low molecular weight

chlorinated solvents such as tetrachloroethene and trichloroethene. Various air stripping methods are available. The implementability of each is discussed in the evaluation criteria sections.

After the stripping the groundwater, the air stream may require emissions controls to meet Maryland air emissions regulations. This is typically performed by use of a post-treatment scrubber using a granular carbon packed absorber. Spent carbon is typically regenerated off-site.

Effectiveness

Air stripping will be effective in removing those volatile organic compounds detected in the groundwater at Site 11. Expected volatile organic removal rate should be as high as 90 percent with 99 percent removal potentially attainable. This degree of removal will allow the air stripper effluent to meet the Maryland surface water quality criteria for volatile organics.

Implementability

Air stripping is generally a readily implementable method for remediation of contaminated groundwater. The shallow tray and bubble diffusion strippers are available as skid-mounted units with process controls and alarms supplied by the manufacturer. Unlike packed towers, these units can typically be quickly cleaned of mild scale/fouling with a pressure sprayer. In addition, the shallow tray unit consists of a series of removable trays, and the unit can be increased or decreased in size by adding or removing trays if flow or volatile organic concentrations change. On the basis of ease of O&M, the shallow tray unit is considered the most implementable air stripper for the site and will be the assumed process for the air stripping alternative.

Physical treatment through air stripping passes the initial screening and shall be retained for further detailed analysis.

Cost

Capital and engineering costs for treatment of contaminated groundwater using a shallow tray air stripper is estimated at $309,000. Annual O&M costs are estimated at $50,000. Total present worth is estimated at $545,000. Cost estimates for groundwater treatment are provided in Appendix A.

<u>Activated Carbon</u>

Activated carbon removes organics from aqueous streams by adsorbing the compounds onto the pore surface area of granular activated carbon (GAC). Activated

carbon can be used in a flow-through packed treatment column or by adding powdered activated carbon (PAC) directly to contaminated water. Direct addition of PAC to water requires separation of the carbon particles from the waste stream prior to discharge of the treated waste, and is generally not implemented in cases where the treatment system is automated. Therefore, activated carbon adsorption as discussed here will assume a flow-through GAC column or bed. Activated carbon treatment would likely require pre-filtration to remove incidental solids from the water which might blind the column.

Effectiveness

Groundwater flow through a GAC column or bed would be an effective means of volatile organic removal. Expected removal rate should be as high as 90 percent with 99 percent removal potentially attainable. This degree of removal will allow the GAC unit effluent to meet the Maryland surface water quality criteria for volatile organics and nitroaromatics.

Implementability

GAC treatment columns or beds are typically skid-mounted units which are relatively simple to install or replace. Activated carbon is readily available from firms nationwide. Installation of a pre-filtration unit is also readily implementable.

Cost

Capital and engineering costs for treatment of contaminated groundwater using a GAC columns or beds is estimated at $237,000. Annual O&M costs are estimated at $48,000 per year. Total present worth is estimated at $463,000. Cost estimates for groundwater treatment are provided in Appendix A.

4.8.7 Treated Groundwater Disposal Alternatives

Discharge of Treated Groundwater

Treated groundwater will be discharged to the stream that is flows on the north-central part of the NSWCWODET facility adjacent to the Site 2 landfill.

Effectiveness

Discharge of treated groundwater to the stream would be an effective means of disposal. Due to the low levels of inorganics found at the site, it is expected that MCLs would be achieved prior to surface water discharge. It is expected that the treatment process would decrease the volatile organic concentrations to levels less than the Maryland surface water quality criteria.

Implementability

Disposal of treated groundwater in the stream is very implementable. The treatment system would be located near the stream making discharge of the treated water technically feasible. Approval of a Maryland discharge permit would have to be secured prior to discharge of the treated groundwater but approval is expected to be obtained.

Cost

Capital and engineering costs for disposal of treated groundwater is estimated at $165,000. Annual O&M costs are estimated at $23,000 per year. Total present worth is estimated at $273,000. Cost estimates for the disposal of treated groundwater are provided in Appendix A.

4.8.8 Summary

A range of alternatives was developed for this site using the technology type evaluations previously described. These alternatives are listed below and will be further evaluated in the detailed analysis section.

Soil Remediation Alternatives

Alternative 1 - No action with continued monitoring

Alternative 2 - Excavation with on-site thermal treatment and on-site disposal

Alternative 3 - Excavation with on-site thermal treatment and off-site disposal

Alternative 4 - Excavation with on-site soil washing and on-site disposal

Alternative 5 - Excavation with on-site soil washing and off-site disposal

Alternative 6 - Excavation with off-site soil washing and off-site disposal

Buried Material Disposal Alternatives

Alternative 1 - Off-site landfill

Groundwater Remediation Alternatives

Alternative 1 - No action with continued monitoring

Alternative 2 - Extraction wells with air stripping and discharge to surface water

Alternative 3 - Extraction wells with GAC treatment and discharge to surface water

5.0 DETAILED ANALYSIS OF ALTERNATIVES

5.1 INTRODUCTION

This section presents the detailed analysis of the remedial alternatives remaining after the initial screening conducted in Section 4.0 of this report. Each alternative is herein reviewed with respect to the nine evaluation criteria presented in the document, ***Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA***, Interim Final, Oswer Directive 9355.5-01, August 1988. The following criteria serve to provide a basis of comparison and allow for ranking of the alternatives by preference:

- **Short-Term Impacts and Effectiveness** - The effectiveness of alternatives in protecting human health and the environment during construction and implementation of the remedial action is evaluated by this criterion. Short-term effectiveness is assessed by the protection of the community, protection of workers, environmental impacts, and time until protection is achieved.

- **Long-Term Effectiveness and Permanence** - This criterion evaluates the long-term protection of human health and the environment at the completion of the remedial action. Effectiveness is assessed with respect to the magnitude of residual risks; adequacy of controls, if any, in managing treatment residuals or untreated wastes that remain at the site; reliability of controls against possible failure, and potential to provide continued protection.

- **Reduction of Toxicity, Mobility, or Volume** - This evaluation criterion address the statutory preference for selecting remedial actions that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances. This preference is satisfied when the treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, irreversible reduction in contaminant mobility or reduction of total volume of contaminated media.

- **Implementability** - This assessment evaluates the technical and administrative feasibility of alternatives and the availability of services and materials.

- **Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)** - This threshold assessment addresses whether or not a remedy will meet all of the applicable or relevant and appropriate requirements of federal or state environmental statutes, standards, criteria and guidelines or provide grounds for invoking a Comprehensive Environmental Response Compensation and Liabilities Act (CERCLA) waiver.

- **Overall Protection of Human Health and the Environment** - This is a threshold assessment which addresses whether or not a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced or controlled. This evaluation allows for consideration of whether an alternative poses any unacceptable short-term or cross-media impacts.

- **Cost** - The estimated capital and long-term maintenance and monitoring costs are evaluated by this criterion.

- **Community Acceptance** - The community acceptance criterion relates to the public perception of the selected remedy and its acceptability as the method of controlling or removing contamination. Community acceptance will be assessed following a review of the public comments received on the Feasibility Study (FS) report.

- **State Acceptance** - The state acceptance criterion relates the State of Maryland's perception of the selected remedy and its acceptability as the method of controlling or removing contamination. State acceptance will be assessed following a review of the state comments on the FS report.

5.2 SITE 2 - APPLE ORCHARD LANDFILL

5.2.1 Soil Remediation Alternatives

5.2.1.1 Alternative 1 - No Action

The no action alternative means that no remedial actions will be implemented to remove/control the Polychlorinated Biphenyl (PCB)-contaminated soil. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

With the no action alternative, no remedial construction takes place, and therefore, there is no potential for increased short-term risks to human health or the environment. The human health and environmental risks presented in Section 3.1.1 for the site will remain. Relying on natural biodegradation as the only means of contaminant reduction makes it unlikely that the no action alternative would be effective in achieving the remedial action objectives for the soil in the foreseeable future.

Long-Term Effectiveness and Permanence

The no action alternative would not be effective in preventing direct human contact with contaminated soils on the landfill surface and provides no environmental protection. Surface runoff would continue to transport PCB-contaminated particles to the adjacent stream and may impact aquatic life.

Reduction of Toxicity, Mobility, or Volume

The no action alternative does not contribute to the reduction of toxicity, mobility, or volume of the contaminated soils on the landfill surface and face outside of the natural biodegradation of PCBs which may occur.

Implementability

This alternative is implementable.

Compliance with ARARs

This alternative does not comply with the chemical-specific ARARs for soils contaminated with PCBs as outlined in Table 3-4. This alternative does not comply with the action-specific ARARs for control of PCB contamination in soils as identified in the USEPA document, ***A Guide on Remedial Action at Superfund Sites with PCB Contamination***. This alternative does not comply with the action-specific ARARs for the containment of hazardous and solid waste as identified in 40 CFR 264.

Overall Protection of Human Health and the Environment

Human health and environmental risks associated with exposure to contaminated soils has not been reduced by the implementation of the no action alternative. Transport of contaminated soils to the adjacent stream with potential migration off-site has not been mitigated. The no action alternative does not meet any of the remedial action objectives for this site.

Cost

Costs for this alternative would be chiefly comprised of monitoring and soil analytical costs. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 11,000
Annual O&M Cost	$ 5,000
Present Worth	$ 62,000

Table 5-1 provides a detailed summary of the estimated costs to implement Soil Alternative 1 - No Action. Backup information for all cost estimates is provided in Appendix A.

TABLE 5-1
SITE #2 APPLE ORCHARD LANDFILL
SOIL REMEDIATION ALTERNATIVE 1
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$2,200
SUBTOTAL	$9,000	$3,700
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$900
ECONOMIC ANALYSIS		
TOTALS	$11,000	$5,000
PRESENT WORTH OF O & M	**$51,000**	
TOTAL PRESENT WORTH	**$62,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

5.2.1.2 Alternative 2 - Synthetic/Soil Cap

The synthetic/soil cap alternative means that a synthetic membrane/soil cover would be placed over the landfill surface and face to contain the PCB-contaminated soil and prevent infiltration to buried wastes. A total area of approximately 57,000 square feet is proposed for remediation. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

Implementation of a synthetic/soil cover will not impact the general public during the construction phase. Construction personnel could be exposed to contaminated dust during clearing, grading and grubbing activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The cover will be completely effective upon establishment of full vegetative growth.

Long-Term Effectiveness and Permanence

A synthetic/soil cover would prevent direct human contact with contaminated soils and would reduce off-site transport of contaminated soils by erosion. This alternative would require long-term maintenance to ensure the integrity of the cover, including reseeding, as necessary, and repair of damage due to weather conditions, animals, undesirable vegetation, etc. Maintenance of the topsoil/vegetation layer for this alternative is not crucial because of the protection afforded by the synthetic membrane liner. When properly installed, the liner itself will retain its integrity for more than 30 years. The synthetic/soil cover provides an excellent barrier to infiltration, while minimizing cover thickness. Thus, with proper maintenance, the synthetic/soil cover alternative provides long-term effectiveness in achieving the remedial action objectives for the site soils.

Reduction of Toxicity, Mobility, or Volume

Placement of a synthetic/soil cover will effectively eliminate the mobility of contaminants due to the migration of soils by erosion. The presence of both the synthetic liner and the vegetation will eliminate infiltration but not completely eliminate the transference of contaminants from soils and buried wastes to groundwater or surface water due to the presence of some soil moisture or leachate already present in the subsurface. The toxicity and volume of the contamination on and in the landfill will not be altered by the placement of a synthetic/soil cover.

Implementability

Materials and equipment for the installation of a synthetic/soil cover are available through the Washington, D.C. and Maryland metropolitan area, making this alternative readily available. There are no permitting problems expected for this alternative.

Compliance with ARARs

This alternative does not comply with the chemical-specific ARARs for soils outlined in Table 3-4. This alternative does comply with the action-specific ARARs for control of PCB contamination in soils as identified in the USEPA document, ***A Guide on Remedial Action at Superfund Sites with PCB Contamination.***

Overall Protection of Human Health and the Environment

Placement of the synthetic/soil cover is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the contaminated soils and transport of contaminated soils to the adjacent stream via erosion, and limits infiltration of precipitation. In addition, this cover offers more reliable, long-term protection since, when properly installed, the synthetic liner will retain its integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for the on-site soils.

Cost

Costs for this alternative would be chiefly comprised of material purchases and cap installation. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 506,000
Annual O&M Cost	$ 5,000
Present Worth	$ 557,000

Table 5-2 provides a detailed summary of the estimated costs to implement Soil Alternative 2 - Synthetic/Soil Cover. Backup information for all cost estimates is provided in Appendix A.

TABLE 5-2
SITE#2 APPLE ORCHARD LANDFILL
SOIL REMEDIATION ALTERNATIVE 2
CAPPING (SYNTHETIC MATERIAL)

	CAPITAL	O & M
SITE CLEARING	$2,400	
GRADING (INCLUDES ADDITIONAL FILL COST)	$62,000	
HDPE SYNTHETIC MEMBRANE	$64,000	
SYNTHETIC FILTER FABRIC (2 LAYERS)	$24,000	
DRAINAGE NET	$26,800	
TOP SOIL FOR CAPPING (@ 6 – INCHES THICKNESS)	$20,000	
SEDIMENT AND EROSION CONTROL	$4,000	
SLOPE PROTECTION	$24,400	
SEEDING	$2,800	
SEED PROTECTION	$3,200	
TOP SOIL FOR SEEDING (@ 3-INCH THICKNESS)	$10,000	
GROUNDWATER MONITORING	$9,000	$1,500
ANALYTICAL		$2,200
SUBTOTAL	$253,000	$3,700
ALLOWANCES		
CONTINGENCY (25%)	$63,250	$900
INSTALLATION/CONSTRUCTION (50%)	$126,500	
ENGINEERING (25%)	$63,250	
ECONOMIC ANALYSIS		
TOTALS	$506,000	$5,000
PRESENT WORTH OF O & M	**$51,000**	
TOTAL PRESENT WORTH	**$557,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

5.2.2 Sediment Remediation Alternatives

5.2.2.1 Alternative 1 - No Action

The no action alternative means that no remedial actions will be implemented to remove/control the PCB-contaminated sediment. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

With the no action alternative, no remedial action takes place, and therefore, there is no potential for increased short-term risks to human health or the environment. The human health and environmental risks presented in Section 3.1.1 for the site will remain. Relying on natural biodegradation as the only means of contaminant reduction makes it unlikely that the no action alternative would be effective in achieving the remedial action objectives for the sediment in the foreseeable future.

Long-Term Effectiveness and Permanence

The no action alternative would not be effective in preventing direct human contact with contaminated sediment in the stream adjacent to the landfill, reducing the amount of PCBs available for migration in the stream and provides no environmental protection. Stream flow especially during heavy rains would continue to transport PCB-contaminated particles downstream which may impact human health and aquatic life.

Reduction of Toxicity, Mobility, or Volume

The no action alternative does not contribute to the reduction of toxicity, mobility, or volume of the contaminated sediment in the stream adjacent to the landfill outside of the natural biodegradation of PCBs which may occur.

Implementability

This alternative has already been implemented.

Compliance with ARARs

This alternative does not comply with the chemical-specific ARARs for sediment outlined in Table 3-4. This alternative does not comply with the action-specific ARARs for control of PCB contamination in sediment as identified in the USEPA document, ***A Guide on Remedial Action at Superfund Sites with PCB Contamination.***

Overall Protection of Human Health and the Environment

Human health and environmental risks associated with exposure to contaminated sediment has not been reduced by the implementation of the no action alternative. Downstream transport of significant quantities of PCBs in the sediment has not been

mitigated. The no action alternative does not meet any of the remedial action objectives for this site.

Cost

Costs for this alternative would be chiefly comprised of monitoring and sediment analytical costs. The Capital, Annual O&M and Present Worth costs for this alternative are as follows:

Capital Cost	$ 11,000
Annual O&M Cost	$ 5,000
Present Worth	$ 62,000

Table 5-3 provides a detailed summary of the estimated costs to implement Sediment Alternative 1 - No Action. Backup information for all cost estimates is provided in Appendix A.

5.2.2.2 Alternative 2 - Excavation with Off-site Sediment Disposal

The sediment excavation alternative means that the PCB-contaminated sediment on the west end of the landfill will be excavated for disposal in an off-site chemical waste landfill. The average PCB concentration in the sediment would be expected to be about 50 mg/kg with maximum concentrations around 150 mg/kg. A total of approximately 167 cubic yards of sediment is expected to be removed. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during excavation of the contaminated sediment. Remediation personnel could be exposed to contaminated dust during clearing and excavation activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The disposal of contaminated sediment in an off-site chemical waste landfill will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

TABLE 5–3
SITE #2 APPLE ORCHARD LANDFILL
SEDIMENT REMEDIATION ALTERNATIVE 1
NO ACTION

	CAPITAL	O & M
SOIL SEDIMENT SAMPLING AND MONITORING ON SITE WELLS	$9,000	$1,500
ANALYTICAL		$2,200
SUBTOTAL	$9,000	$3,700
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$900
ECONOMIC ANALYSIS		
TOTALS	$11,000	$5,000
PRESENT WORTH OF O & M	**$51,000**	
TOTAL PRESENT WORTH	**$62,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi–annual basis.

Long-Term Effectiveness and Permanence

The excavation alternative would be effective in reducing direct human contact with the highest concentrations of PCB-contaminated sediment in the stream adjacent to the landfill and reducing the amount of PCBs available for migration in the stream. The concentration of PCBs in the stream sediment that would be available for transport with potential ecological impacts would also be reduced. However, low levels of PCBs would still remain in the stream for transport. Off-site disposal into a chemical waste landfill would be an effective method of PCB-contaminated sediment disposal.

Reduction of Toxicity, Mobility, or Volume

The sediment excavation alternative does contribute to the reduction of toxicity, mobility, or volume of the contaminated sediment in the stream adjacent to the landfill. Migration of lower PCB-concentrated sediments would continue in the stream after excavation. The volume of PCB-contaminated sediment would be greatly decreased after excavation. Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the sediment. The toxicity and volume of the PCB contamination in the sediment will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

This alternative is very implementable due to the availability of excavation firms and equipment in the area and accessibility of this equipment to the stream sediment. The disposal of PCB-contaminated sediment in a chemical waste landfill could be implemented with no substantial difficulties.

Compliance with ARARs

This alternative does comply with the chemical-specific ARARs for sediment outlined in Table 3-4. All sediment with concentrations higher than the 19 mg/kg action level would be removed. This alternative does comply with the action-specific ARARs for control of PCB contamination in sediment as identified in the USEPA document, ***A Guide on Remedial Action at Superfund Sites with PCB Contamination***. This alternative does comply with the action-specific ARARs for control of PCB contamination in soils as identified in the USEPA document, ***A Guide on Remedial Action at Superfund Sites with PCB Contamination*** and TSCA regulations. The guidance document, Toxic Substance Control Act (TSCA), and RCRA land disposal restriction regulations state that PCB-contaminated soil can be placed in a chemical waste landfill in lieu of treatment provided that the concentrations are less

than 1000 mg/kg. The placement of the sediment in a chemical waste landfill would be consistent with these recommendations.

Overall Protection of Human Health and the Environment

Human health and environmental risks associated with exposure to contaminated sediment has been reduced by the implementation of the excavation alternative. Downstream transport of significant quantities of PCBs in the sediment would be greatly reduced. The excavation alternative does meet the remedial action objectives for the contaminated stream sediment at this site. Placement of the sediment in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the contaminated sediment and limit infiltration of precipitation. In addition, placement of sediment in a chemical waste landfill offers more reliable, long-term protection since, when properly installed, these landfills will retain their integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of PCB-contaminated sediment.

Cost

Costs for this alternative would be chiefly comprised of equipment rental, excavation and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 121,000
Annual O&M Cost	$ 0
Present Worth	$ 121,000

Table 5-4 provides a detailed summary of the estimated costs to implement Sediment Remediation Alternative 2 - Excavation with Off-site Sediment Disposal. Backup information for all cost estimates is provided in Appendix A.

5.2.2.3 Alternative 3 - Excavation with On-site Thermal Treatment/Disposal

Alternative 3 is excavation with on-site thermal destruction of excavated PCB-contaminated sediment followed by on-site disposal of the treatment residuals. Excavated sediment would be staged at the treatment unit prior to treatment. On-site thermal destruction includes the use of a mobile unit to thermally destruct the PCBs in the sediment. This alternative involves placement of the PCB-treated residue on the landfill surface prior

TABLE 5-4
SITE #2 APPLE ORCHARD LANDFILL
SEDIMENT REMEDIATION ALTERNATIVE 2
EXCAVATION WITH OFF-SITE SEDIMENT DISPOSAL

	CAPITAL
EXCAVATION	$1,800
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$2,500
LOADING & HAULING TO LANDFILL	$64,000
LANDFILL CHARGES	$25,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$2,200
SUBTOTAL	$97,000
ALLOWANCES	
CONTINGENCY (25%)	$24,000
TOTAL	$121,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

to capping the landfill. The PCB concentration in the residue would be expected to be less than 10 mg/kg for all of the treatment processes discussed above. A discussion of each of the evaluation criteria for this alternative follows. Excavation criteria evaluations were discussed in Section 5.2.2.2 for Sediment Alternative 2 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during treatment of the contaminated sediment. Treatment unit operator personnel could be exposed to contaminated dust during sediment and treatment residue handling activities and airborne organics during thermal treatment operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. An estimate of air emission rates for thermal treatment for Site 2 is included in a table in Appendix B. The disposal of treatment residue on-site will not impact the general public during the disposal phase. Disposal and construction personnel (during landfill capping activities) could be exposed to contaminated dust during clearing, grading and capping activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Reduction in PCB concentration in the excavated sediment could be expected to be as high as 90 to 99 percent. On-site disposal onto the surface of the landfill (landfill to be capped) would be an effective method of PCB treatment residue disposal. The PCB concentration of the residue would be less than existing in-situ PCB contamination. Human health exposure to treatment residue would be eliminated. Even with the absence of a leachate collection system for the landfill, there is little potential for subsurface migration of PCBs due to their sorption characteristics and the presence of an impermeable cap.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the excavated sediment would be the result of thermal destruction of the PCBs in the sediment. The volume of sediment would change after treatment due to significant moisture reduction. A reduction in mobility is not applicable to the treatment technologies. On-site disposal in conjunction with placement of a synthetic/soil cover will effectively eliminate the mobility of contaminants in the treatment residue. The presence of both the synthetic liner and the vegetation will eliminate infiltration of PCBs remaining in the treatment residuals. The toxicity and volume of the

PCB contamination in the treatment residue will not be altered by the placement of the residuals on the landfill surface and placement of a synthetic/soil cover.

Implementability

This alternative is implementable due to the availability of mobile equipment. However, approval of a PCB thermal destruction permit (including an air permit) may be somewhat difficult to obtain. The disposal of treatment residue on the landfill surface could be implemented with no substantial difficulties. Approval of on-site disposal will be the most difficult implementation facet of this remedial action.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment of PCB contamination in sediment as identified in the USEPA document, ***A Guide on Remedial Action at Superfund Sites with PCB Contamination***. The action-specific ARAR states that thermal destruction is an acceptable treatment option for PCB-contaminated sediment (greater than 50 mg/kg). PCB concentrations detected in the sediment have been as high as 140 mg/kg but typically average less than 50 mg/kg. This alternative does comply with the action-specific ARARs for control of PCB contamination in soils as identified in the USEPA document, ***A Guide on Remedial Action at Superfund Sites with PCB Contamination***". The guidance document suggests that for PCB residues of concentration 1 to 10 mg/kg a cover system be installed to control migration and runoff. The placement of the treatment residues on the landfill surface prior to capping would be consistent with these recommendations.

Overall Protection of Human Health and the Environment

On-site thermal treatment of contaminated sediment prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated sediment. On-site thermal treatment meets the remedial action objective of treatment of excavated PCB-contaminated sediment. Placement of the residuals on the landfill surface in conjunction with installation of a synthetic/soil cover is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues on the landfill surface under this cover offers more reliable, long-term protection since, when properly installed, the synthetic liner will retain its integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment, and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 43,000
Annual O&M Cost	$ 0
Present Worth	$ 43,000

Table 5-5 provides a detailed summary of the estimated costs to implement Sediment Remediation Alternative 3 - Sediment Excavation with On-site Thermal Treatment/On-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.2.2.4 Alternative 4 - Excavation with On-site Thermal Treatment/Off-site Disposal

Alternative 4 is excavation with on-site thermal treatment of excavated PCB-contaminated sediment followed by off-site disposal of the treatment residuals. Excavated sediment would be staged at the treatment unit prior to treatment. On-site thermal treatment includes the use of a mobile unit to thermally destruct the PCBs in the sediment. Excavated sediment would be transported to the on-site treatment facility prior to treatment. This alternative involves placement of the PCB-treated residue in an off-site chemical waste landfill. The PCB concentration in the residue would be expected to be less than 10 mg/kg for all of the treatment processes discussed above. A discussion of each of the evaluation criteria for this alternative follows. Excavation and thermal treatment criteria evaluations were discussed in Sections 5.2.2.2 and 5.2.2.3 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

The disposal of treatment residue in an off-site chemical waste landfill will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Off-site disposal into a chemical waste landfill would be an effective method of PCB treatment residue disposal.

TABLE 5-5
SITE #2 APPLE ORCHARD LANDFILL
SEDIMENT REMEDIATION ALTERNATIVE 3
EXCAVATION WITH ON-SITE THERMAL TREATMENT AND ON-SITE DISPOSAL

	CAPITAL
EXCAVATION	$1,800
STAGING	$3,400
THERMAL TREATMENT	$16,700
TOP SOIL REPLACEMENT FOR EXCAVATED SEDIMENT	$2,500
GRADING	$2,500
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$4,300
SUBTOTAL	$34,000
ALLOWANCES	
CONTINGENCY (25%)	$9,000
TOTAL	$43,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

Reduction of Toxicity, Mobility, or Volume

Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the treatment residue. The toxicity and volume of the PCB contamination in the treatment residue will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

The disposal of treatment residue in a chemical waste landfill could be implemented with no substantial difficulties.

Compliance with ARARs

The USEPA guidance, ***A Guide on Remedial Actions at Superfund Sites with PCB Contamination***, suggests that for PCB residues of concentration 1 to 10 mg/kg a cover system be installed to control migration and runoff. The placement of the treatment residues in a chemical waste landfill would be consistent with these recommendations.

Overall Protection of Human Health and the Environment

Placement of the residuals in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues in a chemical waste landfill offers more reliable, long-term protection since, when properly installed, these landfills will retain their integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 139,000
Annual O&M Cost	$ 0
Present Worth	$ 139,000

Table 5-6 provides a detailed summary of the estimated costs to implement Sediment Remediation Alternative 4 - Sediment Excavation with On-site Thermal Treatment/Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

TABLE 5-6
SITE #2 APPLE ORCHARD LANDFILL
SEDIMENT REMEDIATION ALTERNATIVE 4
EXCAVATION WITH ON-SITE THERMAL TREATMENT AND OFF-SITE DISPOSAL

	CAPITAL
EXCAVATION	$1,800
STAGING	$1,700
THERMAL TREATMENT	$16,700
TOP SOIL REPLACEMENT FOR EXCAVATED SEDIMENT	$2,500
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$4,300
LOADING AND HAULING TO LANDFILL	$64,000
LANDFILL CHARGES	$17,000
SUBTOTAL	$111,000
ALLOWANCES	
CONTINGENCY (25%)	$28,000
TOTAL	$139,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

5.2.2.5 Alternative 5 - Excavation with On-site Soil Washing/On-site Disposal

Sediment remediation Alternative 5 is sediment excavation with on-site soil washing of excavated PCB-contaminated sediment followed by on-site disposal of treatment residuals. Excavated sediment would be staged at the treatment unit prior to treatment. On-site soil washing includes the use of a mobile soil washing unit to physically remove the PCBs in the sediment. This alternative involves placement of the PCB-treated residue on the landfill surface prior to capping the landfill. The PCB concentration in the residue would be expected to be less than 10 mg/kg for all of the treatment processes discussed above. A discussion of each of the evaluation criteria for this alternative follows. Excavation criteria evaluations were discussed in Section 5.2.2.2 for Sediment Alternative 2 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during treatment of the contaminated sediment. Treatment unit operator personnel could be exposed to contaminated dust during sediment and treatment residue handling activities and contaminated washing solutions during soil washing operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The disposal of treatment residue on-site will not impact the general public during the disposal phase. Disposal and construction personnel (during landfill capping activities) could be exposed to contaminated dust during clearing, grading and capping activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Reduction in PCB concentration in the excavated sediment could be expected to be as high as 90 to 99 percent. On-site disposal onto the surface of the landfill (landfill to be capped) would be an effective method of PCB treatment residue disposal. The PCB concentration of the residue would be less than existing in-situ PCB contamination. Human health exposure to treatment residue would be eliminated. Even with the absence of a leachate collection system for the landfill, there is little potential for subsurface migration of PCBs due to their sorption characteristics and the presence of an impermeable cap.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the excavated sediment would be the result of washing of the sediment. The volume of sediment would not change after washing; however, a significant quantity of PCB-contaminated solution (water, surfactants, etc.) would be generated. A reduction in mobility is not applicable to the treatment technologies. On-site disposal in conjunction with placement of a synthetic/soil cover will effectively eliminate the mobility of contaminants in the treatment residue. The presence of both the synthetic liner and the vegetation will eliminate infiltration of PCBs remaining in the treatment residuals. The toxicity and volume of the PCB contamination in the treatment residue will not be altered by the placement of the residuals on the landfill surface and placement of a synthetic/soil cover.

Implementability

This alternative is implementable due to the availability of mobile equipment. Approval of a PCB treatment permit (including an air permit) involving soil washing would be expected to be less difficult to obtain than a permit for the thermal treatment process. The disposal of treatment residue on the landfill surface could be implemented with no substantial difficulties. Approval of on-site disposal (permit may be required) will be the most difficult implementation facet of this remedial action.

Compliance with ARARs

This alternative does comply with the action-specific ARARs for treatment of PCB contamination in sediment as identified in the USEPA document, ***A Guide on Remedial Action at Superfund Sites with PCB Contamination***. The USEPA guide states that soil washing is an acceptable treatment option for PCB-contaminated sediment. However, when a treatment technology other than incineration or thermal treatment is used, equivalence to incineration will be demonstrated when treatment residue contain less than 2 mg/kg PCB. Average concentration of the excavated sediment is expected to be less than 50 mg/kg; however, even with a 90 percent PCB reduction due to soil washing, the PCB concentration in the residue would still be greater than the 2 mg/kg guideline. Therefore, compliance with this action-specific ARAR would not be met. This alternative does comply with the action-specific ARARs for control of PCB contamination in soils as identified in the USEPA document, ***A Guide on Remedial Action at Superfund Sites with PCB Contamination***, suggests that for PCB residues of concentration 1 to 10 mg/kg a cover system be installed to control migration and runoff. The placement of the treatment residues on the landfill surface prior

to capping would be consistent with these recommendations.

Overall Protection of Human Health and the Environment

On-site soil washing of contaminated sediment prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated sediment. On-site soil washing meets the remedial action objective of treatment of excavated PCB-contaminated sediment. Placement of the residuals on the landfill surface in conjunction with installation of a synthetic/soil cover is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues on the landfill surface under this cover offers more reliable, long-term protection since, when properly installed, the synthetic liner will retain its integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 100,000
Annual O&M Cost	$ 0
Present Worth	$ 100,000

Table 5-7 provides a detailed summary of the estimated costs to implement Sediment Remediation Alternative 5 - Sediment Excavation with On-site Soil Washing/On-site Disposal. Cost estimate backup data are provided in Appendix A.

5.2.2.6 Alternative 6 - Excavation with On-site Soil Washing/Off-site Disposal

Sediment remediation alternative 6 is sediment excavation with on-site soil washing of excavated PCB-contaminated sediment followed by off-site disposal of treatment residuals. Excavated sediment would be staged at the treatment unit prior to treatment. On-site soil washing includes the use of a mobile soil washing unit to physically remove the PCBs from the sediment. This alternative involves placement of the PCB-treated residue in an off-site chemical waste landfill. The PCB concentration in the residue would be

TABLE 5-7
SITE #2 APPLE ORCHARD LANDFILL
SEDIMENT REMEDIATION ALTERNATIVE 7
EXCAVATION WITH ON-SITE SOIL WASHING
AND ON-SITE DISPOSAL

	CAPITAL
EXCAVATION	$1,800
STAGING	$3,400
GRADING	$2,500
SOIL WASHING	$62,500
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$2,500
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$4,400
SUBTOTAL	$80,100
ALLOWANCES	
CONTINGENCY (25%)	$20,000
TOTAL	$100,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

expected to be less than 10 mg/kg for all of the treatment processes discussed above. A discussion of each of the evaluation criteria for this alternative follows. Excavation and treatment criteria evaluations were discussed in Sections 5.2.2.2 and 5.2.2.6 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during treatment of the contaminated sediment. Treatment unit operator personnel could be exposed to contaminated dust during sediment and treatment residue handling activities and contaminated washing solutions during soil washing operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The disposal of treatment residue in an off-site chemical waste landfill will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Reduction in PCB concentration in the excavated sediment could be expected to be as high as 90 to 99 percent. Off-site disposal into a chemical waste landfill would be an effective method of PCB treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume - A significant reduction in the toxicity of the excavated sediment would be the result of washing of the sediment. The volume of sediment would not change after washing; however, a significant quantity of PCB-contaminated solution (water, surfactants, etc.) would be generated. A reduction in mobility is not applicable to the treatment technologies. Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the treatment residue. The toxicity and volume of the PCB contamination in the treatment residue will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

This alternative is implementable due to the availability of mobile equipment. Approval of a PCB treatment permit involving soil washing would be expected to be less difficult to obtain than a permit for the thermal treatment process. The disposal of treatment residue in a chemical waste landfill could be implemented with no substantial difficulties.

Compliance with ARARs

This alternative does comply with the action-specific ARARs for treatment of PCB contamination in sediment as identified in the USEPA document, ***A Guide on Remedial Action at Superfund Sites with PCB Contamination***. The USEPA guide states that soil washing is an acceptable treatment option for PCB-contaminated sediment. However, when a treatment technology other than incineration or thermal treatment is used, equivalence to incineration will be demonstrated when treatment residue contain less than 2 mg/kg PCB. Average concentration of the excavated sediment is expected to be less than 50 mg/kg; however, even with a 90 percent PCB reduction due to soil washing, the PCB concentration in the residue would still be greater than the 2 mg/kg guideline. Therefore, compliance with this action-specific ARAR would not be met. This alternative does comply with the action-specific ARARs for control of PCB contamination in soils as identified in the USEPA document, ***A Guide on Remedial Action at Superfund Sites with PCB Contamination***. The USEPA guidance, ***A Guide on Remedial Actions at Superfund Sites with PCB Contamination***, suggests that for PCB residues of concentration 1 to 10 mg/kg a cover system be installed to control migration and runoff. TSCA regulations state that PCB-contaminated soil can be placed in a chemical waste landfill. The placement of the treatment residues in a chemical waste landfill would be consistent with these recommendations.

Overall Protection of Human Health and the Environment

On-site soil washing of contaminated sediment prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated sediment. On-site soil washing meets the remedial action objective of treatment of excavated PCB-contaminated sediment. Placement of the residuals in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues in a chemical waste landfill offers more reliable, long-term protection since, when properly installed, these landfills will retain their integrity for more than 30 years. This alternative satisfies the remedial objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M and Present Worth costs for this alternative are as follows:

Capital Cost	$ 196,000
Annual O&M Cost	$ 0
Present Worth	$ 196,000

Table 5-8 provides a detailed summary of the estimated costs to implement Sediment Remediation Alternative 6 - Sediment Excavation with On-site Soil Washing/Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.2.2.7 Alternative 7 - Excavation with Off-site Soil Washing/Off-site Disposal

Sediment remediation Alternative 7 is sediment excavation with off-site soil washing of excavated PCB-contaminated sediment and off-site disposal. Off-site soil washing includes transport of excavated sediment to an off-site permitted soil washing unit to physically remove the PCBs in the sediment. This alternative involves placement of the PCB-treated residue in an off-site chemical waste landfill. The PCB concentration in the residue would be expected to be less than 10 mg/kg for all of the treatment processes discussed above. A discussion of each of the evaluation criteria for this alternative follows. Excavation criteria evaluations were discussed in Section 5.2.2.2 for Sediment Alternative 2 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during treatment of the contaminated sediment. Treatment unit operator personnel could be exposed to contaminated dust during sediment and treatment residue handling activities and contaminated washing solutions during soil washing operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The disposal of treatment residue in an off-site chemical waste landfill will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Reduction in PCB concentration in the excavated sediment could be expected to be as high as 90 to 99 percent. Off-site disposal into a chemical waste landfill would be an effective method of PCB treatment residue disposal.

TABLE 5-8
SITE #2 APPLE ORCHARD LANDFILL
SEDIMENT REMEDIATION ALTERNATIVE 6
EXCAVATION WITH ON-SITE SOIL WASHING
AND OFF-SITE DISPOSAL

	CAPITAL
EXCAVATION	$1,800
STAGING	$1,700
SOIL WASHING	$62,500
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$2,500
LOADING & HAULING TO LANDFILL	$64,000
LANDFILL CHARGES	$17,000
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$4,400
SUBTOTAL	$156,900
ALLOWANCES	
CONTINGENCY (25%)	$39,000
TOTAL	$196,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the excavated sediment would be the result of washing of the sediment. The volume of sediment would not change after washing; however, a significant quantity of PCB-contaminated solution (water, surfactants, etc.) would be generated. A reduction in mobility is not applicable to the treatment technologies. Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the treatment residue. The toxicity and volume of the PCB contamination in the treatment residue will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

This alternative is implementable due to the availability of off-site treatment facilities. The disposal of treatment residue in a chemical waste landfill could be implemented with no substantial difficulties.

Compliance with ARARs - This alternative does comply with the action-specific ARARs for treatment of PCB contamination in sediment as identified in the USEPA document, ***A Guide on Remedial Action at Superfund Sites with PCB Contamination***. The USEPA guide states that soil washing is an acceptable treatment option for PCB-contaminated sediment. However, when a treatment technology other than incineration or thermal treatment is used, equivalence to incineration will be demonstrated when treatment residue contain less than 2 mg/kg PCB. Average concentration of the excavated sediment is expected to be less than 50 mg/kg; however, even with a 90 percent PCB reduction due to soil washing, the PCB concentration in the residue would still be greater than the 2 mg/kg guideline. Therefore, compliance with this action-specific ARAR would not be met. This alternative does comply with the action-specific ARARs for control of PCB contamination in soils as identified in the USEPA document, ***A Guide on Remedial Action at Superfund Sites with PCB Contamination***. The USEPA guidance, ***A Guide on Remedial Actions at Superfund Sites with PCB Contamination***, suggests that for PCB residues of concentration 1 to 10 mg/kg a cover system be installed to control migration and runoff. TSCA regulations state that PCB-contaminated soil can be placed in a chemical waste landfill. The placement of the treatment residues in a chemical waste landfill would be consistent with these recommendations.

Overall Protection of Human Health and the Environment

Off-site soil washing of contaminated sediment prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated sediment. Off-site soil washing meets the remedial action objective of treatment of excavated PCB-contaminated sediment. Placement of the residuals in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues in a chemical waste landfill offers more reliable, long-term protection since, when properly installed, these landfills will retain their integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of sediment excavation, transport, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 211,000
Annual O&M Cost	$ 0
Present Worth	$ 211,000

Table 5-9 provides a detailed summary of the estimated costs to implement Sediment Remediation Alternative 7 - Sediment Excavation with Off-site Soil Washing/Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.2.3 Comparative Analysis

In the following analysis, the alternatives are evaluated in relation to one another for each of the evaluation criteria. Overall protection of human health and the environment and compliance with ARARs will serve as threshold determinations in that they must be met by any alternative in order for it to be eligible for selection. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative.

TABLE 5-9
SITE #2 APPLE ORCHARD LANDFILL
SEDIMENT REMEDIATION ALTERNATIVE 7
EXCAVATION WITH OFF-SITE SOIL WASHING AND OFF-SITE DISPOSAL

	CAPITAL
EXCAVATION	$1,800
LOADING & HAULING TO TREATMENT SITE	$39,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$2,500
SOIL WASHING	$37,500
LOADING & HAULING TO DISPOSAL SITE	$64,000
LANDFILL CHARGES	$17,000
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$4,400
SUBTOTAL	$169,000
ALLOWANCES	
CONTINGENCY (25%)	$42,000
TOTAL	$211,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

5.2.3.1 Soil Remediation Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health and the environment. On-site workers would continue to be exposed to contaminated surface soils and continued runoff of contaminants to the adjacent stream would occur. Alternative 2 is protective of human health and the environment. Risk through direct contact of PCB-contaminated surface soils are reduced to cancer risk levels less than 10^{-6} for Alternative 2.

Compliance with ARARs

Alternative 1 does not comply with ARARs while Alternative 2 complies with action-specific ARARs for control of PCB contamination as specified in the USEPA guidance document.

Short-Term Impacts and Effectiveness

Although no additional exposure risks would occur for implementation of Alternative 1, Alternative 2 would be much more effective in the short term than Alternative 1.

Long-Term Effectiveness and Permanence

Alternative 2 will provide long-term effectiveness in achieving the remedial action objectives for the site soils while Alternative 1 would not meet these goals. The synthetic/soil cover will retain its integrity for more than 30 years.

Reduction of Toxicity, Mobility, or Volume

Alternative 1 would not reduce the toxicity, mobility, or volume of the PCB-contaminated soils at site. Although Alternative 2 will not reduce the toxicity or volume of contaminated soils, it will reduce the mobility of the PCBs because of the prevention of rainwater from infiltration through the landfill and due to the elimination of runoff contaminated with PCBs.

Implementability

Alternative 1 is implementable because continued sampling would be the only required future action. Alternative 2 is highly implementable because of its wide use and the availability of firms and materials in the local area.

Cost

With regard to cost, Alternative 1 is the least expensive of the two alternatives.

Summary

Because Alternative 1 is not protective of human health and the environment and does not comply with ARARs, it cannot be selected as the preferred alternative for the soils

at the site. Alternative 2, Synthetic/Soil Cap, provides the best balance of tradeoffs with respect to the evaluation criteria, and is proposed as the preferred alternative. A summary of the results of the detailed evaluation for each of the two alternatives is shown below.

Criteria	Soil Alternatives	
	1	2
Overall Protection of Human Health and the Environment	-	+
Compliance with ARARs	-	+
Short-Term Effectiveness	-	+
Long-Term Effectiveness	-	+
Reduction of Toxicity, Mobility, or Volume	-	+
Implementability	+	+
Cost (Present worth)	$ 62,000	$ 557,000
Legend: + = positive 0 = neutral - = negative		

5.2.3.2 Sediment Remediation Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health and the environment. On-site workers could continue to be exposed to contaminated sediment and continued downstream transport of contaminants in the stream sediments would occur. Alternatives 2 through 7 are protective of human health and the environment. Risk through direct contact of PCB-contaminated sediments are reduced to cancer risk levels less than 10^{-6} for all alternatives except Alternative 1.

Compliance with ARARs

Alternative 1 does not comply with ARARs while Alternatives 2 through 7 comply with action-specific ARARs for control of PCB contamination as specified in the USEPA guidance document.

Short-Term Impacts and Effectiveness

Although no additional exposure risks would occur for implementation of Alternative 1, Alternatives 2 through 7 would be more effective in the short term than Alternative 1. Human health exposure for Alternatives 3 through 7 are higher than for Alternative 2 because they require treatment of contaminated sediment prior to disposal. Alternative 2 includes disposal without treatment. Short-term environmental impacts are the same for Alternatives 2 through 7 because they all require excavation which will remove the contaminants from the environment.

Long-Term Effectiveness and Permanence

Alternatives 2 through 7 will provide long-term effectiveness in achieving the remedial action objectives for the site sediments while Alternative 1 would not meet these goals.

Reduction of Toxicity, Mobility, or Volume

Alternative 1 would not reduce the toxicity, mobility, or volume of the PCB-contaminated soils at site. Alternative 2 will not reduce the toxicity, mobility, or volume of contaminated sediment. However, because Alternative 2 includes disposal of contaminated sediment in a chemical waste landfill, mobility is less of a factor because of the presence of liners and leachate control systems. Alternatives 3 through 7 will reduce the toxicity and mobility of contaminated sediment because of treatment of the sediment. The volume of contaminated sediment will remain the same for Alternatives 2 through 7.

Implementability

Alternative 1 is implementable because continued sampling would be the only required future action. Alternative 2 is highly implementable because of the availability of remedial contractors and disposal facilities. Alternatives 3, 4, 5, and 6 are highly implementable because of the availability of contractors who perform mobile on-site treatment of contaminated sediment. Alternative 7 is implementable but the availability of local fixed treatment facilities is not as prevalent as those contractors who conduct on-site activities.

Cost

With regard to cost for those alternatives that quality for selection as the preferred alternative, Alternative 2 is the least expensive. Alternatives 3 and 5 which include on-site disposal of the treatment residuals are considerably more cost effective than Alternatives 4, 6, and 7 which include off-site disposal.

Summary

Because Alternative 1 is not protective of human health and the environment and does not comply with ARARs, it cannot be selected as the preferred alternative for the soils at the site. Alternative 3, Sediment Excavation with On-site Thermal Treatment and On-site Disposal, provides the best balance of tradeoffs with respect to the evaluation criteria, and is proposed as the preferred alternative. A summary of the results of the detailed evaluation for each of the seven alternatives is shown below.

Criteria	Sediment Alternatives						
	1	2	3	4	5	6	7
Overall Protection of Human Health and the Environment	-	+	+	+	+	+	+
Compliance with ARARs	-	+	+	+	+	+	+
Short-Term Effectiveness	-	+	0	0	0	0	0
Long-Term Effectiveness	-	+	+	+	+	+	+
Reduction of Toxicity, Mobility, or Volume	-	0	+	+	+	+	+
Implementability	+	+	+	+	+	+	0
Cost (Present Worth in thousands)	$62	$121	$43	$139	$100	$196	$163

Legend:
+ = positive
0 = neutral
- = negative

5.2.4 Summary of Preferred Alternatives

The following alternatives are proposed as the preferred alternatives to meet the remedial action objectives at Site 2:

- Sediment Excavation with On-site Thermal Treatment and On-site Disposal
- Synthetic/Soil Cap for Surface Soils and Landfill

Conceptual design criteria and drawings will be presented in Section 6.0 of this document.

5.3 SITE 3 - PISTOL RANGE LANDFILL

5.3.1 Soil Remediation Alternatives

5.3.1.1 Alternative 1 - No Action

The no action alternative means that no remedial actions will be implemented to remove/control the contaminated soil on the landfill face. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

With the no action alternative, no remedial construction takes place and, therefore, there is no potential for increased short-term risks to human health or the environment. The human health and environmental risks presented in Section 3.1.2 for the site will remain. Relying on natural biodegradation as the only means of contaminant reduction makes it unlikely that the no action alternative would be effective in achieving the remedial action objectives for the soil in the foreseeable future.

Long-Term Effectiveness and Permanence

The no action alternative would not be effective in preventing direct human contact with contaminated soils on the landfill surface and provides no environmental protection. Surface runoff would potentially continue to transport contaminated particles to the adjacent stream and may impact aquatic life.

Reduction of Toxicity, Mobility, or Volume

The no action alternative does not contribute to the reduction of toxicity, mobility, or volume of the contaminated soils on the landfill face outside of the natural biodegradation of metals which may occur.

Implementability

This alternative has already been implemented.

Compliance with ARARs

This alternative does not comply with the chemical-specific ARARs for soils outlined in Table 3-4.

Overall Protection of Human Health and the Environment

Human health and environmental risks associated with exposure to contaminated soils has not been reduced by the implementation of the no action alternative. Transport of contaminated soils to the adjacent stream with potential migration off-site has not been mitigated. The no action alternative does not meet any of the remedial action objectives for this site.

Cost

Costs for this alternative would be chiefly comprised of monitoring and soil analytical costs. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$11,000
Annual O&M Cost	$ 5,000
Present Worth	$72,000

Table 5-10 provides a detailed summary of the estimated costs to implement Soil Alternative 1 - No Action. Backup information for all cost estimates is provided in Appendix A.

5.3.1.2 Alternative 2 - Synthetic/Soil Cap

The synthetic/soil cap alternative means that a synthetic membrane/soil cover would be placed over the landfill surface and face to contain the contaminated soil and prevent infiltration to buried wastes. A total area of approximately 40,000 square feet is proposed for remediation. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

Implementation of a synthetic/soil cover will not impact the general public during the construction phase. Construction personnel could be exposed to contaminated dust during clearing, grading and grubbing activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The cover will be completely effective upon establishment of full vegetative growth.

Long-Term Effectiveness and Permanence

A synthetic/soil cover would prevent direct human contact with contaminated soils and would reduce off-site transport of contaminated soils by erosion. This alternative would

TABLE 5-10
SITE #3 PISTOL RANGE LANDFILL
SOIL REMEDIATION ALTERNATIVE 1
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$2,800
SUBTOTAL	$9,000	$4,300
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$1,100
ECONOMIC ANALYSIS		
TOTALS	$11,000	$5,000
PRESENT WORTH OF O & M	$61,000	
TOTAL PRESENT WORTH	$72,000	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

require long-term maintenance to ensure the integrity of the cover, including reseeding, as necessary, and repair of damage due to weather conditions, animals, undesirable vegetation, etc. Maintenance of the topsoil/vegetation layer for this alternative is not crucial because of the protection afforded by the synthetic membrane liner. When properly installed, the liner itself will retain its integrity for more than 30 years. The synthetic/soil cover provides an excellent barrier to infiltration, while minimizing cover thickness. Thus, with proper maintenance, the synthetic/soil cover alternative provides long-term effectiveness in achieving the remedial action objectives for the site soils.

Reduction of Toxicity, Mobility, or Volume

Placement of a synthetic/soil cover will effectively eliminate the mobility of contaminants due to the migration of soils by erosion. The presence of both the synthetic liner and the vegetation will eliminate infiltration but not completely eliminate the transference of contaminants from soils and buried wastes to groundwater or surface water due to the presence of some soil moisture or leachate already present in the subsurface. The toxicity and volume of the contamination on and in the landfill will not be altered by the placement of a synthetic/soil cover.

Implementability

Materials and equipment for the installation of a synthetic/soil cover are available throughout the Washington, D.C. and Maryland metropolitan area, making this alternative readily available.

Compliance with ARARs

This alternative does not comply with the chemical-specific ARARs for soils outlined in Table 3-4. This alternative does comply with the action-specific ARARs for control of contaminated soil and the prevention of infiltration which minimizes leachate generation..

Overall Protection of Human Health and the Environment

Placement of the synthetic/soil cover is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the contaminated soils and transport of contaminated soils to the adjacent stream via erosion, and limits infiltration of precipitation. In addition, this cover offers more reliable, long-term protection since, when properly installed, the synthetic liner will retain its integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for the on-site soils.

Cost

Costs for this alternative would be chiefly comprised of material purchases and cap installation. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 388,000
Annual O&M Cost	$ 5,000
Present Worth	$ 449,000

Table 5-11 provides a detailed summary of the estimated costs to implement Soil Alternative 2 - Synthetic/Soil Cover. Backup information for all cost estimates is provided in Appendix A.

5.3.2 Groundwater Remediation Alternatives

5.3.2.1 Alternative 1 - No Action

The no action alternative means that no remedial actions will be implemented to remove or treat the groundwater. Only the natural biodegradation of organic contaminants by indigenous microorganisms would occur. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

With the no action alternative, no remedial construction takes place; therefore, there is no potential for increased short-term risks to human health or the environment. The human health and environmental risks discussed in Section 3.1.2 will remain. Relying on natural biodegradation as the only means of contaminant reduction makes it unlikely that the no action alternative would be effective in achieving the remedial action objectives for the groundwater.

Long-Term Effectiveness and Permanence

Even if the source of groundwater contamination is removed (capping or excavating the landfill), contaminated groundwater would continue to migrate on-site for some period of time with the possibility of migrating off-site towards some receptor (off-site wells). It is difficult to predict if or when contaminants in the groundwater would be reduced to groundwater standards, through either natural biodegradation or groundwater mixing. Thus, the no action alternative is not effective in achieving the remedial action objectives for the

TABLE 5-11
SITE #3 PISTOL RANGE LANDFILL
SOIL REMEDIATION ALTERNATIVE 2
CAPPING (SYNTHETIC MATERIAL)

	CAPITAL	O & M
SITE CLEARING	$550	
GRADING (INCLUDES ADDITIONAL FILL COST)	$53,000	
HDPE SYNTHETIC MEMBRANE	$49,500	
SYNTHETIC FILTER FABRIC (2 LAYERS)	$18,700	
DRAINAGE NET	$20,800	
TOP SOIL FOR CAPPING (@ 6 - INCHES THICKNESS)	$14,500	
SEDIMENT AND EROSION CONTROL	$2,500	
SLOPE PROTECTION	$13,800	
SEEDING	$2,200	
SEED PROTECTION	$2,500	
TOP SOIL FOR SEEDING (@ 3-INCH THICKNESS)	$7,300	
GROUNDWATER MONITORING	$9,000	$1,500
ANALYTICAL COST		$2,800
SUBTOTAL	$194,000	$4,300
ALLOWANCES		
CONTINGENCY (25%)	$48,500	$1,100
INSTALLATION/CONSTRUCTION (50%)	$97,000	
ENGINEERING (25%)	$48,500	
ECONOMIC ANALYSIS		
TOTALS	$388,000	$5,000
PRESENT WORTH OF O & M	**$61,000**	
TOTAL PRESENT WORTH	**$449,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

site.

Reduction of Toxicity, Mobility, or Volume

The no action alternative will not reduce the mobility or volume of contaminated groundwater. Toxicity could be reduced somewhat, over time, by natural biodegradation processes.

Implementability

The no action alternative requires no implementation.

Compliance with ARARs

Action-specific ARARs do not apply to the no action alternative. This alternative would not comply with the chemical-specific ARARs.

The no action alternative would comply with location-specific ARARs.

Overall Protection of Human Health and the Environment

The no action alternative will not be protective of human health and the environment because this alternative allows groundwater to freely migrate off-site. Thus, the no action alternative does not meet the remedial action objectives for groundwater.

Cost

Capital costs would include the installation of additional monitoring wells to monitor the migration rate and potential of the contamination and development of a detailed sampling and analytical plan. Annual O&M costs will include groundwater sampling and analysis of groundwater samples. The Capital, Annual O&M and Present Worth costs for this alternative are as follows:

Capital Cost	$ 11,000
Annual O&M Cost	$ 8,000
Present Worth	$ 98,000

Table 5-12 provides a detailed summary of the estimated costs to implement Groundwater Remediation Alternative 1 - No Action. Backup information for all cost estimates is provided in Appendix A.

5.3.2.2 Alternative 2 - Extraction Wells with Air Stripping and Discharge to Surface Water

Extraction wells are a viable means of withdrawing groundwater to restrict on-site and potential off-site migration of contaminated groundwater. This alternative involves the

TABLE 5-12
SITE #3 PISTOL RANGE LANDFILL
GROUNDWATER REMEDIATION ALTERNATIVE 1
NO ACTION

	CAPITAL	O & M
MONITORING ON SITE WELLS	$9,000	$3,000
ANALYTICAL		$3,200
SUBTOTAL	$9,000	$6,200
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$1,550
ECONOMIC ANALYSIS		
TOTALS	$11,000	$8,000
PRESENT WORTH OF O & M	$87,000	
TOTAL PRESENT WORTH	$98,000	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

collection of contaminated groundwater with extraction wells, ex-situ treatment using a shallow tray air stripper and discharge of treated groundwater to surface water. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There is potential for increased short-term risks to human health due to the drilling of extraction wells, handling and disposal of contaminated subsurface soils and groundwater. Site workers would be subject to increased chemical exposure risks during related to installation of utilities and the treatment system foundation due to volatilization of volatile organics from the overburden soils. These risks may be properly managed through the appropriate use of personal protective equipment, site monitoring and/or control measures, if required. Site workers would not be subject to increased chemical exposure risks during related to installation of the piping system for the discharge. The community surrounding the Naval Surface Warfare Center, Dahlgren Division Detachment, White Oak (NSWCWODET) facility will not be impacted by implementation of this alternative. There are no expected impacts to the environment associated with implementation of this alternative.

Long-Term Effectiveness and Permanence

This alternative would be effective in the long-term remediation of groundwater contamination. Extraction wells would restrict on- and potential off-site migration of contaminants in the overburden and shallow bedrock fractures. Additional treatment or disposal of extracted groundwater is required in association with this alternative. Groundwater collection would reduce the risks of on- and off-site exposure to contamination through ingestion or dermal contact with groundwater from potential drinking water or irrigation wells.

To assure long-term reliability, regularly scheduled maintenance will be performed on the components of the air stripping and discharge system. The trays of the shallow tray air stripper will be cleaned on a monthly basis with a pressure washer to remove accumulated scale. Duplex feed and discharge pumps have been specified for the air stripping system to extend pump life and to provide continuous treatment should one pump fail.

Provided that the groundwater source is controlled (capping the landfill), air stripping will provide a permanent reduction in the concentration of organics in the groundwater once the cleanup goals have been achieved. At that point, groundwater treatment may cease. Thus, the alternative provides a long-term effectiveness in achieving the groundwater

remedial action objectives.

Reduction of Toxicity, Mobility, or Volume

The extraction well alternative will significantly reduce the mobility of contaminants in the groundwater at the site. Collection with subsequent treatment will reduce the toxicity of the contaminants in the groundwater. Collection and treatment by air stripping will have no effect on the volume of contamination, since the volatile organics will be transferred from the groundwater to the air, but not destroyed. The collection but not the treatment of the contaminated groundwater reduces the mobility of the contaminants.

Implementability

This alternative would be highly implementable. This technology is technically feasible, administratively feasible and reliable. All required services and materials are readily available. All air stripping system components are readily available from their respective manufacturers. Installation of the treatment system above the 100-year floodplain elevation is required and could be accomplished by elevating the grade adjacent to the stream that flows by Site 3, installing a berm around the area or locating the treatment system to the east of the landfill. The reliability of the shallow tray air stripper and associated system components have been proven at many prior installations. Implementation of this alternative may require an air permit for discharge to the atmosphere and will require a National Pollution Discharge Elimination System (NPDES) permit from the Maryland Department of the Environment (MDE) to discharge treated water to the stream adjacent to the landfill.

Compliance with ARARs

This alternative complies with all action- and location-specific ARARs for treatment systems. This alternative complies with all chemical-specific ARARs. The proposed air stripping system is capable of meeting the Maryland surface water quality goals for organics that would be mandated in the NPDES permit.

Overall Protection of Human Health and the Environment

The well extraction system would serve to restrict further groundwater contamination migration in both the overburden and shallow bedrock fractures and would effectively capture a significant volume of contaminated groundwater. This would reduce the probability that surface water bodies, residential or on-site wells, and regional water supplies could be impacted by site contaminants. During the installation of the extraction wells, the potential exists for exposure of workers to site contaminants via direct contact or inhalation.

Therefore, this alternative will require the implementation of health and safety measures during the remedial construction activities.

The operation of a groundwater pump and treat system utilizing air stripping will reduce or eliminate the migration of contaminated groundwater on and off the facility, will reduce the toxicity of the groundwater and will meet the remedial action objectives for the site. Eliminating or reducing the migration of contaminated groundwater on and off the site will reduce the potential for human or environmental exposure, and thus will be protective of human health and the environment. Since the water discharged to the surface will contain volatile organic levels below USEPA Maximum Contaminant Levels (MCLs), no impacts to human health are anticipated.

Cost

Capital costs would include the installation of a well extraction, air stripping and discharge system, additional monitoring wells, and development of a detailed sampling and analysis plan. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$414,000
Annual O&M Cost	$ 55,000
Present Worth	$469,000

Table 5-13 provides a detailed summary of the estimated costs to implement Groundwater Remediation Alternative 2 - Extraction wells with Air Stripper and Discharge to Surface Water. Backup information for all cost estimates is provided in Appendix A.

5.3.2.3 Alternative 3 - Extraction wells with Activated Carbon and Discharge to Surface Water

This alternative involves the collection of contaminated groundwater with extraction wells, ex-situ treatment using a granular activated carbon (GAC) system such as a column or bed with subsequent discharge of treated groundwater to the stream that flows adjacent to the landfill. Criteria evaluations for the extraction wells and surface water discharge were discussed in Section 5.3.2.2 for Groundwater Remediation Alternative 2 and will not be repeated in the following sections. A discussion of each of the evaluation criteria for this alternative follows.

TABLE 5-13
SITE #3 PISTOL RANGE LANDFILL
GROUNDWATER REMEDIATION ALTERNATIVE 2
EXTRACTION WELLS WITH AIR STRIPPING AND
DISCHARGE TO SURFACE WATER

	CAPITAL	O & M
COLLECTION WITH EXTRACTION WELLS:		
MANHOLES FOR PUMPS & CONTROLS	$3,000	
WELL INSTALLATION & DEVELOPMENT	$12,600	
PIPING	$23,000	
PUMPS	$4,000	
TANK	$12,000	
POWER		$1,200
AIR STRIPPING TREATMENT:		
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$4,000	$1,000
AIR STRIPPER	$20,000	$2,100
SCRUBBER	$7,200	$1,300
LABOR FOR CHECK – UP OPERATIONS		$20,000
DISCHARGE TO SURFACE WATER:		
PUMPS	$10,000	
TANK	$35,000	
POWER		$3,000
PIPING	$12,000	
DISCHARGE MONITORING	$10,000	$5,000
ANALYTICAL		$10,400
SUBTOTAL	$188,000	$44,000
ALLOWANCES		
CONTINGENCY (25%)	$47,000	$11,000
INSTALLATION/CONSTRUCTION (50%)	$94,000	
ENGINEERING (25%)	$47,000	
ELECTRICAL (20%)	$37,600	
ECONOMIC ANALYSIS		
TOTALS	$414,000	$55,000
PRESENT WORTH OF O & M	**$55,000**	
TOTAL PRESENT WORTH	**$469,000**	

Notes

1 For present worth calculation; interest rate = 10%; inflation = 6%; and project life = 1 year

2. Contingencies were applied to both capital cost and O & M costs.

3. Totals were rounded to the nearest thousands.

Short-Term Impacts and Effectiveness

Site workers would be subject to increased chemical exposure risks during related to installation of utilities and the treatment system foundation due to volatilization of volatile organics from the overburden soils. These risks may be properly managed through the appropriate use of personal protective equipment, site monitoring and/or control measures, if required. Implementation of this alternative, with provision of appropriate worker health and community safety measures, is not expected to significantly impact public health or the environment immediately adjacent to the site. This alternative would become effective immediately upon start-up of the collection and treatment system.

Long-Term Effectiveness and Permanence

To assure long-term reliability, regularly scheduled maintenance will be performed on the components of the GAC treatment system. The GAC will be checked on a monthly basis to determine if the carbon needs replacement with fresh carbon. A pre-filtration unit will be checked on a monthly basis also to ensure that no clogging of the system has occurred. Duplex feed and discharge pumps have been specified for the GAC system to extend pump life and to provide continuous treatment should one pump fail.

Provided that the groundwater source is controlled (capping the landfill), activated carbon adsorption will provide a permanent reduction in the concentration of organics in the groundwater once the cleanup goals have been achieved. At that point, groundwater treatment may cease. Thus, the alternative provides a long-term effectiveness in achieving the groundwater remedial action objectives.

Reduction of Toxicity, Mobility, or Volume

Treatment of contaminated groundwater by activated carbon adsorption will reduce the toxicity of the groundwater. Collection and treatment by activated carbon adsorption will have no effect on the volume of contamination, since the volatile organics will be transferred from the groundwater to the GAC, but not destroyed. The collection but not the treatment of the contaminated groundwater reduces the mobility of the contaminants.

Implementability

GAC treatment columns or bed are typically skid-mounted units which are relatively simple to install and replace and are readily available through numerous manufacturers. Installation of the treatment system above the 100-year floodplain elevation is required and could be accomplished by elevating the grade adjacent to the stream that flows by Site 3, installing a berm around the area or locating the treatment system to the east of the landfill.

The reliability of the GAC columns or beds and associated system components have been proven at many prior installations.

Compliance with ARARs

This alternative complies with all action- and location-specific ARARs for treatment systems. This alternative complies with all chemical-specific ARARs. The proposed GAC treatment system is capable of meeting the Maryland surface water quality goals for organics that would be mandated in the NPDES permit.

Overall Protection of Human Health and the Environment

The operation of a groundwater pump and treat system utilizing GAC adsorption will reduce or eliminate the migration of contaminated groundwater on and off the facility, will reduce the toxicity of the groundwater and will meet the remedial action objectives for the site. Eliminating or reducing the migration of contaminated groundwater on and off the site will reduce the potential for human or environmental exposure, and thus will be protective of human health and the environment.

Cost

The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 389,000
Annual O&M Cost	$ 53,000
Present Worth	$ 442,000

Table 5-14 provides a detailed summary of the estimated costs to implement Groundwater Remediation Alternative 3 - Extraction Wells with Activated Carbon and Discharge to Surface Water. Backup information for all cost estimates is provided in Appendix A.

5.3.3 Comparative Analysis

In the following analysis, the alternatives are evaluated in relation to one another for each of the evaluation criteria. Overall protection of human health and the environment and compliance with ARARs will serve as threshold determinations in that they must be met by any alternative in order for it to be eligible for selection. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative.

TABLE 5-14
SITE #3 PISTOL RANGE LANDFILL
GROUNDWATER REMEDIATION ALTERNATIVE 3
EXTRACTION WELLS WITH ACTIVATED CARBON TREATMENT
AND DISCHARGE TO SURFACE WATER

	CAPITAL	O & M
COLLECTION WITH EXTRACTION WELLS:		
MANHOLES FOR PUMPS & CONTROLS	$3,000	
WELL INSTALLATION & DEVELOPMENT	$12,600	
PIPING	$23,000	
PUMPS	$4,000	
TANK	$12,000	
POWER		$1,200
ACTIVATED CARBON TREATMENT:		
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$4,000	$1,000
ACTIVATED CARBON	$16,000	$2,000
LABOR FOR CHECK-UP OPERATIONS		$20,000
DISCHARGE TO SURFACE WATER:		
PUMPS	$10,000	
TANK	$35,000	
POWER		$3,000
PIPING	$12,000	
DISCHARGE MONITORING	$10,000	$5,000
ANALYTICAL		$10,400
SUBTOTAL	$177,000	$42,600
ALLOWANCES		
CONTINGENCY (25%)	$44,250	$10,700
INSTALLATION/CONSTRUCTION (50%)	$88,500	
ENGINEERING (25%)	$44,250	
ELECTRICAL (20%)	$35,400	
ECONOMIC ANALYSIS		
TOTALS	$389,000	$53,000
PRESENT WORTH OF O & M	**$53,000**	
TOTAL PRESENT WORTH	**$442,000**	

Notes
1 For present worth calculation; interest rate = 10%; inflation = 6%; and project life = 1 year
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

5.3.3.1 Soil Remediation Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health and the environment. Leachate generation would continue to occur with further impacts to groundwater quality expected and continued runoff of contaminants to the adjacent stream would occur. Alternative 2 is protective of human health and the environment because leachate generation and runoff of contaminants would be eliminated.

Compliance with ARARs

Alternative 1 does not comply with ARARs while Alternative 2 complies with action-specific ARARs for reduction of leachate from landfills but does not comply with chemical-specific ARARs for contaminants in soils.

Short-Term Impacts and Effectiveness

Although no additional exposure risks would occur for implementation of Alternative 1, Alternative 2 would be much more effective in the short term than Alternative 1. However, leachate would continue to be generated for some time after installation of the cap because of the presence of soil moisture currently in the subsurface soils and landfill.

Long-Term Effectiveness and Permanence

Alternative 2 will provide long-term effectiveness in achieving the remedial action objectives for the site soils while Alternative 1 would not meet these goals. The synthetic/soil cover will retain its integrity for more than 30 years.

Reduction of Toxicity, Mobility, or Volume

Alternative 1 would not reduce the toxicity, mobility, or volume of the PCB-contaminated soils at site. Although Alternative 2 will not reduce the toxicity or volume of contaminated soils, it will reduce the mobility of the contaminants due to the prevention of contaminated runoff and the prevention of rainwater from infiltration through the landfill and generating leachate which could impact groundwater quality.

Implementability

Alternative 1 is implementable because continued sampling would be the only required future action. Alternative 2 is highly implementable because of its wide use and the availability of firms and materials in the local area.

Cost

With regard to cost, Alternative 1 is the least expensive of the two alternatives.

Summary

Because Alternative 1 is not protective of human health and the environment and does not comply with ARARs, it cannot be selected as the preferred alternative for the soils at the site. Alternative 2, Synthetic/Soil Cap, provides the best balance of tradeoffs with respect to the evaluation criteria, and is proposed as the preferred alternative. A summary of the results of the detailed evaluation for each of the two alternatives is shown below.

Criteria	Soil Alternatives	
	1	2
Overall Protection of Human Health and the Environment	-	+
Compliance with ARARs	-	+
Short-Term Effectiveness	-	0
Long-Term Effectiveness	-	+
Reduction of Toxicity, Mobility, or Volume	-	+
Implementability	+	+
Cost (Present Worth)	$72,000	$449,000
Legend: + = positive 0 = neutral - = negative		

5.3.3.2 Groundwater Remediation Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health and the environment. On- and off-site populations could potentially be exposed to contaminated groundwater and continued migration of contaminants in the groundwater would occur. Alternatives 2 and 3 are protective of human health and the environment due to collection and treatment of contaminated groundwater. Risk through ingestion of and direct contact with contaminated groundwater are reduced to cancer risk levels less than 10^{-6} for Alternatives 2 and 3.

Compliance with ARARs

Alternative 1 does not comply with ARARs while Alternatives 2 and 3 comply with action- and chemical-specific ARARs for groundwater contamination collection and treatment.

Short-Term Impacts and Effectiveness

Although no additional exposure risks would occur for implementation of Alternative 1, Alternatives 2 and 3 would be more effective in the short term than Alternative 1. Short-term human health and environmental impacts are the same for Alternatives 2 and 3 because they both extract contaminated groundwater and treat it prior to discharge to surface water.

Long-Term Effectiveness and Permanence

Alternatives 2 and 3 will provide long-term effectiveness in achieving the remedial action objectives for the site groundwater while Alternative 1 would not meet these goals.

Reduction of Toxicity, Mobility, or Volume

Alternative 1 would not reduce the toxicity, mobility, or volume of the contaminated groundwater at site. Alternatives 2 and 3 will reduce the toxicity, mobility and volume of contaminated groundwater. However, for Alternatives 2 and 3, contaminants will not be eliminated, just transferred to a different media (air and carbon scrubber for air stripper and activated carbon for GAC system).

Implementability

Alternative 1 is implementable because continued sampling would be the only required future action. Alternatives 2 and 3 are highly implementable because they are commonly implemented remedial actions for groundwater and because of the availability of firms and materials in the local area.

Cost

For those alternatives that meet selection criteria, Alternative 3 is the least expensive for this site.

Summary

Because Alternative 1 is not protective of human health and the environment and does not comply with ARARs, it cannot be selected as the preferred alternative for the soils at the site. Alternative 3, Extraction Wells with Activated Carbon Treatment and Discharge to Surface Water, provides the best balance of tradeoffs with respect to the evaluation criteria, and is proposed as the preferred alternative. A summary of the results of the

detailed evaluation for each of the three alternatives is shown below.

Criteria	Groundwater Alternatives		
	1	2	3
Overall Protection of Human Health and the Environment	-	+	+
Compliance with ARARs	-	+	+
Short-Term Effectiveness	-	+	+
Long-Term Effectiveness	-	+	+
Reduction of Toxicity, Mobility, or Volume	-	+	+
Implementability	+	+	+
Cost (Present Worth)	$98,000	$469,000	$442,000
Legend: + = positive 0 = neutral - = negative			

5.3.4 Summary of Preferred Alternatives

The following alternatives are proposed as the preferred alternatives to meet the remedial action objectives at Site 3:

- Synthetic/Soil Cap for Surface Soils and Landfill
- Groundwater Extraction Wells with Activated Carbon Treatment and Discharge to Surface Water

Conceptual design criteria and drawings will be presented in Section 6.0 of this document.

5.4 SITE 4 - CHEMICAL BURIAL SITE

5.4.1 Soil/Buried Waste Remediation Alternatives

5.4.1.1 Alternative 1 - No Action

The no action alternative means that no remedial actions will be implemented to remove/control the contaminated soil and buried waste material in the four burial areas located at Site 4. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

With the no action alternative, no remedial construction takes place, and therefore, there is no potential for increased short-term risks to human health or the environment. The human health and environmental risks presented in Section 3.1.3 for the site will remain. Relying on natural biodegradation as the only means of contaminant reduction makes it unlikely that the no action alternative would be effective in achieving the remedial action objectives for the soil and waste material in the foreseeable future.

Long-Term Effectiveness and Permanence

The no action alternative would not be effective in preventing direct human contact with contaminated soils and materials in the burial areas and provides no environmental protection.

Reduction of Toxicity, Mobility, or Volume

The no action alternative does not contribute to the reduction of toxicity, mobility, or volume of the contaminated soils in the burial areas outside of the natural biodegradation which may occur.

Implementability

This alternative has already been implemented.

Compliance with ARARs

This alternative does not comply with the chemical-specific ARARs for soils outlined in Table 3-4.

Overall Protection of Human Health and the Environment

Human health and environmental risks associated with exposure to contaminated soils has not been reduced by the implementation of the no action alternative. The no action alternative does not meet any of the remedial action objectives for this site.

Cost

Costs for this alternative would be chiefly comprised of monitoring and soil analytical costs. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 11,000
Annual O&M Cost	$ 5,000
Present Worth	$ 72,000

Table 5-15 provides a detailed summary of the estimated costs to implement Soil Alternative 1 - No Action. Backup information for all cost estimates is provided in Appendix A.

5.4.1.2 Alternative 2 - Synthetic/Soil Cap

The synthetic/soil cap alternative means that a synthetic membrane/soil cover would be placed over the burial areas to contain the contaminated soil and prevent infiltration to buried wastes. A total area of approximately 60,000 square feet is proposed for remediation. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

Implementation of a synthetic/soil cover will not impact the general public during the construction phase. Construction personnel could be exposed to contaminated dust during clearing, grading and grubbing activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The cover will be completely effective upon establishment of full vegetative growth.

Long-Term Effectiveness and Permanence

A synthetic/soil cover would prevent direct human contact with contaminated soils. This alternative would require long-term maintenance to ensure the integrity of the cover, including reseeding, as necessary, and repair of damage due to weather conditions, animals, undesirable vegetation, etc. Maintenance of the topsoil/vegetation layer for this alternative is not crucial because of the protection afforded by the synthetic membrane liner. When properly installed, the liner itself will retain its integrity for more than 30 years. The synthetic/soil cover provides an excellent barrier to infiltration, while minimizing cover thickness. Thus, with proper maintenance, the synthetic/soil cover alternative provides long-

TABLE 5–15
SITE #4 CHEMICAL BURIAL SITE
SOIL REMEDIATION ALTERNATIVE 1
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$2,800
SUBTOTAL	$9,000	$4,300
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$1,100
ECONOMIC ANALYSIS		
TOTALS	$11,000	$5,000
PRESENT WORTH OF O & M	**$61,000**	
TOTAL PRESENT WORTH	**$72,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi–annual basis.

term effectiveness in achieving the remedial action objectives for the site soils.

Reduction of Toxicity, Mobility, or Volume

Placement of a synthetic/soil cover will effectively eliminate the mobility of contaminants due to the migration of soils by erosion. The presence of both the synthetic liner and the vegetation will eliminate infiltration but not completely eliminate the transference of contaminants from soils and buried wastes to groundwater due to the presence of some soil moisture or leachate already present in the subsurface. The toxicity and volume of the contamination on and in the burial areas will not be altered by the placement of a synthetic/soil cover.

Implementability

Materials and equipment for the installation of a synthetic/soil cover are available throughout the Washington, D.C. and Maryland metropolitan area, making this alternative readily available.

Compliance with ARARs

This alternative does not comply with the chemical-specific ARARs for soils outlined in Table 3-4. This alternative does comply with the action-specific ARARs for control of contaminated soil and the prevention of infiltration which minimizes leachate generation.

Overall Protection of Human Health and the Environment

Placement of the synthetic/soil cover is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the contaminated soils and prevents infiltration of precipitation. In addition, this cover offers more reliable, long-term protection since, when properly installed, the synthetic liner will retain its integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for the on-site soils.

Cost

Costs for this alternative would be chiefly comprised of material purchases and cap installation. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 341,000
Annual O&M Cost	$ 5,000
Present Worth	$ 402,000

Table 5-16 provides a detailed summary of the estimated costs to implement Soil Alternative 2 - Synthetic/Soil Cover. Backup information for all cost estimates is provided in Appendix A.

5.4.1.3 Alternative 3 - Excavation with On-site Thermal Treatment/On-site Disposal

Alternative 3 is excavation with on-site thermal treatment of excavated contaminated soil followed by on-site disposal of the treatment residuals. Excavated soil would be staged at the treatment unit prior to treatment. On-site thermal treatment includes the use of a mobile incinerator to thermally destruct the organics in the soil. This alternative involves placement of the treatment residuals back in the burial areas. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during excavation, treatment and disposal of the contaminated soils and treatment residues. Treatment unit operator personnel could be exposed to contaminated dust during soil and treatment residue handling activities and airborne organics during thermal treatment operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The disposal of treatment residue on-site will not impact the general public during the disposal phase. Personnel could be exposed to contaminated dust during disposal activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Excavation would be effective in reducing direct human contact with contaminants in the soils. Reduction in organic concentration in the excavated soils could be expected to be as high as 90 to 99 percent. On-site disposal back into the burial areas would be an effective method of treatment residue disposal. Human health exposure to treatment residue would be eliminated.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the excavated soil would be the result of thermal treatment of the soil. The volume of soil would not significantly change after thermal treatment, the amount of treatment residue would be virtually the same as the amount of soil incinerated. A reduction in mobility is not applicable to the treatment

TABLE 5-16
SITE #4 CHEMICAL BURIAL SITE
SOIL REMEDIATION ALTERNATIVE 2
CAPPING (SYNTHETIC MATERIAL)

	CAPITAL	O & M
SITE CLEARING	$1,000	
GRADING	$8,500	
HDPE SYNTHETIC MEMBRANE	$63,000	
SYNTHETIC FILTER FABRIC (2 LAYERS) (2 LAYERS)	$24,000	
DRAINAGE NET	$26,400	
TOP SOIL FOR CAPPING (@ 6 - INCHES THICKNESS)	$18,000	
SEDIMENT AND EROSION CONTROL	$5,000	
SEEDING	$2,800	
SEED PROTECTION	$3,200	
TOP SOIL FOR SEEDING (@ 3-INCH THICKNESS)	$9,000	
GROUNDWATER MONITORING	$9,000	$1,500
ANALYTICAL		$2,800
SUBTOTAL	$170,000	$4,300
ALLOWANCES		
CONTINGENCY (25%)	$43,000	$1,100
INSTALLATION/CONSTRUCTION (50%)	$85,000	
ENGINEERING (25%)	$43,000	
ECONOMIC ANALYSIS		
TOTALS	$341,000	$5,000
PRESENT WORTH OF O & M	**$61,000**	
TOTAL PRESENT WORTH	**$402,000**	

NOTES:
1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

technologies. On-site disposal in conjunction with placement of a soil cover will effectively reduce the mobility of contaminants in the treatment residue. The presence of a soil cover and vegetation will reduce infiltration of organics remaining in the treatment residuals.

Implementability

This alternative is implementable due to the availability of excavation and mobile treatment equipment. However, approval of a thermal treatment permit may be somewhat difficult to obtain. The disposal of treatment residue in the burial areas could be implemented with no substantial difficulties. Approval of on-site disposal (permit may be required) will be the most difficult implementation facet of this remedial action.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment of contaminated soil.

Overall Protection of Human Health and the Environment

Excavation with subsequent on-site thermal treatment of contaminated soil prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated soil. On-site thermal treatment meets the remedial action objective of treatment of excavated contaminated soil. Placement of the residuals in the burial areas in conjunction with a soil cover is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limits infiltration of precipitation. Thus, this alternative satisfies the remedial action objectives for removal of contaminated soils and disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 868,000
Annual O&M Cost	$ 0
Present Worth	$ 868,000

Table 5-17 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 3 - Soil Excavation with On-site Thermal Treatment/On-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.4.1.4 Alternative 4 - Excavation with On-site Thermal Treatment/Off-site Disposal

Alternative 4 is excavation with on-site thermal treatment of excavated contaminated soil followed by off-site disposal of the treatment residuals. Excavated soil would be staged at the treatment unit prior to treatment. On-site thermal treatment includes the use of a mobile incinerator to thermally destruct the organics in the soil. Excavated soil would be transported to the on-site treatment facility prior to treatment. This alternative involves placement of the treatment residuals in an off-site chemical waste landfill. A discussion of each of the evaluation criteria for this alternative follows. Excavation and treatment criteria evaluations were discussed in Section 5.4.1.3 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

The disposal of treatment residue in an off-site chemical waste landfill will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Off-site disposal into a chemical waste landfill would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume

Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the treatment residue. The toxicity and volume of the organic contamination in the treatment residue will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

The disposal of treatment residue in a chemical waste landfill could be implemented with no substantial difficulties.

TABLE 5-17
SITE #4 CHEMICAL BURIAL SITE
SOIL REMEDIATION ALTERNATIVE 3
EXCAVATION WITH ON-SITE THERMAL TREATMENT AND ON-SITE DISPOSAL

	CAPITAL
EXCAVATION	$53,000
STAGING	$50,000
THERMAL TREATMENT	$500,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$75,000
GRADING	$5,000
CONFIRMATION SAMPLING	$4,500
ANALYTICAL	$6,400
SUBTOTAL	$694,000
ALLOWANCES	
CONTINGENCY (25%)	$174,000
TOTAL	$868,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

Compliance with ARARs

The placement of the treatment residues in a chemical waste landfill would comply with action-specific and chemical-specific ARARs.

Overall Protection of Human Health and the Environment

Placement of the residuals in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues in a chemical waste landfill offers more reliable, long-term protection since, when properly installed, these landfills will retain their integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 3,843,000
Annual O&M Cost	$ 0
Present Worth	$ 3,843,000

Table 5-18 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 4 - Soil Excavation with On-site Thermal Treatment/Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.4.1.5 Alternative 5 - Excavation with On-site Soil Washing/On-site Disposal

Soil remediation Alternative 5 is soil excavation with on-site soil washing of excavated contaminated soil followed by on-site disposal of treatment residuals. Excavated soil would be staged at the treatment unit prior to treatment. On-site soil washing includes the use of a mobile soil washing unit to physically remove the organics in the soil. This alternative involves placement of the treated residue into the burial areas as backfill. A discussion of each of the evaluation criteria for this alternative follows. Excavation criteria evaluations were discussed in Section 5.4.1.3 and will not be repeated in the following sections.

TABLE 5-18
SITE #4 CHEMICAL BURIAL SITE
SOIL REMEDIATION ALTERNATIVE 4
EXCAVATION WITH ON-SITE THERMAL TREATMENT AND OFF-SITE DISPOSAL

	CAPITAL
EXCAVATION	$53,000
STAGING	$25,000
THERMAL TREATMENT	$500,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$75,000
LOADING & HAULING TO LANDFILL	$1,910,000
LANDFILL CHARGES	$500,000
CONFIRMATION SAMPLING	$4,500
ANALYTICAL	$6,400
SUBTOTAL	$3,074,000
ALLOWANCES	
CONTINGENCY (25%)	$769,000
TOTAL	$3,843,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during treatment of the contaminated soil. Treatment unit operator personnel could be exposed to contaminated dust during soil and treatment residue handling activities and contaminated washing solutions during soil washing operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The disposal of treatment residue on-site will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust during handling and backfilling activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Reduction in organic concentration in the excavated soil could be expected to be as high as 90 to 99 percent. On-site disposal into the burial areas would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the excavated soil would be the result of washing of the soil. The volume of soil would not change after washing; however, a significant quantity of contaminated solution (water, surfactants, etc.) would be generated. A reduction in mobility is not applicable to the treatment technologies. On-site disposal in conjunction with placement of a soil cover will effectively reduce the mobility of contaminants in the treatment residue. The presence of both the soil and vegetative cover will reduce infiltration of organics remaining in the treatment residuals.

Implementability

This alternative is implementable due to the availability of mobile equipment. Approval of a treatment permit involving soil washing would be expected to be less difficult to obtain than a permit for the thermal destruction process. The disposal of treatment residue into the burial areas could be implemented with no substantial difficulties. Approval of on-site disposal (permit may be required) will be the most difficult implementation facet of this remedial action.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment of contaminated soils.

Overall Protection of Human Health and the Environment

On-site soil washing of contaminated soil prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated soil. On-site soil washing meets the remedial action objective of treatment of excavated contaminated soil. Placement of the residuals in the burial areas as fill in conjunction with installation of a soil cover is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 1,649,000
Annual O&M Cost	$ 0
Present Worth	$ 1,649,000

Table 5-19 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 5 - Soil Excavation with On-site Soil Washing/On-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.4.1.6 Alternative 6 - Excavation with On-site Soil Washing/Off-site Disposal

Soil remediation alternative 6 is soil excavation with on-site soil washing of excavated contaminated soil followed by off-site disposal of treatment residuals. Excavated soil would be staged at the treatment unit prior to treatment. On-site soil washing includes the use of a mobile soil washing unit to physically remove the organics from the soil. This alternative involves placement of the treated residue in an off-site chemical waste landfill. A discussion of each of the evaluation criteria for this alternative follows. Excavation and treatment criteria evaluations were discussed in Sections 5.4.1.3 and 5.4.1.6 and will not be repeated in the following sections.

TABLE 5-19
SITE #4 CHEMICAL BURIAL SITE
SOIL REMEDIATION ALTERNATIVE 5
EXCAVATION WITH ON-SITE SOIL WASHING
AND ON-SITE DISPOSAL

	CAPITAL
EXCAVATION	$53,000
STAGING	$50,000
SOIL WASHING	$1,125,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$75,000
GRADING	$5,000
CONFIRMATION SAMPLING	$4,500
ANALYTICAL	$6,400
SUBTOTAL	$1,319,000
ALLOWANCES	
CONTINGENCY (25%)	$330,000
TOTAL	$1,649,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

Short-Term Impacts and Effectiveness

The disposal of treatment residue in an off-site chemical waste landfill will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Off-site disposal into a chemical waste landfill would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume

Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the treatment residue. The toxicity and volume of the contamination in the treatment residue will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

The disposal of treatment residue in a chemical waste landfill could be implemented with no substantial difficulties.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment and disposal of contaminated soils.

Overall Protection of Human Health and the Environment

Placement of the residuals in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues in a chemical waste landfill offers more reliable, long-term protection since, when properly installed, these landfills will retain their integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 4,624,000
Annual O&M Cost	$ 0
Present Worth	$ 4,624,000

Table 5-20 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 6 - Soil Excavation with On-site Soil Washing/Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.4.1.7 Alternative 7 - Excavation with Off-site Soil Washing/Off-site Disposal

Soil remediation Alternative 7 is soil excavation with off-site soil washing of excavated contaminated soil and off-site disposal. Off-site soil washing includes transport of excavated soil to an off-site permitted soil washing unit to physically remove the organics in the soil. This alternative involves placement of the treated residue in an off-site chemical waste landfill. Excavation criteria evaluations were discussed in Section 5.4.1.3 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during treatment of the contaminated soil. Treatment unit operator personnel could be exposed to contaminated dust during soil and treatment residue handling activities and contaminated washing solutions during soil washing operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The disposal of treatment residue in an off-site chemical waste landfill will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Reduction in organic concentration in the excavated soil could be expected to be as high as 90 to 99 percent. Off-site disposal into a chemical waste landfill would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume - A significant reduction in the toxicity of the excavated soil would be the result of washing of the soil. The volume of soil would not change after washing; however, a significant quantity of organic-contaminated solution (water, surfactants, etc.) would be generated. A reduction in mobility is not applicable to

TABLE 5-20
SITE #4 CHEMICAL BURIAL SITE
SOIL REMEDIATION ALTERNATIVE 6
EXCAVATION WITH ON-SITE SOIL WASHING AND OFF-SITE DISPOSAL

	CAPITAL
EXCAVATION	$53,000
STAGING	$25,000
SOIL WASHING	$1,125,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$75,000
LOADING & HAULING TO LANDFILL	$1,910,000
LANDFILL CHARGES	$500,000
CONFIRMATION SAMPLING	$4,500
ANALYTICAL	$6,400
SUBTOTAL	$3,699,000
ALLOWANCES	
CONTINGENCY (25%)	$925,000
TOTAL	$4,624,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

the treatment technologies. Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the treatment residue. The toxicity and volume of the contamination in the treatment residue will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

This alternative is implementable due to the availability of off-site treatment facilities. The disposal of treatment residue in a chemical waste landfill could be implemented with no substantial difficulties.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment and disposal of contaminated soil.

Overall Protection of Human Health and the Environment

Off-site soil washing of contaminated soil prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated soil. Off-site soil washing meets the remedial action objective of treatment of excavated contaminated soil. Placement of the residuals in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues in a chemical waste landfill offers more reliable, long-term protection since, when properly installed, these landfills will retain their integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of soil excavation, transport, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 5,574,000
Annual O&M Cost	$ 0
Present Worth	$ 5,574,000

Table 5-21 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 7 - Soil Excavation with Off-site Soil Washing/Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.4.2 Buried Waste Material Disposal Alternative

Off-site Disposal

This alternative involves the disposal of an estimated 200 cubic yards of buried waste material in an off-site landfill and will be implemented provided that a soil/buried waste excavation alternative is also selected. Decontamination of the materials with collection of wash water and any free product may be required prior to disposal. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during disposal of the buried waste materials. The disposal of the buried waste materials off-site will not impact the general public during the disposal phase. Personnel could be exposed to contaminated material or free product during handling and disposal activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Off-site disposal would be an effective method of buried waste material disposal. Human health exposure to buried materials would be eliminated.

Reduction of Toxicity, Mobility, or Volume

Off-site disposal will reduce the toxicity, mobility, and volume of wastes at the site. However, decontamination of the wastes may be required prior to disposal which would generate potential additional waste streams (i.e., free product, contaminated decontamination water).

Implementability

The disposal of buried waste materials in an off-site landfill could be implemented with no substantial difficulties.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for disposal of hazardous and solid wastes.

TABLE 5-21
SITE #4 CHEMICAL BURIAL SITE
SOIL REMEDIATION ALTERNATIVE 7
EXCAVATION WITH OFF-SITE SOIL WASHING AND OFF-SITE DISPOSAL

	CAPITAL
EXCAVATION	$53,000
LOADING & HAULING TO TREATMENT SITE	$1,160,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$75,000
SOIL WASHING	$750,000
LOADING & HAULING TO LANDFILL	$1,910,000
LANDFILL CHARGES	$500,000
CONFIRMATION SAMPLING	$4,500
ANALYTICAL	$6,400
SUBTOTAL	$4,459,000
ALLOWANCES	
CONTINGENCY (25%)	$1,115,000
TOTAL	$5,574,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

Overall Protection of Human Health and the Environment

Land disposal in an approved chemical waste landfill greatly reduces the potential human health and environmental risks associated with exposure to buried waste material. Thus, this alternative satisfies the remedial action objectives for proper disposal of buried waste materials.

Cost

Costs for this alternative would be chiefly comprised of disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 133,000
Annual O&M Cost	$ 0
Present Worth	$ 133,000

Table 5-22 provides a detailed summary of the estimated costs to implement Buried Waste Material Disposal Alternative - Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.4.3 Groundwater Remediation Alternatives

5.4.3.1 Alternative 1 - No Action

The no action alternative means that no remedial actions will be implemented to remove or treat the groundwater. Only the natural biodegradation of organic contaminants by indigenous microorganisms would occur. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

With the no action alternative, no remedial construction takes place; therefore, there is no potential for increased short-term risks to human health or the environment. The human health and environmental risks discussed in Section 3.1.3 will remain. Relying on natural biodegradation as the only means of contaminant reduction makes it unlikely that the no action alternative would be effective in achieving the remedial action objectives for the groundwater.

Long-Term Effectiveness and Permanence

Even if the source of groundwater contamination is removed (capping or excavating the burial areas), contaminated groundwater would continue to migrate on-site for some

TABLE 5-22
SITE #4 CHEMICAL BURIAL SITE
BURIED WASTE DISPOSAL ALTERNATIVE
OFF-SITE LANDFILL

	CAPITAL
LOADING & HAULING TO LANDFILL	$76,000
LANDFILL	$30,000
SUBTOTAL	$106,000
ALLOWANCES	
CONTINGENCY (25%)	$27,000
TOTAL	$133,000

period of time with the possibility of migrating on- and off-site towards some receptor (drinking water wells). It is difficult to predict if or when contaminants in the groundwater would be reduced to groundwater standards, through either natural biodegradation or groundwater mixing. Thus, the no action alternative is not effective in achieving the remedial action objectives for the site.

Reduction of Toxicity, Mobility, or Volume

The no action alternative will not reduce the mobility or volume of contaminated groundwater. Toxicity could be reduced somewhat, over time, by natural biodegradation processes.

Implementability

The no action alternative requires no implementation.

Compliance with ARARs

Action-specific ARARs do not apply to the no action alternative. This alternative would not comply with the chemical-specific ARARs.

The no action alternative would comply with location-specific ARARs.

Overall Protection of Human Health and the Environment

The no action alternative will not be protective of human health and the environment because this alternative allows groundwater to freely migrate off-site. Thus, the no action alternative does not meet the remedial action objectives for groundwater.

Cost

Capital costs would include the development of a detailed sampling and analytical plan. Annual O&M costs will include groundwater sampling and analysis of groundwater samples. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 11,000
Annual O&M Cost	$ 8,000
Present Worth	$ 98,000

Table 5-23 provides a detailed summary of the estimated costs to implement Groundwater Remediation Alternative 1 - No Action. Backup information for all cost estimates is provided in Appendix A.

TABLE 5-23
SITE #4 CHEMICAL BURIAL SITE
GROUNDWATER REMEDIATION ALTERNATIVE 1
NO ACTION

	CAPITAL	O & M
MONITORING ON SITE WELLS	$9,000	$3,000
ANALYTICAL		$3,200
SUBTOTAL	$9,000	$6,200
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$1,550
ECONOMIC ANALYSIS		
TOTALS	$11,000	$8,000
PRESENT WORTH OF O & M	$87,000	
TOTAL PRESENT WORTH	$98,000	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

5.4.3.2 Alternative 2 - Extraction Wells with Air Stripping and Discharge to Surface Water

Extraction wells are a viable means of withdrawing groundwater to restrict on-site and potential off-site migration of contaminated groundwater. This alternative involves the collection of contaminated groundwater with extraction wells, ex-situ treatment using a shallow tray air stripper and discharge of treated groundwater to surface water. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There is potential for increased short-term risks to human health due to the drilling of extraction wells, handling and disposal of contaminated subsurface soils and groundwater. Site workers would be subject to increased chemical exposure risks during related to installation of utilities and the treatment system foundation due to volatilization of volatile organics from the overburden soils. These risks may be properly managed through the appropriate use of personal protective equipment, site monitoring and/or control measures, if required. Site workers would not be subject to increased chemical exposure risks during related to installation of the piping system for the discharge. The community surrounding the NSWCWODET facility will not be impacted by implementation of this alternative. There are no expected impacts to the environment associated with implementation of this alternative.

Long-Term Effectiveness and Permanence

This alternative would be effective in the long-term remediation of groundwater contamination. Extraction wells would restrict on-site and potential off-site migration of contaminants in the overburden and shallow saprolite units. Additional treatment or disposal of extracted groundwater is required in association with this alternative. Groundwater collection would reduce the risks of on- and off-site exposure to contamination through ingestion or dermal contact with groundwater from potential drinking water or irrigation wells.

To assure long-term reliability, regularly scheduled maintenance will be performed on the components of the air stripping and discharge system. The trays of the shallow tray air stripper will be cleaned on a monthly basis with a pressure washer to remove accumulated scale. Duplex feed and discharge pumps have been specified for the air stripping system to extend pump life and to provide continuous treatment should one pump fail.

Provided that the groundwater source is controlled or removed (capping or excavating the burial areas), air stripping will provide a permanent reduction in the concentration of organics in the groundwater once the cleanup goals have been achieved. At that point, groundwater treatment may cease. Thus, the alternative provides a long-term effectiveness in achieving the groundwater remedial action objectives.

Reduction of Toxicity, Mobility, or Volume

The extraction well alternative will significantly reduce the mobility of contaminants in the groundwater at the site. Collection with subsequent treatment will reduce the toxicity of the contaminants in the groundwater. Collection and treatment by air stripping will have no effect on the volume of contamination, since the volatile organics will be transferred from the groundwater to the air, but not destroyed. The collection but not the treatment of the contaminated groundwater reduces the mobility of the contaminants.

Implementability

This alternative would be highly implementable. This technology is technically feasible, administratively feasible and reliable. All required services and materials are readily available. All air stripping system components are readily available from their respective manufacturers. The reliability of the shallow tray air stripper and associated system components have been proven at many prior installations. Implementation of this alternative will require a NPDES permit from the MDE to discharge treated water to the stream.

Compliance with ARARs

This alternative complies with all action- and location-specific ARARs for treatment systems. This alternative complies with all chemical-specific ARARs. The proposed air stripping system is capable of meeting the Maryland surface water quality goals for organics that would be mandated in the NPDES permit.

Overall Protection of Human Health and the Environment

The well extraction system would serve to restrict further groundwater contamination migration in both the overburden and shallow bedrock fractures and would effectively capture a significant volume of contaminated groundwater. This would reduce the probability that surface water bodies, residential or on-site wells, and regional water supplies could be impacted by site contaminants. During the installation of the extraction wells, the potential exists for exposure of workers to site contaminants via direct contact or inhalation. Therefore, this alternative will require the implementation of health and safety measures

during the remedial construction activities.

The operation of a groundwater pump and treat system utilizing air stripping will reduce or eliminate the migration of contaminated groundwater on and off the facility, will reduce the toxicity of the groundwater and will meet the remedial action objectives for the site. Eliminating or reducing the migration of contaminated groundwater on and off the site will reduce the potential for human or environmental exposure, and thus will be protective of human health and the environment. Since the water discharged to the surface will contain volatile organic levels below USEPA MCLs, no impacts to human health are anticipated.

Cost

Capital costs would include the installation of a well extraction, air stripping and discharge system, and development of a detailed sampling and analysis plan. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 1,069,000
Annual O&M Cost	$ 86,000
Present Worth	$ 1,650,000

Table 5-24 provides a detailed summary of the estimated costs to implement Groundwater Remediation Alternative 2 - Extraction wells with Air Stripper and Discharge to Surface Water. Backup information for all cost estimates is provided in Appendix A.

5.4.3.3 Alternative 3 - Extraction wells with Activated Carbon and Discharge to Surface Water

This alternative involves the collection of contaminated groundwater with extraction wells, ex-situ treatment using a GAC system such as a column or bed with subsequent discharge of treated groundwater to the stream that flows east of Site 9. Criteria evaluations for the extraction wells and surface water discharge were discussed in Section 5.4.3.2 for Groundwater Remediation Alternative 2 and will not be repeated in the following sections. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

Site workers would be subject to increased chemical exposure risks during related to installation of utilities and the treatment system foundation due to volatilization of volatile organics from the overburden soils. These risks may be properly managed through the

TABLE 5-24
SITE #4 CHEMICAL BURIAL SITE
GROUNDWATER REMEDIATION ALTERNATIVE 2
EXTRACTION WELLS WITH AIR STRIPPING AND
DISCHARGE TO SURFACE WATER

	CAPITAL	O & M
COLLECTION WITH EXTRACTION WELLS:		
MANHOLES FOR PUMPS & CONTROLS	$8,000	
WELL INSTALLATION & DEVELOPMENT	$76,000	
PIPING	$115,500	
PUMPS	$12,000	
TANK	$20,000	
POWER		$2,800
AIR STRIPPING TREATMENT:		
BUILDING	$35,000	
FENCE	$10,000	
FILTRATION	$20,000	$2,500
AIR STRIPPER	$75,000	$3,150
SCRUBBER	$36,000	$2,000
LABOR FOR CHECK – UP OPERATIONS		$40,000
DISCHARGE TO SURFACE WATER:		
PUMPS	$10,000	
TANK	$35,000	
POWER		$3,000
PIPING	$23,000	
DISCHARGE MONITORING	$10,000	$5,000
ANALYTICAL		$10,400
SUBTOTAL	$486,000	$68,850
ALLOWANCES		
CONTINGENCY (25%)	$121,500	$17,200
INSTALLATION/CONSTRUCTION (50%)	$243,000	
ENGINEERING (25%)	$121,500	
ELECTRICAL (20%)	$97,200	
ECONOMIC ANALYSIS		
TOTALS	$1,069,000	$86,000
PRESENT WORTH OF O & M	**$581,000**	
TOTAL PRESENT WORTH	**$1,650,000**	

Notes

1 For present worth calculation; interest rate = 10%; inflation = 6%; and project life = 10 years

2. Contingencies were applied to both capital cost and O & M costs.

3. Totals were rounded to the nearest thousands.

appropriate use of personal protective equipment, site monitoring and/or control measures, if required. Implementation of this alternative, with provision of appropriate worker health and community safety measures, is not expected to significantly impact public health or the environment immediately adjacent to the site. This alternative would become effective immediately upon start-up of the collection and treatment system.

Long-Term Effectiveness and Permanence

To assure long-term reliability, regularly scheduled maintenance will be performed on the components of the GAC treatment system. The GAC will be checked on a monthly basis to determine if the carbon needs replacement with fresh carbon. A pre-filtration unit will be checked on a monthly basis also to ensure that no clogging of the system has occurred. Duplex feed and discharge pumps have been specified for the GAC system to extend pump life and to provide continuous treatment should one pump fail.

Provided that the groundwater source is controlled or removed (capping or excavating the burial areas), activated carbon will provide a permanent reduction in the concentration of organics in the groundwater once the cleanup goals have been achieved. At that point, groundwater treatment may cease. Thus, the alternative provides a long-term effectiveness in achieving the groundwater remedial action objectives.

Reduction of Toxicity, Mobility, or Volume - Treatment of contaminated groundwater by activated carbon adsorption will reduce the toxicity of the groundwater. Collection and treatment by activated carbon adsorption will have no effect on the volume of contamination, since the volatile organics will be transferred from the groundwater to the GAC, but not destroyed. The collection but not the treatment of the contaminated groundwater reduces the mobility of the contaminants.

Implementability

GAC treatment columns or bed are typically skid-mounted units which are relatively simple to install and replace and are readily available through numerous manufacturers. The reliability of the GAC columns or beds and associated system components have been proven at many prior installations.

Compliance with ARARs

This alternative complies with all action- and location-specific ARARs for treatment systems. This alternative complies with all chemical-specific ARARs. The proposed GAC treatment system is capable of meeting the Maryland surface water quality goals for organics that would be mandated in the NPDES permit.

Overall Protection of Human Health and the Environment

The operation of a groundwater pump and treat system utilizing GAC adsorption will reduce or eliminate the migration of contaminated groundwater on and off the facility, will reduce the toxicity of the groundwater and will meet the remedial action objectives for the site. Eliminating or reducing the migration of contaminated groundwater on and off the site will reduce the potential for human or environmental exposure, and thus will be protective of human health and the environment.

Cost

The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 983,000
Annual O&M Cost	$ 84,000
Present Worth	$ 1,459,000

Table 5-25 provides a detailed summary of the estimated costs to implement Groundwater Remediation Alternative 3 - Extraction Wells with Activated Carbon and Discharge to Surface Water. Backup information for all cost estimates is provided in Appendix A.

5.4.4 Comparative Analysis

In the following analysis, the alternatives are evaluated in relation to one another for each of the evaluation criteria. Overall protection of human health and the environment and compliance with ARARs will serve as threshold determinations in that they must be met by any alternative in order for it to be eligible for selection. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative.

5.4.4.1 Soil Remediation Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health and the environment. Infiltration of rainwater to the buried wastes would continue to generate leachate and impact groundwater quality. Alternatives 2 through 7 are protective of human health and the environment. Leachate generation would be reduced or eliminated for all alternatives except for

TABLE 5-25
SITE #4 CHEMICAL BURIAL SITE
GROUNDWATER REMEDIATION ALTERNATIVE 3
EXTRACTION WELLS WITH ACTIVATED CARBON TREATMENT
AND DISCHARGE TO SURFACE WATER

	CAPITAL	O & M
COLLECTION WITH EXTRACTION WELLS:		
MANHOLES FOR PUMPS & CONTROLS	$8,000	
WELL INSTALLATION & DEVELOPMENT	$76,000	
PIPING	$115,500	
PUMPS	$12,000	
TANK	$20,000	
POWER		$2,800
ACTIVATED CARBON TREATMENT:		
BUILDING	$35,000	
FENCE	$10,000	
FILTRATION	$20,000	$2,500
ACTIVATED CARBON	$72,000	$3,500
LABOR FOR CHECK-UP OPERATIONS		$40,000
DISCHARGE TO SURFACE WATER:		
PUMPS	$10,000	
TANK	$35,000	
POWER		$3,000
PIPING	$23,000	
DISCHARGE MONITORING	$10,000	$5,000
ANALYTICAL		$10,400
SUBTOTAL	$447,000	$67,200
ALLOWANCES		
CONTINGENCY (25%)	$111,750	$16,800
INSTALLATION/CONSTRUCTION (50%)	$223,500	
ENGINEERING (25%)	$111,750	
ELECTRICAL (20%)	$89,400	
ECONOMIC ANALYSIS		
TOTALS	$983,000	$84,000
PRESENT WORTH OF O & M	**$476,000**	
TOTAL PRESENT WORTH	**$1,459,000**	

Notes
1 For present worth calculation; interest rate = 10%; inflation = 6%; and project life = 10 years
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

Alternative 1.

Compliance with ARARs

Alternative 1 does not comply with ARARs while Alternatives 3 through 7 comply with action- and chemical-specific ARARs. Alternative 2 complies with action-specific ARARs but not chemical-specific ARARs.

Short-Term Impacts and Effectiveness

Although no additional exposure risks would occur for implementation of Alternative 1, Alternatives 2 through 7 would be more effective in the short term than Alternative 1. Human health exposure for Alternatives 3 through 7 are higher than for Alternative 2 because they require excavation and treatment of contaminated soil prior to disposal. Alternative 2 is capping and does not require contaminated soil handling activities. Short-term environmental impacts are the same for Alternatives 3 through 7 because they all require excavation which will remove the contaminants from the environment. Short-term impacts associated with Alternative 2 include continued leachate generation until soil moisture decreases in the subsurface to the point where leachate cannot be generated.

Long-Term Effectiveness and Permanence

Alternatives 2 through 7 will provide long-term effectiveness in achieving the remedial action objectives for the site soils while Alternative 1 would not meet these goals.

Reduction of Toxicity, Mobility, or Volume

Alternative 1 would not reduce the toxicity, mobility, or volume of the contaminated soils at site. Alternative 2 will not reduce the toxicity or volume of contaminated soil but will reduce the mobility due to infiltration elimination. Alternatives 3 through 7 will reduce the toxicity and mobility of contaminated soil because of treatment of the soil. The volume of contaminated soil will remain the same for Alternatives 3 through 7.

Implementability

Alternative 1 is implementable because continued sampling would be the only required future action. Alternative 2 is highly implementable. Alternatives 3, 4, 5, and 6 are highly implementable because of the availability of contractors who perform mobile on-site treatment of contaminated soil. Alternative 7 is implementable but the availability of local fixed treatment facilities is not as prevalent as those available on-site activities.

Cost

With regard to cost for those alternatives that quality for selection as the preferred alternative, Alternative 2 is the least expensive. Alternatives 3 and 5 which include on-site

disposal of the treatment residuals are considerably more cost effective than Alternatives 4, 6, and 7 which include off-site disposal.

Summary

Because Alternative 1 is not protective of human health and the environment and does not comply with ARARs, it cannot be selected as the preferred alternative for the soils at the site. Alternative 3, Soil Excavation with On-site Thermal Treatment and On-site Disposal, provides the best balance of tradeoffs with respect to the evaluation criteria, and is proposed as the preferred alternative. A summary of the results of the detailed evaluation for each of the seven alternatives is shown below.

Criteria	Soil Alternatives						
	1	2	3	4	5	6	7
Overall Protection of Human Health and the Environment	-	+	+	+	+	+	+
Compliance with ARARs	-	+	+	+	+	+	+
Short-Term Effectiveness	-	0	0	0	0	0	0
Long-Term Effectiveness	-	+	+	+	+	+	+
Reduction of Toxicity, Mobility, or Volume	-	0	+	+	+	+	+
Implementability	+	+	+	+	+	+	0
Cost (Present Worth in millions)	$0.07	$0.4	$0.9	$3.8	$1.6	$4.6	$5.6

Legend:
+ = positive
0 = neutral
- = negative

5.4.4.2 Buried Waste Disposal Remediation Alternatives

Off-site disposal of excavated buried waste materials is the only alternative evaluated for this media, and therefore, no comparative analysis will be provided. Implementation of this alternative will only occur if a soil/buried waste excavation alternative is selected.

5.4.4.3 Groundwater Remediation Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health and the environment. On- and off-site populations could potentially be exposed to contaminated groundwater and continued migration of contaminants in the groundwater would occur. Alternatives 2 and 3 are protective of human health and the environment due to collection and treatment of contaminated groundwater. Risk through ingestion of and contact with contaminated groundwater are reduced to cancer risk levels less than 10^{-6} for Alternatives 2 and 3.

Compliance with ARARs

Alternative 1 does not comply with ARARs while Alternatives 2 and 3 comply with action- and chemical-specific ARARs for groundwater contamination collection and treatment.

Short-Term Impacts and Effectiveness

Although no additional exposure risks would occur for implementation of Alternative 1, Alternatives 2 and 3 would be more effective in the short term than Alternative 1. Short-term human health and environmental impacts are the same for Alternatives 2 and 3 because they both extract contaminated groundwater and treat it prior to discharge to surface water.

Long-Term Effectiveness and Permanence

Alternatives 2 and 3 will provide long-term effectiveness in achieving the remedial action objectives for the site groundwater while Alternative 1 would not meet these goals.

Reduction of Toxicity, Mobility, or Volume

Alternative 1 would not reduce the toxicity, mobility, or volume of the contaminated groundwater at site. Alternatives 2 and 3 will reduce the toxicity, mobility and volume of contaminated groundwater. However, for Alternatives 2 and 3, contaminants will not be eliminated, just transferred to a different media (air and carbon scrubber for air stripper and activated carbon for GAC system).

Implementability

Alternative 1 is implementable because continued sampling would be the only required future action. Alternatives 2 and 3 are highly implementable because they are commonly implemented remedial actions for groundwater and because of the availability of firms and materials in the local area.

Cost

With regard to cost for those alternatives that quality for selection as the preferred alternative, Alternative 3 is the least expensive.

Summary

Because Alternative 1 is not protective of human health and the environment and does not comply with ARARs, it cannot be selected as the preferred alternative for the soils at the site. Alternative 3, Extraction Wells with Activated Carbon Treatment and Discharge to Surface Water, provides the best balance of tradeoffs with respect to the evaluation criteria, and is proposed as the preferred alternative. A summary of the results of the detailed evaluation for each of the three alternatives is shown below.

Criteria	Groundwater Alternatives		
	1	2	3
Overall Protection of Human Health and the Environment	-	+	+
Compliance with ARARs	-	+	+
Short-Term Effectiveness	-	+	+
Long-Term Effectiveness	-	+	+
Reduction of Toxicity, Mobility, or Volume	-	+	+
Implementability	+	+	+
Cost (Present Worth in thousands)	$98	$1,650	$1,459
Legend: + = positive 0 = neutral - = negative			

5.4.5 Summary of Preferred Alternatives

The following alternatives are proposed as the preferred alternatives to meet the remedial action objectives at Site 4:

- Excavation of Contaminated Soil and Buried Waste Materials, On-site Thermal Treatment of Soils, On-site Disposal of Treatment Residuals and Off-site Disposal of Buried Waste Materials

- Groundwater Extraction Wells with Activated Carbon Treatment and Discharge to Surface Water

Conceptual design criteria and drawings will be presented in Section 6.0 of this document.

5.5 SITE 7 - ORDNANCE BURN AREA

5.5.1 Soil Remediation Alternatives

5.5.1.1 Alternative 1 - No Action

The no action alternative means that no remedial actions will be implemented to remove/control the contaminated soil in the burn area located at Site 7. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

With the no action alternative, no remedial construction takes place, and therefore, there is no potential for increased short-term risks to human health or the environment. The human health and environmental risks presented in Section 3.1.4 for the site will remain. Relying on natural biodegradation as the only means of contaminant reduction makes it unlikely that the no action alternative would be effective in achieving the remedial action objectives for the soil and waste material in the foreseeable future.

Long-Term Effectiveness and Permanence

The no action alternative would not be effective in preventing direct human contact with contaminated soils in the burn area and provides no environmental protection.

Reduction of Toxicity, Mobility, or Volume

The no action alternative does not contribute to the reduction of toxicity, mobility, or volume of the contaminated soils in the burn area outside of the natural biodegradation which may occur.

Implementability

This alternative has already been implemented.

Compliance with ARARs

This alternative does not comply with the chemical-specific ARARs for soils outlined in Table 3-4.

Overall Protection of Human Health and the Environment

Human health and environmental risks associated with exposure to contaminated soils has not been reduced by the implementation of the no action alternative. The no action alternative does not meet any of the remedial action objectives for this site.

Cost

Costs for this alternative would be chiefly comprised of monitoring and soil analytical costs. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 11,000
Annual O&M Cost	$ 9,000
Present Worth	$ 117,000

Table 5-26 provides a detailed summary of the estimated costs to implement Soil Alternative 1 - No Action. Backup information for all cost estimates is provided in Appendix A.

5.5.1.2 Alternative 2 - Synthetic/Soil Cap

The synthetic/soil cap alternative means that a synthetic membrane/soil cover would be placed over the burn area to contain the contaminated soil and prevent infiltration through the contaminated soils. A total area of approximately 15,000 square feet is proposed for remediation. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

Implementation of a synthetic/soil cover will not impact the general public during the construction phase. Construction personnel could be exposed to contaminated dust during clearing, grading and grubbing activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The cover will be completely effective upon establishment of full vegetative growth.

TABLE 5-26
SITE #7 ORDNANCE BURN AREA
SOIL REMEDIATION ALTERNATIVE 1
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$6,000
SUBTOTAL	$9,000	$7,500
ALLOWANCES		
CONTINGENCY (25%)	$2,300	$1,900
ECONOMIC ANALYSIS		
TOTALS	$11,000	$9,000
PRESENT WORTH OF O & M	**$106,000**	
TOTAL PRESENT WORTH	**$117,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

Long-Term Effectiveness and Permanence

A synthetic/soil cover would prevent direct human contact with contaminated soils. This alternative would require long-term maintenance to ensure the integrity of the cover, including reseeding, as necessary, and repair of damage due to weather conditions, animals, undesirable vegetation, etc. Maintenance of the topsoil/vegetation layer for this alternative is not crucial because of the protection afforded by the synthetic membrane liner. When properly installed, the liner itself will retain its integrity for more than 30 years. The synthetic/soil cover provides an excellent barrier to infiltration, while minimizing cover thickness. Thus, with proper maintenance, the synthetic/soil cover alternative provides long-term effectiveness in achieving the remedial action objectives for the site soils.

Reduction of Toxicity, Mobility, or Volume

Placement of a synthetic/soil cover will effectively eliminate the mobility of contaminants due to the migration of soils by erosion. The presence of both the synthetic liner and the vegetation will eliminate infiltration but not completely eliminate the transference of contaminants from soils and buried wastes to groundwater due to the presence of some soil moisture or leachate already present in the subsurface. The toxicity and volume of the contamination on and in the burn area will not be altered by the placement of a synthetic/soil cover.

Implementability

Materials and equipment for the installation of a synthetic/soil cover are available throughout the Washington, D.C. and Maryland metropolitan area, making this alternative readily available.

Compliance with ARARs

This alternative does not comply with the chemical-specific ARARs for soils outlined in Table 3-4. This alternative does comply with the action-specific ARARs for control of contaminated soil and the prevention of infiltration which minimizes leachate generation.

Overall Protection of Human Health and the Environment

Placement of the synthetic/soil cover is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the contaminated soils and prevents infiltration of precipitation. In addition, this cover offers more reliable, long-term protection since, when properly installed, the synthetic liner will retain its integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for the on-site soils.

Cost

Costs for this alternative would be chiefly comprised of material purchases and cap installation. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 133,000
Annual O&M Cost	$ 8,000
Present Worth	$ 223,000

Table 5-27 provides a detailed summary of the estimated costs to implement Soil Alternative 2 - Synthetic/Soil Cover. Backup information for all cost estimates is provided in Appendix A.

5.5.1.3 Alternative 3 - In-situ Soil Flushing

Alternative 3 is in-situ soil flushing. This alternative involves injecting solvents or surfactants into the subsurface soils to enhance contaminant mobility resulting in increased recovery of contaminants in groundwater. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during in-situ treatment of the contaminated soils. In-situ equipment operator personnel could be exposed to contaminated dust during injection activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

In-situ soil flushing would be effective in reducing contaminant concentration in the subsurface soils. However, groundwater would be further impacted, therefore, requiring a groundwater remediation system to collect and treat contaminated groundwater. Over time, the majority of contaminants that could leach out of the soils would be removed.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the contaminants in the soil would occur. The volume of soil would not change. The mobility of contaminants in the subsurface soils would increase with significant leachate generation and groundwater impacts.

TABLE 5-27
SITE #7 ORDNANCE BURN AREA
SOIL REMEDIATION ALTERNATIVE 2
CAPPING (SYNTHETIC MATERIAL)

	CAPITAL	O & M
SITE CLEARING	$550	
GRADING (INCLUDES ADDITONAL FILL COST)	$20,000	
HDPE SYNTHETIC MEMBRANE	$14,300	
SYNTHETIC FILTER FABRIC (2 LAYERS)	$5,400	
DRAINAGE NET	$6,000	
TOP SOIL FOR CAPPING (@ 6 - INCHES THICKNESS)	$4,200	
SEDIMENT AND EROSION CONTROL	$3,500	
SEEDING	$600	
SEED PROTECTION	$700	
TOP SOIL FOR SEEDING (@ 3-INCH THICKNESS)	$2,100	
GROUNDWATER MONITORING	$9,000	$1,500
ANALYTICAL		$5,000
SUBTOTAL	$66,400	$6,500
ALLOWANCES		
CONTINGENCY (25%)	$16,600	$1,600
INSTALLATION/CONSTRUCTION (50%)	$33,200	
ENGINEERING (25%)	$16,600	
ECONOMIC ANALYSIS		
TOTALS	$133,000	$8,000
PRESENT WORTH OF O & M	**$90,000**	
TOTAL PRESENT WORTH	**$223,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

Implementability

This alternative is implementable due to the availability of vendor -available equipment for in-situ soil flushing.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment of contaminated soil.

Overall Protection of Human Health and the Environment

In-situ soil flushing is protective of human health from potential exposure to contaminated soils. However, because significant impacts to groundwater quality would be expected, a groundwater remediation system would be required to collect and treat the contaminants that have entered the groundwater from leachate generation. Thus, this alternative satisfies the remedial action objectives for treatment of contaminated soils.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization and operating activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 2,539,000
Annual O&M Cost	$ 0
Present Worth	$ 2,539,000

Table 5-28 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 3 - In-situ Soil Flushing. Backup information for all cost estimates is provided in Appendix A.

5.5.1.4 Alternative 4 - In-situ Soil Fixation

Alternative 4 is in-situ soil fixation. This alternative involves fixation of the contaminants through the addition of a fixing or stabilizing material to bind up the contaminants so that leachate generation could not occur. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during in-situ fixation of the contaminated soils. In-situ equipment operator personnel could be exposed to contaminated dust during

TABLE 5-28
SITE #7 ORDNANCE BURN AREA
SOIL REMEDIATION ALTERNATIVE 3
IN-SITU FLUSHING

	CAPITAL
MOBILIZATION AND DEMOBILIZATION OF RECOVERY SYSTEM PROCESS TRAILER	$15,000
SOIL FLUSHING	$1,670,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$6,000
SUBTOTAL	$1,692,500
ALLOWANCES	
CONTINGENCY (25%)	$423,000
ENGINEERING (25%)	$423,000
TOTAL	$2,539,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

fixation activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

In-situ soil fixation would be effective in reducing contaminant migration and leachate generation in the subsurface soils. It is not known what percentage of contaminants would actually be bound up with no leaching into the groundwater.

Reduction of Toxicity, Mobility, or Volume

No reduction in the toxicity of the contaminants in the soil would occur. The volume of soil would not change. The mobility of contaminants in the subsurface soils would decrease dramatically with minimal contaminants left in the subsurface that could leach into the groundwater.

Implementability

This alternative is implementable due to the availability of vendor -available equipment for in-situ soil fixation.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment/control of contaminated soil.

Overall Protection of Human Health and the Environment

In-situ soil fixation is protective of human health from potential exposure to contaminated soils. Residual contamination would be left in the soils; however, significant leaching of these contaminants would not be expected. Thus, this alternative satisfies the remedial action objectives for control of contaminated soils.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization and operating activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 4,387,000
Annual O&M Cost	$ 0
Present Worth	$ 4,387,000

Table 5-29 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 4 - In-situ Soil Fixation. Backup information for all cost estimates is provided in Appendix A.

5.5.1.5 Alternative 5 - Excavation with On-site Soil Washing/On-site Disposal

Soil remediation Alternative 5 is soil excavation with on-site soil washing of excavated contaminated soil followed by on-site disposal of treatment residuals. As discussed in Section 4.5.1.3, excavation would be limited to a depth of 10 feet to remove the soils with the highest level of nitroaromatics. Excavated soil would be staged at the treatment unit prior to treatment. On-site soil washing includes the use of a mobile soil washing unit to physically remove the nitroaromatics in the soil. This alternative involves placement of the treated residue into the burn area as backfill. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during excavation and treatment of the contaminated soil. Excavation and treatment unit operator personnel could be exposed to contaminated dust during excavation operations, soil and treatment residue handling activities and contaminated washing solutions during soil washing operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The disposal of treatment residue on-site will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust during handling and backfilling activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Reduction in nitroaromatic concentration in the excavated soil could be expected to be as high as 90 percent. On-site disposal into the burn area would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the excavated soil would be the result of washing of the soil. The volume of soil would not change after washing; however, a significant quantity of contaminated solution (water, surfactants, etc.) would be generated. A reduction in mobility is not applicable to the treatment technologies. On-site disposal in

TABLE 5-29
SITE #7 ORDNANCE BURN AREA
SOIL REMEDIATION ALTERNATIVE 4
IN-SITU FIXATION

	CAPITAL
FIXATION	$2,917,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$6,000
SUBTOTAL	$2,924,500
ALLOWANCES	
CONTINGENCY (25%)	$731,000
ENGINEERING (25%)	$731,000
TOTAL	$4,387,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

conjunction with placement of a soil cover will effectively reduce the mobility of contaminants in the treatment residue. The presence of both the soil and vegetative cover will reduce infiltration of organics remaining in the treatment residuals.

Implementability

This alternative is implementable due to the availability of mobile equipment. Approval of a treatment permit involving soil washing would be expected to be less difficult to obtain than a permit for the thermal destruction process. The disposal of treatment residue into the burn area could be implemented with no substantial difficulties. Approval of on-site disposal (permit may be required) will be the most difficult implementation facet of this remedial action.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment of contaminated soils.

Overall Protection of Human Health and the Environment

On-site soil washing of contaminated soil prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated soil. On-site soil washing meets the remedial action objective of treatment of excavated contaminated soil. Placement of the residuals in the burn area as fill in conjunction with installation of a soil cover is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 1,130,000
Annual O&M Cost	$ 0
Present Worth	$ 1,130,000

Table 5-30 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 5 - Soil Excavation with On-site Soil Washing/On-site Disposal.

TABLE 5-30
SITE #7 ORDNANCE BURN AREA
SOIL REMEDIATION ALTERNATIVE 5
EXCAVATION WITH ON-SITE SOIL WASHING
AND ON-SITE DISPOSAL

	CAPITAL
EXCAVATION	$36,000
STAGING	$34,000
SOIL WASHING	$765,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$51,000
GRADING	$3,400
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$12,000
SUBTOTAL	$904,400
ALLOWANCES	
CONTINGENCY (25%)	$226,000
TOTAL	$1,130,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

Backup information for all cost estimates is provided in Appendix A.

5.5.1.6 Alternative 6 - Excavation with On-site Soil Washing/Off-site Disposal

Soil remediation Alternative 6 is soil excavation with on-site soil washing of excavated contaminated soil followed by off-site disposal of treatment residuals. Excavated soil would be staged at the treatment unit prior to treatment. On-site soil washing includes the use of a mobile soil washing unit to physically remove the organics from the soil. This alternative involves placement of the treated residue in an off-site chemical waste landfill. A discussion of each of the evaluation criteria for this alternative follows. Excavation and on-site treatment evaluation criteria were discussed in Section 5.5.1.5 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

The disposal of treatment residue in an off-site chemical waste landfill will not impact the general public. Disposal personnel could be exposed to contaminated dust; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Off-site disposal into a chemical waste landfill would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume

Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the treatment residue. The toxicity and volume of the contamination in the treatment residue will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

The disposal of treatment residue in a chemical waste landfill could be implemented with no substantial difficulties.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment and disposal of contaminated soils.

Overall Protection of Human Health and the Environment

Placement of the residuals in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human

contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues in a chemical waste landfill offers more reliable, long-term protection since, when properly installed, these landfills will retain their integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 3,154,000
Annual O&M Cost	$ 0
Present Worth	$ 3,154,000

Table 5-31 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 6 - Soil Excavation with On-site Soil Washing/Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.5.1.7 Alternative 7 - Excavation with Off-site Soil Washing/Off-site Disposal

Soil remediation Alternative 7 is soil excavation with off-site soil washing of excavated contaminated soil and off-site disposal. Off-site soil washing includes transport of excavated soil to an off-site permitted soil washing unit to physically remove the organics in the soil. This alternative involves placement of the treated residue in an off-site chemical waste landfill. Excavation criteria evaluations were discussed in Section 5.5.1.5 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during treatment of the contaminated soil. Treatment unit operator personnel could be exposed to contaminated dust during soil and treatment residue handling activities and contaminated washing solutions during soil washing operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The disposal of treatment residue in an off-site chemical waste landfill will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust; however, these exposure

TABLE 5-31
SITE #7 ORDNANCE BURN AREA
SOIL REMEDIATION ALTERNATIVE 6
EXCAVATION WITH ON-SITE SOIL WASHING
AND OFF-SITE DISPOSAL

	CAPITAL
EXCAVATION	$36,000
STAGING	$17,000
SOIL WASHING	$765,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$51,000
LOADING & HAULING TO LANDFILL	$1,299,000
LANDFILL CHARGES	$340,000
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$12,000
SUBTOTAL	$2,523,000
ALLOWANCES	
CONTINGENCY (25%)	$631,000
TOTAL	$3,154,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Reduction in nitroaromatic concentration in the excavated soil could be expected to be as high as 90 percent. Off-site disposal into a chemical waste landfill would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the excavated soil would be the result of washing of the soil. The volume of soil would not change after washing; however, a significant quantity of nitroaromatic-contaminated solution (water, surfactants, etc.) would be generated. A reduction in mobility is not applicable to the treatment technologies. Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the treatment residue. The toxicity and volume of the contamination in the treatment residue will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

This alternative is implementable due to the availability of off-site treatment facilities. The disposal of treatment residue in a chemical waste landfill could be implemented with no substantial difficulties.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment and disposal of contaminated soil.

Overall Protection of Human Health and the Environment

Off-site soil washing of contaminated soil prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated soil. Off-site soil washing meets the remedial action objective of treatment of excavated contaminated soil. Placement of the residuals in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues in a chemical waste landfill offers more reliable, long-term protection since, when properly installed, these landfills will retain their integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of soil excavation, transport, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 3,800,000
Annual O&M Cost	$ 0
Present Worth	$ 3,800,000

Table 5-32 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 7 - Soil Excavation with Off-site Soil Washing/Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.5.1.8 Alternative 8 - Limited Excavation with On-site Soil Washing and On-site Disposal and In-situ Soil Flushing

Alternative 8 is limited excavation of shallow soils to a depth of 10 feet with on-site soil washing and on-site disposal of treatment residuals, and in-situ soil flushing of deeper soils from 10 to approximately 30 feet below grade.

Excavated soil would be staged at the treatment unit prior to treatment. On-site soil washing includes the use of a mobile soil washing unit to physically remove the nitroaromatics in the soil. This alternative involves placement of the treated residue into the burn area as backfill.

This alternative also involves injecting solvents or surfactants into the subsurface soils to enhance contaminant mobility resulting in increased recovery of contaminants in groundwater. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during excavation and treatment of the contaminated soil. Excavation and treatment unit operator personnel could be exposed to contaminated dust during excavation operations, soil and treatment residue handling activities and contaminated washing solutions during soil washing operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The disposal of treatment residue on-site will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust during handling and backfilling activities; however, these exposure risks

TABLE 5-32
SITE #7 ORDNANCE BURN AREA
SOIL REMEDIATION ALTERNATIVE 7
EXCAVATION WITH OFF-SITE SOIL WASHING AND OFF-SITE DISPOSAL

	CAPITAL
EXCAVATION	$36,000
LOADING & HAULING TO TREATMENT SITE	$789,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$51,000
SOIL WASHING	$510,000
LOADING & HAULING TO LANDFILL	$1,299,000
LANDFILL CHARGES	$340,000
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$12,000
SUBTOTAL	$3,040,000
ALLOWANCES	
CONTINGENCY (25%)	$760,000
TOTAL	$3,800,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

are easily addressed through the use of appropriate health and safety procedures and equipment.

There are no impacts to the general public during in-situ treatment of the contaminated soils. In-situ equipment operator personnel could be exposed to contaminated dust during injection activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Reduction in nitroaromatic concentration in the excavated soil could be expected to be as high as 90 percent. On-site disposal into the burn area would be an effective method of treatment residue disposal.

In-situ soil flushing would be effective in reducing contaminant concentration in the deeper subsurface soils. However, groundwater would be further impacted, therefore, requiring a groundwater remediation system to collect and treat contaminated groundwater. Over time, the majority of contaminants that could leach out of the soils would be removed.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the excavated soil would be the result of washing of the soil. The volume of soil would not change after washing; however, a significant quantity of contaminated solution (water, surfactants, etc.) would be generated. A reduction in mobility is not applicable to the treatment technologies. On-site disposal in conjunction with placement of a soil cover will effectively reduce the mobility of contaminants in the treatment residue. The presence of both the soil and vegetative cover will reduce infiltration of organics remaining in the treatment residuals.

A significant reduction in the toxicity of the contaminants in the deeper soils would occur. The volume of soil would not change. The mobility of contaminants in the subsurface soils would increase with significant leachate generation and groundwater impacts.

Implementability

This alternative is implementable due to the availability of mobile equipment. Approval of a treatment permit involving soil washing would be expected to be less difficult to obtain than a permit for the thermal destruction process. The disposal of treatment residue into the burn area could be implemented with no substantial difficulties. Approval of on-site disposal (permit may be required) will be the most difficult implementation facet of this remedial action.

This alternative is implementable due to the availability of vendor -available equipment for in-situ soil flushing.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment of contaminated soils.

Overall Protection of Human Health and the Environment

On-site soil washing of contaminated soil prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated soil. On-site soil washing meets the remedial action objective of treatment of excavated contaminated soil. Placement of the residuals in the burn area as fill in conjunction with installation of a soil cover is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

In-situ soil flushing is protective of human health from potential exposure to contaminated soils. However, because significant impacts to groundwater quality would be expected, a groundwater remediation system would be required to collect and treat the contaminants that have entered the groundwater from leachate generation. Thus, this alternative satisfies the remedial action objectives for treatment of contaminated soils.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization and operating activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 2,819,000
Annual O&M Cost	$ 0
Present Worth	$ 2,819,000

Table 5-32b provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 8 - Limited Excavation with On-site Soil Washing/On-site Disposal and In-situ Soil Flushing. Backup information for all cost estimates is provided in Appendix A.

TABLE 5-32b
SITE #7 ORDNANCE BURN AREA
SOIL REMEDIATION ALTERNATIVE 8
EXCAVATION WITH ON-SITE SOIL WASHING/ON-SITE DISPOSAL
AND IN-SITU SOIL FLUSHING

	CAPITAL
EXCAVATION AND TREATMENT:	
EXCAVATION	$36,000
STAGING	$34,000
SOIL WASHING	$765,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$51,000
GRADING	$3,400
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$12,000
SOIL WASHING TOTAL	$904,400
IN-SITU SOIL FLUSHING:	
MOBILIZATION AND DEMOBILIZATION OF RECOVERY SYSTEM PROCESS TRAILER	$15,000
SOIL FLUSHING	$1,102,200
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$6,000
SOIL FLUSHING TOTAL	$1,124,700
ALLOWANCES	
CONTINGENCY (25%)	$507,000
ENGINEERING (25%)	$281,000
TOTAL	$2,817,000

NOTES:
1. Analytical cost reflects two sampling phases after treatment is completed.
2. Engineering allowance applied to soil flushing total only.
3. Totals were rounded to the nearest thousands.

5.5.2 Groundwater Remediation Alternatives

5.5.2.1 Alternative 1 - No Action

The no action alternative means that no remedial actions will be implemented to remove or treat the groundwater. Only the natural biodegradation of organic contaminants by indigenous microorganisms would occur. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

With the no action alternative, no remedial construction takes place; therefore, there is no potential for increased short-term risks to human health or the environment. The human health and environmental risks discussed in Section 3.1.4 will remain. Relying on natural biodegradation as the only means of contaminant reduction makes it unlikely that the no action alternative would be effective in achieving the remedial action objectives for the groundwater.

Long-Term Effectiveness and Permanence

Even if the source of groundwater contamination is removed (capping or excavating the burn area), contaminated groundwater would continue to migrate on-site for some period of time with the possibility of migrating on- and off-site towards some receptor (drinking water wells). It is difficult to predict if or when contaminants in the groundwater would be reduced to groundwater standards, through either natural biodegradation or groundwater mixing. Thus, the no action alternative is not effective in achieving the remedial action objectives for the site.

Reduction of Toxicity, Mobility, or Volume

The no action alternative will not reduce the mobility or volume of contaminated groundwater. Toxicity could be reduced somewhat, over time, by natural biodegradation processes.

Implementability

The no action alternative requires no implementation.

Compliance with ARARs

Action-specific ARARs do not apply to the no action alternative. This alternative would not comply with the chemical-specific ARARs.

The no action alternative would comply with location-specific ARARs.

Overall Protection of Human Health and the Environment

The no action alternative will not be protective of human health and the environment because this alternative allows groundwater to freely migrate off-site. Thus, the no action alternative does not meet the remedial action objectives for groundwater.

Cost

Capital costs would include the development of a detailed sampling and analytical plan. Annual O&M costs will include groundwater sampling and analysis of groundwater samples. The Capital, Annual O&M and Present Worth costs for this alternative are as follows:

Capital Cost	$ 11,000
Annual O&M Cost	$ 9,000
Present Worth	$ 117,000

Table 5-33 provides a detailed summary of the estimated costs to implement Groundwater Remediation Alternative 1 - No Action. Backup information for all cost estimates is provided in Appendix A.

5.5.2.2 Alternative 2 - Extraction wells with Activated Carbon and Discharge to Surface Water

Extraction wells are a viable means of withdrawing groundwater to restrict on-site and potential off-site migration of contaminated groundwater. This alternative involves the collection of contaminated groundwater with extraction wells, ex-situ treatment using a GAC system such as a column or bed with subsequent discharge of treated groundwater to the stream that flows to the east of Site 9. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

Site workers would be subject to increased chemical exposure risks during related to installation of extraction wells, utilities, treatment system foundation and discharge piping due to volatilization of nitroaromatics from the overburden soils. These risks may be properly managed through the appropriate use of personal protective equipment, site monitoring and/or control measures, if required. Implementation of this alternative, with provision of appropriate worker health and community safety measures, is not expected to significantly impact public health or the environment immediately adjacent to the site. This

TABLE 5-33
SITE #7 ORDNANCE BURN AREA
GROUNDWATER REMEDIATION ALTERNATIVE 1
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$6,000
SUBTOTAL	$9,000	$7,500
ALLOWANCES		
CONTINGENCY (25%)	$2,300	$1,900
ECONOMIC ANALYSIS		
TOTALS	$11,000	$9,000
PRESENT WORTH OF O & M	**$106,000**	
TOTAL PRESENT WORTH	**$117,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

alternative would become effective immediately upon start-up of the collection and treatment system.

Long-Term Effectiveness and Permanence

This alternative would be effective in the long-term remediation of groundwater contamination. Groundwater collection would reduce the risks of on- and off-site exposure to contamination through ingestion or dermal contact with groundwater from potential drinking water or irrigation wells.

To assure long-term reliability, regularly scheduled maintenance will be performed on the components of the GAC treatment system. The GAC will be checked on a monthly basis to determine if the carbon needs replacement with fresh carbon. A pre-filtration unit will be checked on a monthly basis also to ensure that no clogging of the system has occurred. Duplex feed and discharge pumps have been specified for the GAC system to extend pump life and to provide continuous treatment should one pump fail.

Provided that the groundwater source is controlled or removed (capping or excavating the burn area), activated carbon will provide a permanent reduction in the concentration of nitroaromatics in the groundwater once the cleanup goals have been achieved. At that point, groundwater treatment may cease. Thus, the alternative provides a long-term effectiveness in achieving the groundwater remedial action objectives.

Reduction of Toxicity, Mobility, or Volume

Treatment of contaminated groundwater by activated carbon adsorption will reduce the toxicity of the groundwater. Collection and treatment by activated carbon adsorption will have no effect on the volume of contamination, since the nitroaromatics will be transferred from the groundwater to the GAC, but not destroyed. The collection but not the treatment of the contaminated groundwater reduces the mobility of the contaminants.

Implementability

This alternative would be highly implementable. GAC treatment columns or bed are typically skid-mounted units which are relatively simple to install and replace and are readily available through numerous manufacturers. The reliability of the GAC columns or beds and associated system components have been proven at many prior installations.

Compliance with ARARs

This alternative complies with all action- and location-specific ARARs for treatment systems. This alternative complies with all chemical-specific ARARs. The proposed GAC treatment system is capable of meeting the Maryland surface water quality goals for

nitroaromatics that would be mandated in the NPDES permit.

Overall Protection of Human Health and the Environment

The well extraction system would serve to restrict further groundwater contaminant migration in both the overburden and saprolite fractures and would effectively capture a significant volume of contaminated groundwater. This would reduce the probability that surface water bodies, residential or on-site wells, and regional water supplies could be impacted by site contaminants.

The operation of a groundwater pump and treat system utilizing GAC adsorption will reduce or eliminate the migration of contaminated groundwater on and off the facility, will reduce the toxicity of the groundwater and will meet the remedial action objectives for the site. Eliminating or reducing the migration of contaminated groundwater on and off the site will reduce the potential for human or environmental exposure, and thus will be protective of human health and the environment.

Cost

The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 462,000
Annual O&M Cost	$ 74,000
Present Worth	$ 567,000

Table 5-34 provides a detailed summary of the estimated costs to implement Groundwater Remediation Alternative 2 - Extraction Wells with Activated Carbon and Discharge to Surface Water. Backup information for all cost estimates is provided in Appendix A.

5.5.3 Comparative Analysis

In the following analysis, the alternatives are evaluated in relation to one another for each of the evaluation criteria. Overall protection of human health and the environment and compliance with ARARs will serve as threshold determinations in that they must be met by any alternative in order for it to be eligible for selection. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative.

TABLE 5-34
SITE #7 ORDNANCE BURN AREA
GROUNDWATER REMEDIATION ALTERNATIVE 2
EXTRACTION WELLS WITH ACTIVATED CARBON TREATMENT
AND DISCHARGE TO SURFACE WATER

	CAPITAL	O & M
COLLECTION WITH EXTRACTION WELLS:		
MANHOLES FOR PUMPS & CONTROLS	$3,000	
WELL INSTALLATION & DEVELOPMENT	$23,400	
PIPING	$15,000	
PUMPS	$6,000	
TANK	$12,000	
POWER		$1,300
ACTIVATED CARBON TREATMENT:		
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$6,000	$1,500
ACTIVATED CARBON	$32,000	$2,400
LABOR FOR CHECK-UP OPERATIONS		$20,000
DISCHARGE TO SURFACE WATER:		
PUMPS	$10,000	
TANK	$35,000	
POWER		$3,000
PIPING	$23,000	
DISCHARGE MONITORING	$10,000	$5,000
ANALYTICAL		$26,000
SUBTOTAL	$210,000	$59,200
ALLOWANCES		
CONTINGENCY (25%)	$52,500	$14,800
INSTALLATION/CONSTRUCTION (50%)	$105,000	
ENGINEERING (25%)	$52,500	
ELECTRICAL (20%)	$42,000	
ECONOMIC ANALYSIS		
TOTALS	$462,000	$74,000
PRESENT WORTH OF O & M	**$105,000**	
TOTAL PRESENT WORTH	**$567,000**	

Notes
1 For present worth calculation; interest rate = 10%; inflation = 6%; and project life = 1.5 year
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

5.5.3.1 Soil Remediation Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health and the environment. Infiltration of rainwater through the burn area soils would continue to generate leachate and impact groundwater quality. Alternatives 2 through 8 are protective of human health and the environment. However, only Alternatives 3, 4, and 8 treat all the contaminated soils on-site. Alternatives 5, 6, and 7 only involve excavation to a depth of 10 feet. Leachate generation would be reduced or eliminated for all alternatives except for Alternative 1.

Compliance with ARARs

Alternative 1 does not comply with ARARs while Alternatives 3, 5, 6, 7, and 8 comply with action- and chemical-specific ARARs. Alternatives 2 and 4 complies with action-specific ARARs but not chemical-specific ARARs.

Short-Term Impacts and Effectiveness

Although no additional exposure risks would occur for implementation of Alternative 1, Alternatives 2 through 8 would be more effective in the short term than Alternative 1. Human health exposure for Alternatives 5, 6, 7, and 8 are higher than for Alternatives 2, 3, and 4 because they require excavation and treatment of contaminated soil prior to disposal. Alternative 2 is capping and does not require contaminated soil handling activities. Alternatives 3 and 4 are in-situ treatments and human exposure is minimal. Short-term environmental impacts are the same for Alternatives 5, 6, 7, and 8 because they all require excavation which will remove the contaminants from the environment. Short-term impacts associated with Alternative 2 include continued leachate generation until soil moisture decreases in the subsurface to the point where leachate cannot be generated. Leachate generation will continue for Alternatives 3 and 4 but contaminant concentrations available for transport with the leachate would be minimal.

Long-Term Effectiveness and Permanence

Alternatives 3, 4, and 8 will provide long-term effectiveness in achieving the remedial action objectives for the site soils while Alternative 1 would not meet these goals. Alternatives 5, 6, and 7 do not treat all the contaminated soils and, therefore, leaching could impact groundwater quality in the future.

Reduction of Toxicity, Mobility, or Volume

Alternative 1 would not reduce the toxicity, mobility, or volume of the contaminated soils at site. Alternative 2 will not reduce the toxicity or volume of contaminated soil but will reduce the mobility due to infiltration elimination. Alternatives 3 through 7 will reduce the toxicity and mobility of contaminated soil because of treatment of the soil. The volume of contaminated soil will remain the same for Alternatives 3 through 8.

Implementability

Alternative 1 is implementable because continued sampling would be the only required future action. Alternative 2 is highly implementable. Alternatives 5, 6 and 7 are highly implementable because of the availability of contractors who perform mobile on-site treatment of contaminated soil. Alternatives 3, 4, and 8 are implementable but the availability of contractors who perform in-situ treatment is not as prevalent as those contractors who conduct on-site ex-situ treatment activities.

Cost

With regard to cost for those alternatives that quality for selection as the preferred alternative, Alternative 2 is the least expensive. Alternative 5 which includes on-site disposal of the treatment residuals is considerably more cost effective than Alternatives 6 and 7 which include off-site disposal. Alternatives 3, 4, and 8 (in-situ treatments) are the most economical because they involve treatment of three times more contaminated soil than the excavation alternatives (Alternatives 5, 6, and 7).

Summary

Because Alternative 1 is not protective of human health and the environment and does not comply with ARARs, it cannot be selected as the preferred alternative for the soils at the site. Alternative 8, Limited Excavation with On-site Soil Washing/On-site Disposal and In-situ Soil Flushing, provides the best balance of tradeoffs with respect to the evaluation criteria, and is proposed as the preferred alternative. A summary of the results of the detailed evaluation for each of the eight alternatives is shown below.

Criteria	Soil Alternatives							
	1	2	3	4	5	6	7	8
Overall Protection of Human Health and the Environment	-	+	+	+	+	+	+	+
Compliance with ARARs	-	+	+	+	+	+	+	+
Short-Term Effectiveness	-	0	+	+	0	0	0	+
Long-Term Effectiveness	-	+	+	+	+	+	+	+
Reduction of Toxicity, Mobility, or Volume	-	0	+	+	+	+	+	+
Implementability	+	+	0	0	+	+	+	+
Cost (Present Worth in millions)	$0.1	$0.2	$2.5	$4.4	$1.1	$3.2	$3.8	$2.8
Legend: + = positive 0 = neutral - = negative								

5.5.3.2 Groundwater Remediation Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health and the environment. On- and off-site populations could potentially be exposed to contaminated groundwater and continued migration of contaminants in the groundwater would occur. Alternative 2 is protective of human health and the environment due to collection and treatment of contaminated groundwater. Risk through ingestion of and contact with contaminated groundwater are reduced to cancer risk levels less than 10^{-6} for Alternative 2.

Compliance with ARARs

Alternative 1 does not comply with ARARs while Alternative 2 complies with action- and chemical-specific ARARs for groundwater contamination collection and treatment.

Short-Term Impacts and Effectiveness

Although no additional exposure risks would occur for implementation of Alternative 1, Alternative 2 would be more effective in the short term than Alternative 1.

Long-Term Effectiveness and Permanence

Alternative 2 will provide long-term effectiveness in achieving the remedial action objectives for the site groundwater while Alternative 1 would not meet these goals.

Reduction of Toxicity, Mobility, or Volume

Alternative 1 would not reduce the toxicity, mobility, or volume of the contaminated groundwater at site. Alternative 2 will reduce the toxicity, mobility and volume of contaminated groundwater. However, for Alternative 2, contaminants will not be eliminated, just transferred to a different media (activated carbon for GAC system).

Implementability

Alternative 1 is implementable because continued sampling would be the only required future action. Alternative 2 is highly implementable because it is a commonly implemented remedial action for groundwater and because of the availability of firms and materials in the local area.

Cost

Although Alternative 1 is the least expensive groundwater alternative, it does not meet selection criteria and will not be proposed as the selected alternative.

Summary

Because Alternative 1 is not protective of human health and the environment and does not comply with ARARs, it cannot be selected as the preferred alternative for the soils at the site. Alternative 2, Extraction wells with Activated Carbon Treatment and Discharge to Surface Water, meets criteria requirements and is proposed as the preferred alternative. A summary of the results of the detailed evaluation for each of the 2 alternatives is shown below.

Criteria	Groundwater Alternatives	
	1	2
Overall Protection of Human Health and the Environment	-	+
Compliance with ARARs	-	+
Short-Term Effectiveness	-	+
Long-Term Effectiveness	-	+
Reduction of Toxicity, Mobility, or Volume	-	+
Implementability	+	+
Cost (Present Worth in thousands)	$117	$567
Legend: + = positive 0 = neutral - = negative		

5.5.4 Summary of Preferred Alternatives

The following alternatives are proposed as the preferred alternatives to meet the remedial action objectives at Site 7:

- Limited Excavation with On-site Soil Washing/On-site Disposal and In-situ Soil Flushing of Contaminated Soils
- Groundwater Extraction Wells with Activated Carbon Treatment and Discharge to Surface Water

Conceptual design criteria and drawings will be presented in Section 6.0 of this document.

5.6 SITE 8 - ABANDONED CHEMICAL DISPOSAL PIT

5.6.1 Soil/Buried Waste Remediation Alternatives

5.6.1.1 Alternative 1 - No Action

The no action alternative means that no remedial actions will be implemented to remove/control the contaminated soil and buried waste material in the disposal pit located at Site 8. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

With the no action alternative, no remedial construction takes place, and therefore, there is no potential for increased short-term risks to human health or the environment. The human health and environmental risks presented in Section 3.1.5 for the site will remain. Relying on natural biodegradation as the only means of contaminant reduction makes it unlikely that the no action alternative would be effective in achieving the remedial action objectives for the soil and waste material in the foreseeable future.

Long-Term Effectiveness and Permanence

The no action alternative would not be effective in preventing direct human contact with contaminated soils in the disposal pit and provides no environmental protection.

Reduction of Toxicity, Mobility, or Volume

The no action alternative does not contribute to the reduction of toxicity, mobility, or volume of the contaminated soils in the disposal pit outside of the natural biodegradation which may occur.

Implementability

This alternative has already been implemented.

Compliance with ARARs

This alternative does not comply with the chemical-specific ARARs for soils outlined in Table 3-4.

Overall Protection of Human Health and the Environment

Human health and environmental risks associated with exposure to contaminated soils has not been reduced by the implementation of the no action alternative. The no action alternative does not meet any of the remedial action objectives for this site.

Cost

Costs for this alternative would be chiefly comprised of monitoring and soil analytical costs. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 11,000
Annual O&M Cost	$ 5,000
Present Worth	$ 62,000

Table 5-35 provides a detailed summary of the estimated costs to implement Soil Alternative 1 - No Action. Backup information for all cost estimates is provided in Appendix A.

5.6.1.2 Alternative 2 - Synthetic/Soil Cap

The synthetic/soil cap alternative means that a synthetic membrane/soil cover would be placed over the disposal pit to contain the contaminated soil and prevent infiltration to buried wastes. A total area of approximately 4,000 square feet is proposed for remediation. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

Implementation of a synthetic/soil cover will not impact the general public during the construction phase. Construction personnel could be exposed to contaminated dust during clearing, grading and grubbing activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The cover will be completely effective upon establishment of full vegetative growth.

Long-Term Effectiveness and Permanence

A synthetic/soil cover would prevent direct human contact with contaminated soils. This alternative would require long-term maintenance to ensure the integrity of the cover, including reseeding, as necessary, and repair of damage due to weather conditions, animals, undesirable vegetation, etc. Maintenance of the topsoil/vegetation layer for this alternative is not crucial because of the protection afforded by the synthetic membrane liner. When properly installed, the liner itself will retain its integrity for more than 30 years. The synthetic/soil cover provides an excellent barrier to infiltration, while minimizing cover thickness. Thus, with proper maintenance, the synthetic/soil cover alternative provides long-

TABLE 5-35
SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
SOIL REMEDIATION ALTERNATIVE 1
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$2,200
SUBTOTAL	$9,000	$3,700
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$900
ECONOMIC ANALYSIS		
TOTALS	$11,000	$5,000
PRESENT WORTH OF O & M	**$51,000**	
TOTAL PRESENT WORTH	**$62,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

term effectiveness in achieving the remedial action objectives for the site soils.

Reduction of Toxicity, Mobility, or Volume

Placement of a synthetic/soil cover will effectively eliminate the mobility of contaminants due to the migration of soils by erosion. The presence of both the synthetic liner and the vegetation will eliminate infiltration but not completely eliminate the transference of contaminants from soils and buried wastes to groundwater due to the presence of some soil moisture or leachate already present in the subsurface. The toxicity and volume of the contamination on and in the disposal pit will not be altered by the placement of a synthetic/soil cover.

Implementability

Materials and equipment for the installation of a synthetic/soil cover are available throughout the Washington, D.C. and Maryland metropolitan area, making this alternative readily available.

Compliance with ARARs

This alternative does not comply with the chemical-specific ARARs for soils outlined in Table 3-4. This alternative does comply with the action-specific ARARs for control of contaminated soil and the prevention of infiltration which minimizes leachate generation.

Overall Protection of Human Health and the Environment

Placement of the synthetic/soil cover is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the contaminated soils and prevents infiltration of precipitation. In addition, this cover offers more reliable, long-term protection since, when properly installed, the synthetic liner will retain its integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for the on-site soils.

Cost

Costs for this alternative would be chiefly comprised of material purchases and cap installation. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 64,000
Annual O&M Cost	$ 3,000
Present Worth	$ 101,000

TABLE 5-36
SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
SOIL REMEDIATION ALTERNATIVE 2
CAPPING (SYNTHETIC MATERIAL)

	CAPITAL	O & M
SITE CLEARING	$550	
GRADING (INCLUDES ADDITONAL FILL COST)	$8,000	
HDPE SYNTHETIC MEMBRANE	$5,000	
SYNTHETIC FILTER FABRIC (2 LAYERS)	$1,900	
DRAINAGE NET	$2,100	
TOP SOIL FOR CAPPING (@ 6 - INCHES THICKNESS)	$1,500	
SEDIMENT AND EROSION CONTROL	$2,500	
SEEDING	$300	
SEED PROTECTION	$300	
TOP SOIL FOR SEEDING (@ 3-INCH THICKNESS)	$750	
GROUNDWATER MONITORING	$9,000	$1,000
ANALYTICAL		$1,600
SUBTOTAL	$32,000	$2,600
ALLOWANCES		
CONTINGENCY (25%)	$8,000	$650
INSTALLATION/CONSTRUCTION (50%)	$16,000	
ENGINEERING (25%)	$8,000	
ECONOMIC ANALYSIS		
TOTALS	$64,000	$3,000
PRESENT WORTH OF O & M	**$37,000**	
TOTAL PRESENT WORTH	**$101,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

Table 5-36 provides a detailed summary of the estimated costs to implement Soil Alternative 2 - Synthetic/Soil Cover. Backup information for all cost estimates is provided in Appendix A.

5.6.1.3 Alternative 3 - Excavation with On-site Thermal Treatment/Disposal

Alternative 3 is excavation with on-site thermal treatment of excavated contaminated soil followed by on-site disposal of the treatment residuals. Excavated soil would be staged at the treatment unit prior to treatment. On-site thermal treatment includes the use of a mobile unit to thermally destruct the organics in the soil. This alternative involves placement of the treatment residuals back in the disposal pit. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during excavation, treatment and disposal of the contaminated soils and treatment residues. Treatment unit operator personnel could be exposed to contaminated dust during soil and treatment residue handling activities and airborne organics during thermal treatment operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The disposal of treatment residue on-site will not impact the general public during the disposal phase. Personnel could be exposed to contaminated dust during disposal activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Excavation would be effective in reducing direct human contact with contaminants in the soils. Reduction in organic concentration in the excavated soils could be expected to be as high as 90 to 99 percent. On-site disposal back into the disposal pit would be an effective method of treatment residue disposal. Human health exposure to treatment residue would be eliminated.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the excavated soil would be the result of thermal treatment of the soil. The volume of soil would not significantly change after thermal treatment, the amount of treatment residue would be virtually the same as the amount of soil incinerated. A reduction in mobility is not applicable to the treatment technologies. On-site disposal in conjunction with placement of a soil cover will effectively

reduce the mobility of contaminants in the treatment residue. The presence of a soil cover and vegetation will reduce infiltration of organics remaining in the treatment residuals.

Implementability

This alternative is implementable due to the availability of excavation and mobile treatment equipment. However, approval of a thermal treatment permit may be somewhat difficult to obtain. The disposal of treatment residue in the disposal pit could be implemented with no substantial difficulties. Approval of on-site disposal (permit may be required) will be the most difficult implementation facet of this remedial action.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment of contaminated soil.

Overall Protection of Human Health and the Environment

Excavation with subsequent on-site thermal treatment of contaminated soil prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated soil. On-site thermal treatment meets the remedial action objective of treatment of excavated contaminated soil. Placement of the residuals in the disposal pit in conjunction with a soil cover is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limits infiltration of precipitation. Thus, this alternative satisfies the remedial action objectives for removal of contaminated soils and disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 249,000
Annual O&M Cost	$ 0
Present Worth	$ 249,000

Table 5-37 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 3 - Soil Excavation with On-site Thermal Treatment/On-site Disposal. Backup information for all cost estimates is provided in Appendix A.

TABLE 5-37
SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
SOIL REMEDIATION ALTERNATIVE 3
EXCAVATION WITH ON-SITE THERMAL TREATMENT
AND ON-SITE DISPOSAL

	CAPITAL
EXCAVATION	$15,000
STAGING	$14,000
THERMAL TREATMENT	$140,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$21,000
GRADING	$3,400
CONFIRMATION SAMPLING	$2,000
ANALYTICAL	$3,200
SUBTOTAL	$199,000
ALLOWANCES	
CONTINGENCY (25%)	$50,000
TOTAL	$249,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

5.6.1.4 Alternative 4 - Excavation with On-site Thermal Treatment/Off-site Disposal

Alternative 4 is excavation with on-site thermal treatment of excavated contaminated soil followed by off-site disposal of the treatment residuals. Excavated soil would be staged at the treatment unit prior to treatment. On-site thermal treatment includes the use of a mobile unit to thermally destruct the organics in the soil. Excavated soil would be transported to the on-site treatment facility prior to treatment. This alternative involves placement of the treatment residuals in an off-site chemical waste landfill. A discussion of each of the evaluation criteria for this alternative follows. Excavation and treatment criteria evaluations were discussed in Section 5.6.1.3 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

The disposal of treatment residue in an off-site chemical waste landfill will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Off-site disposal into a chemical waste landfill would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume

Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the treatment residue. The toxicity and volume of the organic contamination in the treatment residue will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

The disposal of treatment residue in a chemical waste landfill could be implemented with no substantial difficulties.

Compliance with ARARs

The placement of the treatment residues in a chemical waste landfill would comply with action-specific and chemical-specific ARARs.

Overall Protection of Human Health and the Environment

Placement of the residuals in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human

contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues in a chemical waste landfill offers more reliable, long-term protection since, when properly installed, these landfills will retain their integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 1,079,000
Annual O&M Cost	$ 0
Present Worth	$ 1,079,000

Table 5-38 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 4 - Soil Excavation with On-site Thermal Treatment/Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.6.1.5 Alternative 5 - Excavation with On-site Soil Washing/On-site Disposal

Soil remediation Alternative 5 is soil excavation with on-site soil washing of excavated contaminated soil followed by on-site disposal of treatment residuals. Excavated soil would be staged at the treatment unit prior to treatment. On-site soil washing includes the use of a mobile soil washing unit to physically remove the organics in the soil. This alternative involves placement of the treated residue into the disposal pit as backfill. A discussion of each of the evaluation criteria for this alternative follows. Excavation criteria evaluations were discussed in Section 5.6.1.3 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during treatment of the contaminated soil. Treatment unit operator personnel could be exposed to contaminated dust during soil and treatment residue handling activities and contaminated washing solutions during soil washing operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The disposal of treatment residue on-site will not impact the general public during the disposal phase. Disposal personnel

TABLE 5-38
SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
SOIL REMEDIATION ALTERNATIVE 4
EXCAVATION WITH ON-SITE THERMAL TREATMENT AND OFF-SITE DISPOSAL

	CAPITAL
EXCAVATION	$15,000
STAGING	$7,000
THERMAL TREATMENT	$140,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$21,000
LOADING & HAULING TO LANDFILL	$535,000
LANDFILL CHARGES	$140,000
CONFIRMATION SAMPLING	$2,000
ANALYTICAL	$3,200
SUBTOTAL	$863,000
ALLOWANCES	
CONTINGENCY (25%)	$216,000
TOTAL	$1,079,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

could be exposed to contaminated dust during handling and backfilling activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Reduction in organic concentration in the excavated soil could be expected to be as high as 90 to 99 percent. On-site disposal into the disposal pit would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the excavated soil would be the result of washing of the soil. The volume of soil would not change after washing; however, a significant quantity of contaminated solution (water, surfactants, etc.) would be generated. A reduction in mobility is not applicable to the treatment technologies. On-site disposal in conjunction with placement of a soil cover will effectively reduce the mobility of contaminants in the treatment residue. The presence of both the soil and vegetative cover will reduce infiltration of organics remaining in the treatment residuals.

Implementability

This alternative is implementable due to the availability of mobile equipment. Approval of a treatment permit involving soil washing would be expected to be less difficult to obtain than a permit for the thermal destruction process. The disposal of treatment residue into the disposal pit could be implemented with no substantial difficulties. Approval of on-site disposal (permit may be required) will be the most difficult implementation facet of this remedial action.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment of contaminated soils.

Overall Protection of Human Health and the Environment

On-site soil washing of contaminated soil prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated soil. On-site soil washing meets the remedial action objective of treatment of excavated contaminated soil. Placement of the residuals in the disposal pit as fill in conjunction with installation of a soil cover is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. Thus, this alternative satisfies the remedial action

objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 468,000
Annual O&M Cost	$ 0
Present Worth	$ 468,000

Table 5-39 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 5 - Soil Excavation with On-site Soil Washing/On-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.6.1.6 Alternative 6 - Excavation with On-site Soil Washing/Off-site Disposal

Soil remediation Alternative 6 is soil excavation with on-site soil washing of excavated contaminated soil followed by off-site disposal of treatment residuals. Excavated soil would be staged at the treatment unit prior to treatment. On-site soil washing includes the use of a mobile soil washing unit to physically remove the organics from the soil. This alternative involves placement of the treated residue in an off-site chemical waste landfill. A discussion of each of the evaluation criteria for this alternative follows. Excavation and treatment criteria evaluations were discussed in Sections 5.6.1.3 and 5.6.1.6 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

The disposal of treatment residue in an off-site chemical waste landfill will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Off-site disposal into a chemical waste landfill would be an effective method of treatment residue disposal.

TABLE 5-39
SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
SOIL REMEDIATION ALTERNATIVE 5
EXCAVATION WITH ON-SITE SOIL WASHING
AND ON-SITE DISPOSAL

	CAPITAL
EXCAVATION	$15,000
STAGING	$14,000
SOIL WASHING	$315,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$21,000
GRADING	$3,400
CONFIRMATION SAMPLING	$2,000
ANALYTICAL	$3,200
SUBTOTAL	$374,000
ALLOWANCES	
CONTINGENCY (25%)	$94,000
TOTAL	$468,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

Reduction of Toxicity, Mobility, or Volume

Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the treatment residue. The toxicity and volume of the contamination in the treatment residue will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

The disposal of treatment residue in a chemical waste landfill could be implemented with no substantial difficulties.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment and disposal of contaminated soils.

Overall Protection of Human Health and the Environment

Placement of the residuals in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues in a chemical waste landfill offers more reliable, long-term protection since, when properly installed, these landfills will retain their integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 1,298,000
Annual O&M Cost	$ 0
Present Worth	$ 1,298,000

Table 5-40 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 6 - Soil Excavation with On-site Soil Washing/Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

TABLE 5-40
SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
SOIL REMEDIATION ALTERNATIVE 6
EXCAVATION WITH ON-SITE SOIL WASHING
AND OFF-SITE DISPOSAL

	CAPITAL
EXCAVATION	$15,000
STAGING	$7,000
SOIL WASHING	$315,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$21,000
LOADING & HAULING TO LANDFILL	$535,000
LANDFILL CHARGES	$140,000
CONFIRMATION SAMPLING	$2,000
ANALYTICAL	$3,200
SUBTOTAL	$1,038,000
ALLOWANCES	
CONTINGENCY (25%)	$260,000
TOTAL	$1,298,000

NOTES:

1. **Analytical cost reflects two sampling phases after treatment is completed.**
2. **Totals were rounded to the nearest thousands.**

5.6.1.7 Alternative 7 - Excavation with Off-site Soil Washing/Off-site Disposal

Soil remediation Alternative 7 is soil excavation with off-site soil washing of excavated contaminated soil and off-site disposal. Off-site soil washing includes transport of excavated soil to an off-site permitted soil washing unit to physically remove the organics in the soil. This alternative involves placement of the treated residue in an off-site chemical waste landfill. Excavation criteria evaluations were discussed in Section 5.6.1.3 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during treatment of the contaminated soil. Treatment unit operator personnel could be exposed to contaminated dust during soil and treatment residue handling activities and contaminated washing solutions during soil washing operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The disposal of treatment residue in an off-site chemical waste landfill will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Reduction in organic concentration in the excavated soil could be expected to be as high as 90 to 99 percent. Off-site disposal into a chemical waste landfill would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the excavated soil would be the result of washing of the soil. The volume of soil would not change after washing; however, a significant quantity of organic-contaminated solution (water, surfactants, etc.) would be generated. A reduction in mobility is not applicable to the treatment technologies. Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the treatment residue. The toxicity and volume of the contamination in the treatment residue will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

This alternative is implementable due to the availability of off-site treatment facilities. The disposal of treatment residue in a chemical waste landfill could be implemented with no substantial difficulties.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment and disposal of contaminated soil.

Overall Protection of Human Health and the Environment

Off-site soil washing of contaminated soil prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated soil. Off-site soil washing meets the remedial action objective of treatment of excavated contaminated soil. Placement of the residuals in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues in a chemical waste landfill offers more reliable, long-term protection since, when properly installed, these landfills will retain their integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of soil excavation, transport, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 1,564,000
Annual O&M Cost	$ 0
Present Worth	$ 1,564,000

Table 5-41 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 7 - Soil Excavation with Off-site Soil Washing/Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.6.2 Buried Waste Material Disposal Alternative

Off-site Disposal

This alternative involves the disposal of an estimated 200 cubic yards of buried waste material in an off-site landfill and will be implemented provided that a soil/buried waste excavation alternative is also selected. Decontamination of the materials with collection of wash water and any free product may be required prior to disposal. A discussion of each

TABLE 5-41
SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
SOIL REMEDIATION ALTERNATIVE 7
EXCAVATION WITH OFF-SITE SOIL WASHING
AND OFF-SITE DISPOSAL

	CAPITAL
EXCAVATION	$15,000
LOADING & HAULING TO TREATMENT SITE	$325,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$21,000
SOIL WASHING	$210,000
LOADING & HAULING TO LANDFILL	$535,000
LANDFILL CHARGES	$140,000
CONFIRMATION SAMPLING	$2,000
ANALYTICAL	$3,200
SUBTOTAL	$1,251,000
ALLOWANCES	
CONTINGENCY (25%)	$313,000
TOTAL	$1,564,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during disposal of the buried waste materials. The disposal of the buried waste materials off-site will not impact the general public during the disposal phase. Personnel could be exposed to contaminated material or free product during handling and disposal activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Off-site disposal would be an effective method of buried waste material disposal. Human health exposure to buried materials would be eliminated.

Reduction of Toxicity, Mobility, or Volume

Off-site disposal will reduce the toxicity, mobility and volume of wastes at the site. However, decontamination of the wastes may be required prior to disposal which would generate potential additional waste streams (i.e., free product, contaminated decontamination water).

Implementability

The disposal of buried waste materials in an off-site landfill could be implemented with no substantial difficulties.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for disposal of hazardous and solid wastes.

Overall Protection of Human Health and the Environment

Land disposal in an approved chemical waste landfill greatly reduces the potential human health and environmental risks associated with exposure to buried waste material. Thus, this alternative satisfies the remedial action objectives for proper disposal of buried waste materials.

Cost

Costs for this alternative would be chiefly comprised of disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 133,000
Annual O&M Cost	$ 0
Present Worth	$ 133,000

Table 5-42 provides a detailed summary of the estimated costs to implement Buried Waste Material Disposal Alternative - Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.6.3 Groundwater Remediation Alternatives

5.6.3.1 Alternative 1 - No Action

The no action alternative means that no remedial actions will be implemented to remove or treat the groundwater. Only the natural biodegradation of organic contaminants by indigenous microorganisms would occur. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

With the no action alternative, no remedial construction takes place; therefore, there is no potential for increased short-term risks to human health or the environment. The human health and environmental risks discussed in Section 3.1.5 will remain. Relying on natural biodegradation as the only means of contaminant reduction makes it unlikely that the no action alternative would be effective in achieving the remedial action objectives for the groundwater.

Long-Term Effectiveness and Permanence

Even if the source of groundwater contamination is removed (capping or excavating the disposal pit), contaminated groundwater would continue to migrate on-site for some period of time with the possibility of migrating on- and off-site towards some receptor (drinking water wells). It is difficult to predict if or when contaminants in the groundwater would be reduced to groundwater standards, through either natural biodegradation or groundwater mixing. Thus, the no action alternative is not effective in achieving the remedial action objectives for the site.

Reduction of Toxicity, Mobility, or Volume

The no action alternative will not reduce the mobility or volume of contaminated groundwater. Toxicity could be reduced somewhat, over time, by natural biodegradation processes.

Implementability

The no action alternative requires no implementation.

TABLE 5-42
SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
BURIED WASTE DISPOSAL ALTERNATIVE
OFF-SITE LANDFILL

	CAPITAL
LOADING & HAULING TO LANDFILL	$76,000
LANDFILL	$30,000
SUBTOTAL	$106,000
ALLOWANCES	
CONTINGENCY (25%)	$27,000
TOTAL	$133,000

Compliance with ARARs

Action-specific ARARs do not apply to the no action alternative. This alternative would not comply with the chemical-specific ARARs.

The no action alternative would comply with location-specific ARARs.

Overall Protection of Human Health and the Environment

The no action alternative will not be protective of human health and the environment because this alternative allows groundwater to freely migrate off-site. Thus, the no action alternative does not meet the remedial action objectives for groundwater.

Cost

Capital costs would include the development of a detailed sampling and analytical plan. Annual O&M costs will include groundwater sampling and analysis of groundwater samples. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 11,000
Annual O&M Cost	$ 5,000
Present Worth	$ 72,000

Table 5-43 provides a detailed summary of the estimated costs to implement Groundwater Remediation Alternative 1 - No Action. Backup information for all cost estimates is provided in Appendix A.

5.6.3.2 Alternative 2 - Extraction Wells with Air Stripping and Discharge to Surface Water

Extraction wells are a viable means of withdrawing groundwater to restrict on-site and potential off-site migration of contaminated groundwater. This alternative involves the collection of contaminated groundwater with extraction wells, ex-situ treatment using a shallow tray air stripper and discharge of treated groundwater to surface water. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There is potential for increased short-term risks to human health due to the drilling of extraction wells, handling and disposal of contaminated subsurface soils and groundwater. Site workers would be subject to increased chemical exposure risks during related to installation of utilities and the treatment system foundation due to volatilization of volatile

TABLE 5-43
SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
GROUNDWATER REMEDIATION ALTERNATIVE 1
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$2,800
SUBTOTAL	$9,000	$4,300
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$1,100
ECONOMIC ANALYSIS		
TOTALS	$11,000	$5,000
PRESENT WORTH OF O & M	$61,000	
TOTAL PRESENT WORTH	$72,000	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

organics from the overburden soils. These risks may be properly managed through the appropriate use of personal protective equipment, site monitoring and/or control measures, if required. Site workers would not be subject to increased chemical exposure risks during related to installation of the piping system for the discharge. The community surrounding the NSWCWODET facility will not be impacted by implementation of this alternative. There are no expected impacts to the environment associated with implementation of this alternative.

Long-Term Effectiveness and Permanence

This alternative would be effective in the long-term remediation of volatile organic contamination. However, the effectiveness for semivolatile organic is unknown. Extraction wells would restrict on- and potential off-site migration of contaminants in the overburden and shallow saprolite units. Additional treatment for semivolatiles of extracted groundwater may be required in association with this alternative. Groundwater collection would reduce the risks of on- and off-site exposure to contamination through ingestion or dermal contact with groundwater from potential drinking water or irrigation wells.

To assure long-term reliability, regularly scheduled maintenance will be performed on the components of the air stripping and discharge system. The trays of the shallow tray air stripper will be cleaned on a monthly basis with a pressure washer to remove accumulated scale. Duplex feed and discharge pumps have been specified for the air stripping system to extend pump life and to provide continuous treatment should one pump fail.

Provided that the groundwater source is controlled or removed (capping or excavating the disposal pit), air stripping will provide a permanent reduction in the concentration of organics in the groundwater once the cleanup goals have been achieved. At that point, groundwater treatment may cease. Thus, the alternative provides a long-term effectiveness in achieving the groundwater remedial action objectives.

Reduction of Toxicity, Mobility, or Volume

The extraction well alternative will significantly reduce the mobility of contaminants in the groundwater at the site. Collection with subsequent treatment will reduce the toxicity of the contaminants in the groundwater. Collection and treatment by air stripping will have no effect on the volume of contamination, since the volatile organics will be transferred from the groundwater to the air, but not destroyed. The collection but not the treatment of the contaminated groundwater reduces the mobility of the contaminants.

Implementability

This alternative would be highly implementable. This technology is technically feasible, administratively feasible and reliable. All required services and materials are readily available. All air stripping system components are readily available from their respective manufacturers. The reliability of the shallow tray air stripper and associated system components have been proven at many prior installations. Implementation of this alternative will require a NPDES permit from the MDE to discharge treated water to the stream.

Compliance with ARARs

This alternative complies with all action- and location-specific ARARs for treatment systems. This alternative complies with all chemical-specific ARARs. The proposed air stripping system is capable of meeting the Maryland surface water quality goals for organics that would be mandated in the NPDES permit.

Overall Protection of Human Health and the Environment

The well extraction system would serve to restrict further groundwater contamination migration in both the overburden and shallow bedrock fractures and would effectively capture a significant volume of contaminated groundwater. This would reduce the probability that surface water bodies, residential or on-site wells, and regional water supplies could be impacted by site contaminants. During the installation of the extraction wells, the potential exists for exposure of workers to site contaminants via direct contact or inhalation. Therefore, this alternative will require the implementation of health and safety measures during the remedial construction activities.

The operation of a groundwater pump and treat system utilizing air stripping will reduce or eliminate the migration of contaminated groundwater on and off the facility, will reduce the toxicity of the groundwater and will meet the remedial action objectives for the site. Eliminating or reducing the migration of contaminated groundwater on and off the site will reduce the potential for human or environmental exposure, and thus will be protective of human health and the environment. Since the water discharged to the surface will contain volatile organic levels below USEPA MCLs, no impacts to human health are anticipated.

Cost

Capital costs would include the installation of a well extraction, air stripping and discharge system, and development of a detailed sampling and analysis plan. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 469,000
Annual O&M Cost	$ 64,000
Present Worth	$ 501,000

Table 5-44 provides a detailed summary of the estimated costs to implement Groundwater Remediation Alternative 2 - Extraction wells with Air Stripper and Discharge to Surface Water. Backup information for all cost estimates is provided in Appendix A.

5.6.3.3 Alternative 3 - Extraction wells with Activated Carbon and Discharge to Surface Water

This alternative involves the collection of contaminated groundwater with extraction wells, ex-situ treatment using a GAC system such as a column or bed with subsequent discharge of treated groundwater to the stream that flows adjacent to the landfill. Criteria evaluations for the extraction wells and surface water discharge were discussed in Section 5.6.3.2 for Groundwater Remediation Alternative 2 and will not be repeated in the following sections. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

Site workers would be subject to increased chemical exposure risks during related to installation of utilities and the treatment system foundation due to volatilization of volatile organics from the overburden soils. These risks may be properly managed through the appropriate use of personal protective equipment, site monitoring and/or control measures, if required. Implementation of this alternative, with provision of appropriate worker health and community safety measures, is not expected to significantly impact public health or the environment immediately adjacent to the site. This alternative would become effective immediately upon start-up of the collection and treatment system.

Long-Term Effectiveness and Permanence

To assure long-term reliability, regularly scheduled maintenance will be performed on the components of the GAC treatment system. The GAC will be checked on a monthly basis to determine if the carbon needs replacement with fresh carbon. A pre-filtration unit

TABLE 5-44
SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
GROUNDWATER REMEDIATION ALTERNATIVE 2
EXTRACTION WELLS WITH AIR STRIPPING AND
DISCHARGE TO SURFACE WATER

	CAPITAL	O & M
COLLECTION WITH EXTRACTION WELLS:		
MANHOLES FOR PUMPS & CONTROLS	$4,000	
WELL INSTALLATION & DEVELOPMENT	$30,000	
PIPING	$13,200	
PUMPS	$6,000	
TANK	$12,000	
POWER		$1,300
AIR STRIPPING TREATMENT:		
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$4,000	$1,000
AIR STRIPPER	$20,000	$2,100
SCRUBBER	$7,200	$1,300
LABOR FOR CHECK – UP OPERATIONS		$27,000
DISCHARGE TO SURFACE WATER:		
PUMPS	$10,000	
TANK	$35,000	
POWER		$3,000
PIPING	$20,000	
DISCHARGE MONITORING	$16,500	$5,000
ANALYTICAL		$10,400
SUBTOTAL	$213,000	$51,100
ALLOWANCES		
CONTINGENCY (25%)	$53,250	$12,800
INSTALLATION/CONSTRUCTION (50%)	$106,500	
ENGINEERING (25%)	$53,250	
ELECTRICAL (20%)	$42,600	
ECONOMIC ANALYSIS		
TOTALS	$469,000	$64,000
PRESENT WORTH OF O & M	**$32,000**	
TOTAL PRESENT WORTH	**$501,000**	

Notes

1 For present worth calculation; interest rate = 10%; inflation = 6%; and project life = 0.5 year

2. Contingencies were applied to both capital cost and O & M costs.

3. Totals were rounded to the nearest thousands.

will be checked on a monthly basis also to ensure that no clogging of the system has occurred. Duplex feed and discharge pumps have been specified for the GAC system to extend pump life and to provide continuous treatment should one pump fail.

Provided that the groundwater source is controlled or removed (capping or excavating the disposal pit), activated carbon will provide a permanent reduction in the concentration of organics in the groundwater once the cleanup goals have been achieved. At that point, groundwater treatment may cease. Thus, the alternative provides a long-term effectiveness in achieving the groundwater remedial action objectives.

Reduction of Toxicity, Mobility, or Volume

Treatment of contaminated groundwater by activated carbon adsorption will reduce the toxicity of the groundwater. Collection and treatment by activated carbon adsorption will have no effect on the volume of contamination, since the volatile organics will be transferred from the groundwater to the GAC, but not destroyed. The collection but not the treatment of the contaminated groundwater reduces the mobility of the contaminants.

Implementability

GAC treatment columns or bed are typically skid-mounted units which are relatively simple to install and replace and are readily available through numerous manufacturers. The reliability of the GAC columns or beds and associated system components have been proven at many prior installations.

Compliance with ARARs

This alternative complies with all action- and location-specific ARARs for treatment systems. This alternative complies with all chemical-specific ARARs. The proposed GAC treatment system is capable of meeting the Maryland surface water quality goals for organics that would be mandated in the NPDES permit.

Overall Protection of Human Health and the Environment

The operation of a groundwater pump and treat system utilizing GAC adsorption will reduce or eliminate the migration of contaminated groundwater on and off the facility, will reduce the toxicity of the groundwater and will meet the remedial action objectives for the site. Eliminating or reducing the migration of contaminated groundwater on and off the site will reduce the potential for human or environmental exposure, and thus will be protective of human health and the environment.

TABLE 5-45
SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
GROUNDWATER REMEDIATION ALTERNATIVE 3
EXTRACTION WELLS WITH ACTIVATED CARBON TREATMENT
AND DISCHARGE TO SURFACE WATER

	CAPITAL	O & M
COLLECTION WITH EXTRACTION WELLS:		
MANHOLES FOR PUMPS & CONTROLS	$4,000	
WELL INSTALLATION & DEVELOPMENT	$30,000	
PIPING	$13,200	
PUMPS	$6,000	
TANK	$12,000	
POWER		$1,300
ACTIVATED CARBON TREATMENT:		
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$4,000	$1,000
ACTIVATED CARBON	$16,000	$2,000
LABOR FOR CHECK-UP OPERATIONS		$27,000
DISCHARGE TO SURFACE WATER:		
PUMPS	$10,000	
TANK	$35,000	
POWER		$3,000
PIPING	$20,000	
DISCHARGE MONITORING	$16,500	$5,000
ANALYTICAL		$10,400
SUBTOTAL	$202,000	$49,700
ALLOWANCES		
CONTINGENCY (25%)	$50,500	$12,400
INSTALLATION/CONSTRUCTION (50%)	$101,000	
ENGINEERING (25%)	$50,500	
ELECTRICAL (20%)	$40,400	
ECONOMIC ANALYSIS		
TOTALS	$444,000	$62,000
PRESENT WORTH OF O & M	**$31,000**	
TOTAL PRESENT WORTH	**$475,000**	

Notes
1 For present worth calculation; interest rate = 10%; inflation = 6%; and project life = 0.5 year
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

Cost

The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 444,000
Annual O&M Cost	$ 62,000
Present Worth	$ 475,000

Table 5-45 provides a detailed summary of the estimated costs to implement Groundwater Remediation Alternative 3 - Extraction Wells with Activated Carbon and Discharge to Surface Water. Backup information for all cost estimates is provided in Appendix A.

5.6.4 Comparative Analysis

In the following analysis, the alternatives are evaluated in relation to one another for each of the evaluation criteria. Overall protection of human health and the environment and compliance with ARARs will serve as threshold determinations in that they must be met by any alternative in order for it to be eligible for selection. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative.

5.6.4.1 Soil Remediation Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health and the environment. Infiltration of rainwater to the buried wastes would continue to generate leachate and impact groundwater quality. Alternatives 2 through 7 are protective of human health and the environment. Leachate generation would be reduced or eliminated for all alternatives except for Alternative 1.

Compliance with ARARs

Alternative 1 does not comply with ARARs while Alternatives 3 through 7 comply with action- and chemical-specific ARARs. Alternative 2 complies with action-specific ARARs but not chemical-specific ARARs.

Short-Term Impacts and Effectiveness

Although no additional exposure risks would occur for implementation of Alternative 1, Alternatives 2 through 7 would be more effective in the short term than Alternative 1. Human health exposure for Alternatives 3 through 7 are higher than for Alternative 2 because they require excavation and treatment of contaminated soil prior to disposal. Alternative 2 is capping and does not require contaminated soil handling activities. Short-term environmental impacts are the same for Alternatives 3 through 7 because they all require excavation which will remove the contaminants from the environment. Short-term impacts associated with Alternative 2 include continued leachate generation until soil moisture decreases in the subsurface to the point where leachate cannot be generated.

Long-Term Effectiveness and Permanence

Alternatives 2 through 7 will provide long-term effectiveness in achieving the remedial action objectives for the site soils while Alternative 1 would not meet these goals.

Reduction of Toxicity, Mobility, or Volume

Alternative 1 would not reduce the toxicity, mobility, or volume of the contaminated soils at site. Alternative 2 will not reduce the toxicity or volume of contaminated soil but will reduce the mobility due to infiltration elimination. Alternatives 3 through 7 will reduce the toxicity and mobility of contaminated soil because of treatment of the soil. The volume of contaminated soil will remain the same for Alternatives 3 through 7.

Implementability

Alternative 1 is implementable because continued sampling would be the only required future action. Alternative 2 is highly implementable. Alternatives 3, 4, 5, and 6 are highly implementable because of the availability of contractors who perform mobile on-site treatment of contaminated soil. Alternative 7 is implementable but the availability of local fixed treatment facilities is not as prevalent as those contractors who conduct on-site activities.

Cost

With regard to cost for those alternatives that quality for selection as the preferred alternative, Alternative 2 is the least expensive. Alternatives 3 and 5 which include on-site disposal of the treatment residuals are considerably more cost effective than Alternatives 4, 6, and 7 which include off-site disposal.

Summary

Because Alternative 1 is not protective of human health and the environment and does not comply with ARARs, it cannot be selected as the preferred alternative for the soils at the site. Alternative 3, Excavation with On-site Thermal Treatment and On-site Disposal, provides the best balance of tradeoffs with respect to the evaluation criteria, and is proposed as the preferred alternative. A summary of the results of the detailed evaluation for each of the eight alternatives is shown below.

Criteria	Soil Alternatives						
	1	2	3	4	5	6	7
Overall Protection of Human Health and the Environment	-	+	+	+	+	+	+
Compliance with ARARs	-	+	+	+	+	+	+
Short-Term Effectiveness	-	0	0	0	0	0	0
Long-Term Effectiveness	-	+	+	+	+	+	+
Reduction of Toxicity, Mobility, or Volume	-	0	+	+	+	+	+
Implementability	+	+	+	+	+	+	0
Cost (Present Worth in millions)	$0.06	$0.1	$0.25	$1.1	$0.5	$1.3	$1.6

Legend:
+ = positive
0 = neutral
- = negative

5.6.4.2 Buried Waste Disposal Remediation Alternatives

Off-site disposal of excavated buried waste materials is the only alternative evaluated for this media, and therefore, no comparative analysis will be provided. Implementation of this alternative will only occur if a soil/buried waste excavation alternative is selected.

5.6.4.3 Groundwater Remediation Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health and the environment. On- and off-site populations could potentially be exposed to contaminated groundwater and continued migration of contaminants in the groundwater would occur. Alternatives 2 and 3 are protective of human health and the environment due to collection and treatment of contaminated groundwater. Risk through ingestion of and contact with contaminated groundwater are reduced to cancer risk levels less than 10^{-6} for Alternatives 2 and 3.

Compliance with ARARs

Alternative 1 does not comply with ARARs while Alternatives 2 and 3 comply with action- and chemical-specific ARARs for groundwater contamination collection and treatment.

Short-Term Impacts and Effectiveness

Although no additional exposure risks would occur for implementation of Alternative 1, Alternatives 2 and 3 would be more effective in the short term than Alternative 1. Short-term human health and environmental impacts are the same for Alternatives 2 and 3 because they both extract contaminated groundwater and treat it prior to discharge to surface water.

Long-Term Effectiveness and Permanence

Alternatives 2 and 3 will provide long-term effectiveness in achieving the remedial action objectives for the site groundwater while Alternative 1 would not meet these goals.

Reduction of Toxicity, Mobility, or Volume

Alternative 1 would not reduce the toxicity, mobility, or volume of the contaminated groundwater at site. Alternatives 2 and 3 will reduce the toxicity, mobility and volume of contaminated groundwater. However, for Alternatives 2 and 3, contaminants will not be eliminated, just transferred to a different media (air and carbon scrubber for air stripper and activated carbon for GAC system).

Implementability

Alternative 1 is implementable because continued sampling would be the only required future action. Alternatives 2 and 3 are highly implementable because they are commonly implemented remedial actions for groundwater and because of the availability of firms and materials in the local area.

Cost

With regard to cost for those alternatives that quality for selection as the preferred alternative, Alternative 3 is the least expensive.

Summary

Because Alternative 1 is not protective of human health and the environment and does not comply with ARARs, it cannot be selected as the preferred alternative for the soils at the site. Alternative 3, Extraction Wells with Activated Carbon Treatment and Discharge to Surface Water, provides the best balance of tradeoffs with respect to the evaluation criteria, and is proposed as the preferred alternative. A summary of the results of the detailed evaluation for each of the three alternatives is shown below.

Criteria	Groundwater Alternatives		
	1	2	3
Overall Protection of Human Health and the Environment	-	+	+
Compliance with ARARs	-	+	+
Short-Term Effectiveness	-	+	+
Long-Term Effectiveness	-	+	+
Reduction of Toxicity, Mobility, or Volume	-	+	+
Implementability	+	+	+
Cost (Present Worth in thousands)	$72	$501	$475

Legend:
+ = positive
0 = neutral
- = negative

5.6.5 Summary of Preferred Alternatives

The following alternatives are proposed as the preferred alternatives to meet the remedial action objectives at Site 8:

- Excavation of Contaminated Soils and Buried Materials, On-site Thermal

Treatment of soils, On-site Disposal of Treatment Residuals, and Off-site Disposal of Buried Materials

- Groundwater Extraction Wells with Activated Carbon Treatment and Discharge to Surface Water

Conceptual design criteria and drawings will be presented in Section 6.0 of this document.

5.7 SITE 9 - INDUSTRIAL WASTEWATER DISPOSAL AREA 300

5.7.1 Soil/Buried Material Remediation Alternatives

5.7.1.1 Alternative 1 - No Action

The no action alternative means that no remedial actions will be implemented to remove/control the contaminated soil and buried material in the leaching wells and field located at Site 9. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

With the no action alternative, no remedial construction takes place, and therefore, there is no potential for increased short-term risks to human health or the environment. The human health and environmental risks presented in Section 3.1.6 for the site will remain. Relying on natural biodegradation as the only means of contaminant reduction makes it unlikely that the no action alternative would be effective in achieving the remedial action objectives for the soil and waste material in the foreseeable future..

Long-Term Effectiveness and Permanence

The no action alternative would not be effective in preventing direct human contact with contaminated soils and materials in the leaching wells and field and provides no environmental protection.

Reduction of Toxicity, Mobility, or Volume

The no action alternative does not contribute to the reduction of toxicity, mobility, or volume of the contaminated soils in the leaching wells and field outside of the natural biodegradation which may occur.

Implementability

This alternative has already been implemented.

Compliance with ARARs

This alternative does not comply with the chemical-specific ARARs for soils outlined in Table 3-4.

Overall Protection of Human Health and the Environment

Human health and environmental risks associated with exposure to contaminated soils has not been reduced by the implementation of the no action alternative. The no action alternative does not meet any of the remedial action objectives for this site.

Cost

Costs for this alternative would be chiefly comprised of monitoring and soil analytical costs. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 11,000
Annual O&M Cost	$ 18,000
Present Worth	$ 209,000

Table 5-46 provides a detailed summary of the estimated costs to implement Soil Alternative 1 - No Action. Backup information for all cost estimates is provided in Appendix A.

5.7.1.2 Alternative 2 - Excavation with On-site Thermal Treatment/Disposal

Alternative 2 is excavation with on-site thermal treatment of excavated contaminated soil followed by on-site disposal of the treatment residuals. Excavated soil would be staged at the treatment unit prior to treatment. On-site thermal treatment includes the use of a mobile unit to thermally destruct the organics in the soil. This alternative involves placement of the treatment residuals back in the excavated areas. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during excavation, treatment and disposal of the contaminated soils and treatment residues. Treatment unit operator personnel could be exposed to contaminated dust during soil and treatment residue handling activities and airborne organics during thermal treatment operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and

TABLE 5–46
SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
SOIL REMEDIATION ALTERNATIVE 1
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$12,600
SUBTOTAL	$9,000	$14,100
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$3,500
ECONOMIC ANALYSIS		
TOTALS	$11,000	$18,000
PRESENT WORTH OF O & M	**$198,000**	
TOTAL PRESENT WORTH	**$209,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi–annual basis.

equipment. The disposal of treatment residue on-site will not impact the general public during the disposal phase. Personnel could be exposed to contaminated dust during disposal activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Excavation would be effective in reducing direct human contact with contaminants in the soils. Reduction in organic concentration in the excavated soils could be expected to be as high as 90 to 99 percent. On-site disposal back into the excavated areas would be an effective method of treatment residue disposal. Human health exposure to treatment residue would be eliminated.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the excavated soil would be the result of thermal treatment of the soil. The volume of soil would not significantly change after thermal treatment, the amount of treatment residue would be virtually the same as the amount of soil incinerated. A reduction in mobility is not applicable to the treatment technologies. On-site disposal in conjunction with placement of a soil cover will effectively reduce the mobility of contaminants in the treatment residue. The presence of a soil cover and vegetation will reduce infiltration of organics remaining in the treatment residuals.

Implementability

This alternative is implementable due to the availability of excavation and mobile treatment equipment. However, approval of a thermal treatment permit may be somewhat difficult to obtain. The disposal of treatment residue in the excavated areas could be implemented with no substantial difficulties. Approval of on-site disposal (permit may be required) will be the most difficult implementation facet of this remedial action.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment of contaminated soil.

Overall Protection of Human Health and the Environment

Excavation with subsequent on-site thermal treatment of contaminated soil prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated soil. On-site thermal treatment meets the remedial action objective of treatment of excavated contaminated soil. Placement of the residuals in the excavated areas in conjunction with a soil cover is protective of the human health and the

environment in that it would reduce the potential for both direct human contact with the treatment residues and limits infiltration of precipitation. Thus, this alternative satisfies the remedial action objectives for removal of contaminated soils and disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 203,000
Annual O&M Cost	$ 0
Present Worth	$ 203,000

Table 5-47 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 2 - Soil Excavation with On-site Thermal Treatment/On-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.7.1.3 Alternative 3 - Excavation with On-site Thermal Treatment/Off-site Disposal

Alternative 3 is excavation with on-site thermal treatment of excavated contaminated soil followed by off-site disposal of the treatment residuals. Excavated soil would be staged at the treatment unit prior to treatment. On-site thermal treatment includes the use of a mobile unit to thermally destruct the organics in the soil. Excavated soil would be transported to the on-site treatment facility prior to treatment. This alternative involves placement of the treatment residuals in an off-site chemical waste landfill. A discussion of each of the evaluation criteria for this alternative follows. Excavation and treatment criteria evaluations were discussed in Section 5.7.1.2 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

The disposal of treatment residue in an off-site chemical waste landfill will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

TABLE 5-47
SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
SOIL REMEDIATION ALTERNATIVE 2
EXCAVATION WITH ON-SITE THERMAL TREATMENT AND ON-SITE DISPOSAL

	CAPITAL
EXCAVATION	$11,000
STAGING	$10,000
THERMAL TREATMENT	$100,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$15,000
GRADING	$8,500
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$14,000
SUBTOTAL	$162,000
ALLOWANCES	
CONTINGENCY (25%)	$41,000
TOTAL	$203,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

Long-Term Effectiveness and Permanence

Off-site disposal into a chemical waste landfill would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume

Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the treatment residue. The toxicity and volume of the organic contamination in the treatment residue will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

The disposal of treatment residue in a chemical waste landfill could be implemented with no substantial difficulties.

Compliance with ARARs

The placement of the treatment residues in a chemical waste landfill would comply with action-specific and chemical-specific ARARs.

Overall Protection of Human Health and the Environment

Placement of the residuals in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues in a chemical waste landfill offers more reliable, long-term protection since, when properly installed, these landfills will retain their integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 788,000
Annual O&M Cost	$ 0
Present Worth	$ 788,000

Table 5-48 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 3 - Soil Excavation with On-site Thermal Treatment/Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.7.1.4 Alternative 4 - Excavation with On-site Soil Washing/On-site Disposal

Soil remediation Alternative 4 is soil excavation with on-site soil washing of excavated contaminated soil followed by on-site disposal of treatment residuals. Excavated soil would be staged at the treatment unit prior to treatment. On-site soil washing includes the use of a mobile soil washing unit to physically remove the organics in the soil. This alternative involves placement of the treated residue into the excavated areas as backfill. A discussion of each of the evaluation criteria for this alternative follows. Excavation criteria evaluations were discussed in Section 5.7.1.2 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during treatment of the contaminated soil. Treatment unit operator personnel could be exposed to contaminated dust during soil and treatment residue handling activities and contaminated washing solutions during soil washing operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The disposal of treatment residue on-site will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust during handling and backfilling activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Reduction in organic concentration in the excavated soil could be expected to be as high as 90 to 99 percent. On-site disposal into the excavated areas would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the excavated soil would be the result of washing of the soil. The volume of soil would not change after washing; however, a significant quantity of contaminated solution (water, surfactants, etc.) would be generated. A reduction in mobility is not applicable to the treatment technologies. On-site disposal in conjunction with placement of a soil cover will effectively reduce the mobility of contaminants in the treatment residue. The presence of both the soil and vegetative cover

TABLE 5-48
SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
SOIL REMEDIATION ALTERNATIVE 3
EXCAVATION WITH ON-SITE THERMAL TREATMENT AND OFF-SITE DISPOSAL

	CAPITAL
EXCAVATION	$11,000
STAGING	$5,000
THERMAL TREATMENT	$100,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$15,000
LOADING & HAULING TO LANDFILL	$382,000
LANDFILL CHARGES	$100,000
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$14,000
SUBTOTAL	$630,000
ALLOWANCES	
CONTINGENCY (25%)	$158,000
TOTAL	$788,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

will reduce infiltration of organics remaining in the treatment residuals.

Implementability

This alternative is implementable due to the availability of mobile equipment. Approval of a treatment permit involving soil washing would be expected to be less difficult to obtain than a permit for the thermal destruction process. The disposal of treatment residue into the excavated areas could be implemented with no substantial difficulties. Approval of on-site disposal (permit may be required) will be the most difficult implementation facet of this remedial action.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment of contaminated soils.

Overall Protection of Human Health and the Environment

On-site soil washing of contaminated soil prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated soil. On-site soil washing meets the remedial action objective of treatment of excavated contaminated soil. Placement of the residuals in the excavated areas as fill in conjunction with installation of a soil cover is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 359,000
Annual O&M Cost	$ 0
Present Worth	$ 359,000

Table 5-49 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 4 - Soil Excavation with On-site Soil Washing/On-site Disposal. Backup information for all cost estimates is provided in Appendix A.

TABLE 5-49
SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
SOIL REMEDIATION ALTERNATIVE 4
EXCAVATION WITH ON-SITE SOIL WASHING AND ON-SITE DISPOSAL

	CAPITAL
EXCAVATION	$11,000
STAGING	$10,000
SOIL WASHING	$225,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$15,000
GRADING	$8,500
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$14,000
SUBTOTAL	$287,000
ALLOWANCES	
CONTINGENCY (25%)	$72,000
TOTAL	$359,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

5.7.1.5 Alternative 5 - Excavation with On-site Soil Washing/Off-site Disposal

Soil remediation Alternative 5 is soil excavation with on-site soil washing of excavated contaminated soil followed by off-site disposal of treatment residuals. Excavated soil would be staged at the treatment unit prior to treatment. On-site soil washing includes the use of a mobile soil washing unit to physically remove the organics from the soil. This alternative involves placement of the treated residue in an off-site chemical waste landfill. A discussion of each of the evaluation criteria for this alternative follows. Excavation and treatment criteria evaluations were discussed in Sections 5.7.1.2 and 5.7.1.5 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

The disposal of treatment residue in an off-site chemical waste landfill will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Off-site disposal into a chemical waste landfill would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume

Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the treatment residue. The toxicity and volume of the contamination in the treatment residue will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

The disposal of treatment residue in a chemical waste landfill could be implemented with no substantial difficulties.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment and disposal of contaminated soils.

Overall Protection of Human Health and the Environment

Placement of the residuals in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues in a chemical waste landfill offers more reliable, long-term protection

since, when properly installed, these landfills will retain their integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 944,000
Annual O&M Cost	$ 0
Present Worth	$ 944,000

Table 5-50 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 5 - Soil Excavation with On-site Soil Washing/Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.7.1.6 Alternative 6 - Excavation with Off-site Soil Washing/Off-site Disposal

Soil remediation Alternative 6 is soil excavation with off-site soil washing of excavated contaminated soil and off-site disposal. Off-site soil washing includes transport of excavated soil to an off-site permitted soil washing unit to physically remove the organics in the soil. This alternative involves placement of the treated residue in an off-site chemical waste landfill. Excavation criteria evaluations were discussed in Section 5.7.1.2 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during treatment of the contaminated soil. Treatment unit operator personnel could be exposed to contaminated dust during soil and treatment residue handling activities and contaminated washing solutions during soil washing operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The disposal of treatment residue in an off-site chemical waste landfill will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

TABLE 5-50
SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
SOIL REMEDIATION ALTERNATIVE 5
EXCAVATION WITH ON-SITE SOIL WASHING
AND OFF-SITE DISPOSAL

	CAPITAL
EXCAVATION	$11,000
STAGING	$5,000
SOIL WASHING	$225,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$15,000
LOADING & HAULING TO LANDFILL	$382,000
LANDFILL CHARGES	$100,000
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$14,000
SUBTOTAL	$755,000
ALLOWANCES	
CONTINGENCY (25%)	$189,000
TOTAL	$944,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

Long-Term Effectiveness and Permanence

Reduction in organic concentration in the excavated soil could be expected to be as high as 90 to 99 percent. Off-site disposal into a chemical waste landfill would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the excavated soil would be the result of washing of the soil. The volume of soil would not change after washing; however, a significant quantity of organic-contaminated solution (water, surfactants, etc.) would be generated. A reduction in mobility is not applicable to the treatment technologies. Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the treatment residue. The toxicity and volume of the contamination in the treatment residue will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

This alternative is implementable due to the availability of off-site treatment facilities. The disposal of treatment residue in a chemical waste landfill could be implemented with no substantial difficulties.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment and disposal of contaminated soil.

Overall Protection of Human Health and the Environment

Off-site soil washing of contaminated soil prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated soil. Off-site soil washing meets the remedial action objective of treatment of excavated contaminated soil. Placement of the residuals in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues in a chemical waste landfill offers more reliable, long-term protection since, when properly installed, these landfills will retain their integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of soil excavation, transport, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 1,134,000
Annual O&M Cost	$ 0
Present Worth	$ 1,134,000

Table 5-51 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 6 - Soil Excavation with Off-site Soil Washing/Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.7.2 Buried Material Disposal Alternative

Off-site Disposal

This alternative involves the disposal of an estimated 50 cubic yards of buried material in an off-site landfill and will be implemented provided that a soil/buried material excavation alternative is also selected. Decontamination of the materials with collection of wash water and any free product may be required prior to disposal. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during disposal of the buried materials. The disposal of the buried materials off-site will not impact the general public during the disposal phase. Personnel could be exposed to contaminated material or free product during handling and disposal activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Off-site disposal would be an effective method of buried material disposal. Human health exposure to buried materials would be eliminated.

Reduction of Toxicity, Mobility, or Volume

Off-site disposal will reduce the toxicity, mobility and volume of wastes at the site. However, decontamination of the materials may be required prior to disposal which would generate potential additional waste streams (i.e., free product, contaminated

TABLE 5-51
SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
SOIL REMEDIATION ALTERNATIVE 6
EXCAVATION WITH OFF-SITE SOIL WASHING AND OFF-SITE DISPOSAL

	CAPITAL
EXCAVATION	$11,000
LOADING & HAULING TO TREATMENT SITE	$232,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$15,000
SOIL WASHING	$150,000
LOADING & HAULING TO LANDFILL	$382,000
LANDFILL CHARGES	$100,000
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$14,000
SUBTOTAL	$907,000
ALLOWANCES	
CONTINGENCY (25%)	$227,000
TOTAL	$1,134,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

decontamination water).

Implementability

The disposal of buried materials in an off-site landfill could be implemented with no substantial difficulties.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for disposal of hazardous and solid wastes.

Overall Protection of Human Health and the Environment

Land disposal in an approved chemical waste landfill greatly reduces the potential human health and environmental risks associated with exposure to buried material. Thus, this alternative satisfies the remedial action objectives for proper disposal of buried materials.

Cost

Costs for this alternative would be chiefly comprised of disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 33,000
Annual O&M Cost	$ 0
Present Worth	$ 33,000

Table 5-52 provides a detailed summary of the estimated costs to implement Buried Material Disposal Alternative - Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.7.3 Groundwater Remediation Alternatives

5.7.3.1 Alternative 1 - No Action

The no action alternative means that no remedial actions will be implemented to remove or treat the groundwater. Only the natural biodegradation of organic contaminants by indigenous microorganisms would occur. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

With the no action alternative, no remedial construction takes place; therefore, there is no potential for increased short-term risks to human health or the environment. The

TABLE 5-52
SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
BURIED WASTE DISPOSAL ALTERNATIVE
OFF-SITE LANDFILL

	CAPITAL
LOADING & HAULING TO LANDFILL	$19,000
LANDFILL	$7,500
SUBTOTAL	$26,500
ALLOWANCES	
CONTINGENCY (25%)	$6,600
TOTAL	$33,000

human health and environmental risks discussed in Section 3.1.6 will remain. Relying on natural biodegradation as the only means of contaminant reduction makes it unlikely that the no action alternative would be effective in achieving the remedial action objectives for the groundwater.

Long-Term Effectiveness and Permanence

Even if the source of groundwater contamination is removed (excavating the leaching wells and field), contaminated groundwater would continue to migrate on-site for some period of time with the possibility of migrating on- and off-site towards some receptor (drinking water wells). It is difficult to predict if or when contaminants in the groundwater would be reduced to groundwater standards, through either natural biodegradation or groundwater mixing. Thus, the no action alternative is not effective in achieving the remedial action objectives for the site.

Reduction of Toxicity, Mobility, or Volume

The no action alternative will not reduce the mobility or volume of contaminated groundwater. Toxicity could be reduced somewhat, over time, by natural biodegradation processes.

Implementability

The no action alternative requires no implementation.

Compliance with ARARs

Action-specific ARARs do not apply to the no action alternative. This alternative would not comply with the chemical-specific ARARs.

The no action alternative would comply with location-specific ARARs.

Overall Protection of Human Health and the Environment

The no action alternative will not be protective of human health and the environment because this alternative allows groundwater to freely migrate off-site. Thus, the no action alternative does not meet the remedial action objectives for groundwater.

Cost

Capital costs would include the development of a detailed sampling and analytical plan. Annual O&M costs will include groundwater sampling and analysis of groundwater samples. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 11,000
Annual O&M Cost	$ 18,000
Present Worth	$ 209,000

Table 5-53 provides a detailed summary of the estimated costs to implement Groundwater Remediation Alternative 1 - No Action. Backup information for all cost estimates is provided in Appendix A.

5.7.3.2 Alternative 2 - Extraction Wells with Air Stripping and Discharge to Surface Water

Extraction wells are a viable means of withdrawing groundwater to restrict on-site and potential off-site migration of contaminated groundwater. This alternative involves the collection of contaminated groundwater with extraction wells, ex-situ treatment using a shallow tray air stripper and discharge of treated groundwater to surface water. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There is potential for increased short-term risks to human health due to the drilling of extraction wells, handling and disposal of contaminated subsurface soils and groundwater. Site workers would be subject to increased chemical exposure risks during related to installation of utilities and the treatment system foundation due to volatilization of volatile organics from the overburden soils. These risks may be properly managed through the appropriate use of personal protective equipment, site monitoring and/or control measures, if required. Site workers would not be subject to increased chemical exposure risks during related to installation of the piping system for the discharge. The community surrounding the NSWCWODET facility will not be impacted by implementation of this alternative. There are no expected impacts to the environment associated with implementation of this alternative.

Long-Term Effectiveness and Permanence

This alternative would be effective in the long-term remediation of volatile organic contamination. However, effectiveness of removal of nitroaromatics is unknown. Extraction wells would restrict on- and potential off-site migration of contaminants in the overburden and shallow saprolite units. Additional treatment (nitroaromatics) of extracted groundwater may be required in association with this alternative. Groundwater collection would reduce the risks of on- and off-site exposure to contamination through ingestion or dermal contact

TABLE 5-53
SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
GROUNDWATER REMEDIATION ALTERNATIVE 1
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$12,600
SUBTOTAL	$9,000	$14,100
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$3,500
ECONOMIC ANALYSIS		
TOTALS	$11,000	$18,000
PRESENT WORTH OF O & M	**$198,000**	
TOTAL PRESENT WORTH	**$209,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

with groundwater from potential drinking water or irrigation wells.

To assure long-term reliability, regularly scheduled maintenance will be performed on the components of the air stripping and discharge system. The trays of the shallow tray air stripper will be cleaned on a monthly basis with a pressure washer to remove accumulated scale. Duplex feed and discharge pumps have been specified for the air stripping system to extend pump life and to provide continuous treatment should one pump fail.

Provided that the groundwater source is removed (excavating the leaching wells and field), air stripping may provide a permanent reduction in the concentration of volatile organics in the groundwater once the cleanup goals have been achieved. However, it is unlikely that nitroaromatic concentrations would be decreased to acceptable cleanup levels. Thus, the alternative does not provide a long-term effectiveness in achieving the groundwater remedial action objectives.

Reduction of Toxicity, Mobility, or Volume

The extraction well alternative will significantly reduce the mobility of contaminants in the groundwater at the site. Collection with subsequent treatment will reduce the toxicity of the contaminants in the groundwater. Collection and treatment by air stripping will have no effect on the volume of contamination, since the volatile organics and nitroaromatics will be transferred from the groundwater to the air, but not destroyed. The collection but not the treatment of the contaminated groundwater reduces the mobility of the contaminants.

Implementability

This alternative would be highly implementable. This technology is technically feasible, administratively feasible and reliable. All required services and materials are readily available. All air stripping system components are readily available from their respective manufacturers. The reliability of the shallow tray air stripper and associated system components have been proven at many prior installations. Implementation of this alternative will require a NPDES permit from the MDE to discharge treated water to the stream.

Compliance with ARARs

This alternative complies with all action- and location-specific ARARs for treatment systems. This alternative complies with all chemical-specific ARARs. The proposed air stripping system is capable of meeting the Maryland surface water quality goals for organics that would be mandated in the NPDES permit.

Overall Protection of Human Health and the Environment

The well extraction system would serve to restrict further groundwater contamination migration in both the overburden and shallow bedrock fractures and would effectively capture a significant volume of contaminated groundwater. This would reduce the probability that surface water bodies, residential or on-site wells, and regional water supplies could be impacted by site contaminants. During the installation of the extraction wells, the potential exists for exposure of workers to site contaminants via direct contact or inhalation. Therefore, this alternative will require the implementation of health and safety measures during the remedial construction activities.

The operation of a groundwater pump and treat system utilizing air stripping will reduce or eliminate the migration of contaminated groundwater on and off the facility, will only reduce the toxicity of the volatile organics in the groundwater and but will not meet the remedial action objectives for the site because of the uncertainty on nitroaromatic removal. Eliminating or reducing the migration of contaminated groundwater on and off the site will reduce the potential for human or environmental exposure, and thus will be protective of human health and the environment.

Cost

Capital costs would include the installation of a well extraction, air stripping and discharge system, and development of a detailed sampling and analysis plan. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 629,000
Annual O&M Cost	$ 107,000
Present Worth	$ 1,302,000

Table 5-54 provides a detailed summary of the estimated costs to implement Groundwater Remediation Alternative 2 - Extraction wells with Air Stripper and Discharge to Surface Water. Backup information for all cost estimates is provided in Appendix A.

5.7.3.3 Alternative 3 - Extraction wells with Activated Carbon and Discharge to Surface Water

This alternative involves the collection of contaminated groundwater with extraction wells, ex-situ treatment using a GAC system such as a column or bed with subsequent discharge of treated groundwater to the stream that flows adjacent to the landfill. Criteria

TABLE 5–54
SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
GROUNDWATER REMEDIATION ALTERNATIVE 2
EXTRACTION WELLS WITH AIR STRIPPING AND
DISCHARGE TO SURFACE WATER

	CAPITAL	O & M
COLLECTION WITH EXTRACTION WELLS:		
MANHOLES FOR PUMPS & CONTROLS	$8,000	
WELL INSTALLATION & DEVELOPMENT	$38,000	
PIPING	$66,000	
PUMPS	$10,400	
TANK	$12,000	
POWER		$2,500
AIR STRIPPING TREATMENT:		
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$6,000	$1,500
AIR STRIPPER	$30,000	$2,500
SCRUBBER	$14,000	$1,500
LABOR FOR CHECK – UP OPERATIONS		$33,000
DISCHARGE TO SURFACE WATER:		
PUMPS	$10,000	
TANK	$35,000	
POWER		$3,000
PIPING	$5,000	
DISCHARGE MONITORING	$16,500	$5,000
ANALYTICAL		$36,400
SUBTOTAL	$286,000	$85,400
ALLOWANCES		
CONTINGENCY (25%)	$71,500	$21,400
INSTALLATION/CONSTRUCTION (50%)	$143,000	
ENGINEERING (25%)	$71,500	
ELECTRICAL (20%)	$57,200	
ECONOMIC ANALYSIS		
TOTALS	$629,000	$107,000
PRESENT WORTH OF O & M	**$673,000**	
TOTAL PRESENT WORTH	**$1,302,000**	

Notes

1 For present worth calculation; interest rate = 10%; inflation = 6%; and project life = 9 years

2. Contingencies were applied to both capital cost and O & M costs.

3. Totals were rounded to the nearest thousands.

evaluations for the extraction wells and surface water discharge were discussed in Section 5.7.3.2 for Groundwater Remediation Alternative 2 and will not be repeated in the following sections. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

Site workers would be subject to increased chemical exposure risks during related to installation of utilities and the treatment system foundation due to volatilization of volatile organics from the overburden soils. These risks may be properly managed through the appropriate use of personal protective equipment, site monitoring and/or control measures, if required. Implementation of this alternative, with provision of appropriate worker health and community safety measures, is not expected to significantly impact public health or the environment immediately adjacent to the site. This alternative would become effective immediately upon start-up of the collection and treatment system.

Long-Term Effectiveness and Permanence

To assure long-term reliability, regularly scheduled maintenance will be performed on the components of the GAC treatment system. The GAC will be checked on a monthly basis to determine if the carbon needs replacement with fresh carbon. A pre-filtration unit will be checked on a monthly basis also to ensure that no clogging of the system has occurred. Duplex feed and discharge pumps have been specified for the GAC system to extend pump life and to provide continuous treatment should one pump fail.

Provided that the groundwater source is controlled or removed (excavating the leaching wells), activated carbon will provide a permanent reduction in the concentration of organics in the groundwater once the cleanup goals have been achieved. At that point, groundwater treatment may cease. Thus, the alternative provides a long-term effectiveness in achieving the groundwater remedial action objectives.

Reduction of Toxicity, Mobility, or Volume

Treatment of contaminated groundwater by activated carbon adsorption will reduce the toxicity of the groundwater. Collection and treatment by activated carbon adsorption will have no effect on the volume of contamination, since the organics will be transferred from the groundwater to the GAC, but not destroyed. The collection but not the treatment of the contaminated groundwater reduces the mobility of the contaminants.

Implementability

GAC treatment columns or bed are typically skid-mounted units which are relatively simple to install and replace and are readily available through numerous manufacturers.

The reliability of the GAC columns or beds and associated system components have been proven at many prior installations.

Compliance with ARARs

This alternative complies with all action- and location-specific ARARs for treatment systems. This alternative complies with all chemical-specific ARARs. The proposed GAC treatment system is capable of meeting the Maryland surface water quality goals for organics that would be mandated in the NPDES permit.

Overall Protection of Human Health and the Environment

The operation of a groundwater pump and treat system utilizing GAC adsorption will reduce or eliminate the migration of contaminated groundwater on and off the facility, will reduce the toxicity of the groundwater and will meet the remedial action objectives for the site. Eliminating or reducing the migration of contaminated groundwater on and off the site will reduce the potential for human or environmental exposure, and thus will be protective of human health and the environment.

Cost

The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 603,000
Annual O&M Cost	$ 105,000
Present Worth	$ 1,263,000

Table 5-55 provides a detailed summary of the estimated costs to implement Groundwater Remediation Alternative 3 - Extraction Wells with Activated Carbon and Discharge to Surface Water. Backup information for all cost estimates is provided in Appendix A.

5.7.4 Comparative Analysis

In the following analysis, the alternatives are evaluated in relation to one another for each of the evaluation criteria. Overall protection of human health and the environment and compliance with ARARs will serve as threshold determinations in that they must be met by any alternative in order for it to be eligible for selection. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative.

TABLE 5-55
SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
GROUNDWATER REMEDIATION ALTERNATIVE 3
EXTRACTION WELLS WITH ACTIVATED CARBON TREATMENT
AND DISCHARGE TO SURFACE WATER

	CAPITAL	O & M
COLLECTION WITH EXTRACTION WELLS:		
MANHOLES FOR PUMPS & CONTROLS	$8,000	
WELL INSTALLATION & DEVELOPMENT	$38,000	
PIPING	$66,000	
PUMPS	$10,400	
TANK	$12,000	
POWER		$2,500
ACTIVATED CARBON TREATMENT:		
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$6,000	$1,500
ACTIVATED CARBON	$32,000	$2,300
LABOR FOR CHECK-UP OPERATIONS		$33,000
DISCHARGE TO SURFACE WATER:		
PUMPS	$10,000	
TANK	$35,000	
POWER		$3,000
PIPING	$5,000	
DISCHARGE MONITORING	$16,500	$5,000
ANALYTICAL		$36,400
SUBTOTAL	$274,000	$83,700
ALLOWANCES		
CONTINGENCY (25%)	$68,500	$20,900
INSTALLATION/CONSTRUCTION (50%)	$137,000	
ENGINEERING (25%)	$68,500	
ELECTRICAL (20%)	$54,800	
ECONOMIC ANALYSIS		
TOTALS	$603,000	$105,000
PRESENT WORTH OF O & M	**$660,000**	
TOTAL PRESENT WORTH	**$1,263,000**	

Notes
1 For present worth calculation; interest rate = 10%; inflation = 6%; and project life = 9 years
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

5.7.4.1 Soil Remediation Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health and the environment. Infiltration of rainwater to the buried wastes would continue to generate leachate and impact groundwater quality. Alternatives 2 through 6 are protective of human health and the environment. Leachate generation would be reduced or eliminated for all alternatives except for Alternative 1.

Compliance with ARARs

Alternative 1 does not comply with ARARs while Alternatives 2 through 6 comply with action- and chemical-specific ARARs.

Short-Term Impacts and Effectiveness

Although no additional exposure risks would occur for implementation of Alternative 1, Alternatives 2 through 6 would be more effective in the short term than Alternative 1. Short-term environmental impacts are the same for Alternatives 2 through 6 because they all require excavation which will remove the contaminants from the environment.

Long-Term Effectiveness and Permanence

Alternatives 2 through 6 will provide long-term effectiveness in achieving the remedial action objectives for the site soils while Alternative 1 would not meet these goals.

Reduction of Toxicity, Mobility, or Volume

Alternative 1 would not reduce the toxicity, mobility, or volume of the contaminated soils at site. Alternatives 2 through 6 will reduce the toxicity and mobility of contaminated soil because of treatment of the soil. The volume of contaminated soil will remain the same for Alternatives 2 through 6.

Implementability

Alternative 1 is implementable because continued sampling would be the only required future action. Alternatives 2 through 5 are highly implementable because of the availability of contractors who perform mobile on-site treatment of contaminated soil. Alternative 6 is implementable but the availability of local fixed treatment facilities is not as prevalent as those contractors who conduct on-site activities.

Cost

With regard to cost for those alternatives that quality for selection as the preferred alternative, Alternative 2 is the least expensive. Alternatives 2 and 4 which include on-site disposal of the treatment residuals are considerably more cost effective than Alternatives

3, 5, and 6 which include off-site disposal.

Summary

Because Alternative 1 is not protective of human health and the environment and does not comply with ARARs, it cannot be selected as the preferred alternative for the soils at the site. Alternative 2, Excavation with On-site Thermal Treatment and On-site Disposal, provides the best balance of tradeoffs with respect to the evaluation criteria, and is proposed as the preferred alternative. A summary of the results of the detailed evaluation for each of the six alternatives is shown below.

Criteria	Soil Alternatives					
	1	2	3	4	5	6
Overall Protection of Human Health and the Environment	-	+	+	+	+	+
Compliance with ARARs	-	+	+	+	+	+
Short-Term Effectiveness	-	0	0	0	0	0
Long-Term Effectiveness	-	+	+	+	+	+
Reduction of Toxicity, Mobility, or Volume	-	+	+	+	+	+
Implementability	+	+	+	+	+	0
Cost (Present Worth in millions)	$0.2	$0.2	$0.8	$0.4	$0.9	$1.1

Legend:
+ = positive
0 = neutral
- = negative

5.7.4.2 Buried Waste Disposal Remediation Alternatives

Off-site disposal of excavated buried waste materials is the only alternative evaluated for this media and, therefore, no comparative analysis will be provided. Implementation of this alternative will only occur if a soil/buried waste excavation alternative is selected.

5.7.4.3 Groundwater Remediation Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health and the environment. On- and off-site populations could potentially be exposed to contaminated groundwater and continued migration of contaminants in the groundwater would occur. Alternatives 2 and 3 are protective of human health and the environment due to collection and treatment of contaminated groundwater. However, Alternative 2 may require additional treatment to reduce nitroaromatic concentrations to acceptable levels. Risk through ingestion of and contact with contaminated groundwater are reduced to cancer risk levels less than 10^{-6} for Alternative 3.

Compliance with ARARs

Alternative 1 does not comply with ARARs while Alternative 3 complies with action- and chemical-specific ARARs for groundwater contamination collection and treatment. Alternative 2 may not comply with chemical-specific ARARs.

Short-Term Impacts and Effectiveness

Although no additional exposure risks would occur for implementation of Alternative 1, Alternatives 2 and 3 would be more effective in the short-term than Alternative 1. Short-term human health and environmental impacts are the same for Alternatives 2 and 3 because they both extract contaminated groundwater and treat it prior to discharge to surface water.

Long-Term Effectiveness and Permanence

Alternative 3 will provide long-term effectiveness in achieving the remedial action objectives for the site groundwater while Alternative 2 may not meet these goals without additional treatment. Alternative 1 will not meet the remedial action objectives.

Reduction of Toxicity, Mobility, or Volume

Alternative 1 would not reduce the toxicity, mobility, or volume of the contaminated groundwater at site. Alternatives 2 and 3 will reduce the toxicity, mobility and volume of contaminated groundwater. However, for Alternatives 2 and 3, contaminants will not be eliminated, just transferred to a different media (air and carbon scrubber for air stripper and activated carbon for GAC system).

Implementability

Alternative 1 is implementable because continued sampling would be the only required future action. Alternatives 2 and 3 are highly implementable because they are

commonly implemented remedial actions for groundwater and because of the availability of firms and materials in the local area.

Cost

With regard to cost for those alternatives that quality for selection as the preferred alternative, Alternative 3 is the least expensive.

Summary

Because Alternative 1 is not protective of human health and the environment and does not comply with ARARs, it cannot be selected as the preferred alternative for the soils at the site. Alternative 3, Extraction Wells with Activated Carbon Treatment and Discharge to Surface Water, provides the best balance of tradeoffs with respect to the evaluation criteria, and is proposed as the preferred alternative. A summary of the results of the detailed evaluation for each of the three alternatives is shown below.

Criteria	Groundwater Alternatives		
	1	2	3
Overall Protection of Human Health and the Environment	-	0	+
Compliance with ARARs	-	0	+
Short-Term Effectiveness	-	0	+
Long-Term Effectiveness	-	0	+
Reduction of Toxicity, Mobility, or Volume	-	+	+
Implementability	+	+	+
Cost (Present Worth in millions)	$0.2	$1.3	$1.3

Legend:
+ = positive
0 = neutral
- = negative

5.7.5 Summary of Preferred Alternatives

The following alternatives are proposed as the preferred alternatives to meet the remedial action objectives at Site 9:

- Excavation of Contaminated Soils and Buried Materials, On-site Thermal Treatment of soils, On-site Disposal of Treatment Residuals, and Off-site Disposal of Buried Materials

- Groundwater Extraction Wells with Activated Carbon Treatment and Discharge to Surface Water

Conceptual design criteria and drawings will be presented in Section 6.0 of this document.

5.8 SITE 11 - INDUSTRIAL WASTEWATER DISPOSAL AREA 100

5.8.1 Soil/Buried Material Remediation Alternatives

5.8.1.1 Alternative 1 - No Action

The no action alternative means that no remedial actions will be implemented to remove/control the contaminated soil and buried material in the leaching wells located at Site 11. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

With the no action alternative, no remedial construction takes place, and therefore, there is no potential for increased short-term risks to human health or the environment. The human health and environmental risks presented in Section 3.1.7 for the site will remain. Relying on natural biodegradation as the only means of contaminant reduction makes it unlikely that the no action alternative would be effective in achieving the remedial action objectives for the soil and waste material in the foreseeable future.

Long-Term Effectiveness and Permanence

The no action alternative would not be effective in preventing direct human contact with contaminated soils and materials in the leaching wells and provides no environmental protection.

Reduction of Toxicity, Mobility, or Volume

The no action alternative does not contribute to the reduction of toxicity, mobility, or volume of the contaminated soils in the leaching wells outside of the natural biodegradation which may occur.

Implementability

This alternative has already been implemented.

Compliance with ARARs

This alternative does not comply with the chemical-specific ARARs for soils outlined in Table 3-4.

Overall Protection of Human Health and the Environment

Human health and environmental risks associated with exposure to contaminated soils has not been reduced by the implementation of the no action alternative. The no action alternative does not meet any of the remedial action objectives for this site.

Cost

Costs for this alternative would be chiefly comprised of monitoring and soil analytical costs. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 11,000
Annual O&M Cost	$ 7,000
Present Worth	$ 88,000

Table 5-56 provides a detailed summary of the estimated costs to implement Soil Alternative 1 - No Action. Backup information for all cost estimates is provided in Appendix A.

5.8.1.2 Alternative 2 - Excavation with On-site Thermal Treatment/Disposal

Alternative 2 is excavation with on-site thermal treatment of excavated contaminated soil followed by on-site disposal of the treatment residuals. Excavated soil would be staged at the treatment unit prior to treatment. On-site thermal treatment includes the use of a mobile unit to thermally destruct the organics in the soil. This alternative involves placement of the treatment residuals back in the excavated areas. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during excavation, treatment and disposal of the contaminated soils and treatment residues. Treatment unit operator personnel could be exposed to contaminated dust during soil and treatment residue handling activities and airborne organics during thermal treatment operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and

TABLE 5-56
SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
SOIL REMEDIATION ALTERNATIVE 1
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$4,000
SUBTOTAL	$9,000	$5,500
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$1,400
ECONOMIC ANALYSIS		
TOTALS	$11,000	$7,000
PRESENT WORTH OF O & M	**$77,000**	
TOTAL PRESENT WORTH	**$88,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

equipment. The disposal of treatment residue on-site will not impact the general public during the disposal phase. Personnel could be exposed to contaminated dust during disposal activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Excavation would be effective in reducing direct human contact with contaminants in the soils. Reduction in organic concentration in the excavated soils could be expected to be as high as 90 to 99 percent. On-site disposal back into the excavated areas would be an effective method of treatment residue disposal. Human health exposure to treatment residue would be eliminated.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the excavated soil would be the result of thermal treatment of the soil. The volume of soil would not significantly change after thermal treatment, the amount of treatment residue would be virtually the same as the amount of soil incinerated. A reduction in mobility is not applicable to the treatment technologies. On-site disposal in conjunction with placement of a soil cover will effectively reduce the mobility of contaminants in the treatment residue. The presence of a soil cover and vegetation will reduce infiltration of organics remaining in the treatment residuals.

Implementability

This alternative is implementable due to the availability of excavation and mobile treatment equipment. However, approval of a thermal treatment permit may be somewhat difficult to obtain. The disposal of treatment residue in the excavated areas could be implemented with no substantial difficulties. Approval of on-site disposal (permit may be required) will be the most difficult implementation facet of this remedial action.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment of contaminated soil.

Overall Protection of Human Health and the Environment

Excavation with subsequent on-site thermal treatment of contaminated soil prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated soil. On-site thermal treatment meets the remedial action objective of treatment of excavated contaminated soil. Placement of the residuals in the excavated areas in conjunction with a soil cover is protective of the human health and the

environment in that it would reduce the potential for both direct human contact with the treatment residues and limits infiltration of precipitation. Thus, this alternative satisfies the remedial action objectives for removal of contaminated soils and disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 98,000
Annual O&M Cost	$ 0
Present Worth	$ 98,000

Table 5-57 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 2 - Soil Excavation with On-site Thermal Treatment/On-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.8.1.3 Alternative 3 - Excavation with On-site Thermal Treatment/Off-site Disposal

Alternative 3 is excavation with on-site thermal treatment of excavated contaminated soil followed by off-site disposal of the treatment residuals. Excavated soil would be staged at the treatment unit prior to treatment. On-site thermal treatment includes the use of a mobile unit to thermally destruct the organics in the soil. Excavated soil would be transported to the on-site treatment facility prior to treatment. This alternative involves placement of the treatment residuals in an off-site chemical waste landfill. A discussion of each of the evaluation criteria for this alternative follows. Excavation and treatment criteria evaluations were discussed in Section 5.8.1.2 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

The disposal of treatment residue in an off-site chemical waste landfill will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

TABLE 5-57
SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
SOIL REMEDIATION ALTERNATIVE 2
EXCAVATION WITH ON-SITE THERMAL TREATMENT
AND ON-SITE TREATMENT

	CAPITAL
EXCAVATION	$5,000
STAGING	$9,000
THERMAL TREATMENT	$45,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$6,800
GRADING	$5,100
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$4,400
SUBTOTAL	$78,000
ALLOWANCES	
CONTINGENCY (25%)	$20,000
TOTAL	$98,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

Long-Term Effectiveness and Permanence

Off-site disposal into a chemical waste landfill would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume

Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the treatment residue. The toxicity and volume of the organic contamination in the treatment residue will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

The disposal of treatment residue in a chemical waste landfill could be implemented with no substantial difficulties.

Compliance with ARARs

The placement of the treatment residues in a chemical waste landfill would comply with action-specific and chemical-specific ARARs.

Overall Protection of Human Health and the Environment

Placement of the residuals in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues in a chemical waste landfill offers more reliable, long-term protection since, when properly installed, these landfills will retain their integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 358,000
Annual O&M Cost	$ 0
Present Worth	$ 358,000

Table 5-58 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 3 - Soil Excavation with On-site Thermal Treatment/Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.8.1.4 Alternative 4 - Excavation with On-site Soil Washing/On-site Disposal

Soil remediation Alternative 4 is soil excavation with on-site soil washing of excavated contaminated soil followed by on-site disposal of treatment residuals. Excavated soil would be staged at the treatment unit prior to treatment. On-site soil washing includes the use of a mobile soil washing unit to physically remove the organics in the soil. This alternative involves placement of the treated residue into the excavated areas as backfill. A discussion of each of the evaluation criteria for this alternative follows. Excavation criteria evaluations were discussed in Section 5.8.1.2 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during treatment of the contaminated soil. Treatment unit operator personnel could be exposed to contaminated dust during soil and treatment residue handling activities and contaminated washing solutions during soil washing operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The disposal of treatment residue on-site will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust during handling and backfilling activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Reduction in organic concentration in the excavated soil could be expected to be as high as 90 to 99 percent. On-site disposal into the excavated areas would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the excavated soil would be the result of washing of the soil. The volume of soil would not change after washing; however, a significant quantity of contaminated solution (water, surfactants, etc.) would be generated. A reduction in mobility is not applicable to the treatment technologies. On-site disposal in conjunction with placement of a soil cover will effectively reduce the mobility of contaminants in the treatment residue. The presence of both the soil and vegetative cover

TABLE 5-58
SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
SOIL REMEDIATION ALTERNATIVE 3
EXCAVATION WITH ON-SITE THERMAL TREATMENT
AND OFF-SITE TREATMENT

	CAPITAL
EXCAVATION	$5,000
STAGING	$4,500
THERMAL TREATMENT	$45,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$6,800
LOADING & HAULING TO LANDFILL	$172,000
LANDFILL CHARGES	$45,000
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$4,400
SUBTOTAL	$286,000
ALLOWANCES	
CONTINGENCY (25%)	$72,000
TOTAL	$358,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.

2. Totals were rounded to the nearest thousands.

will reduce infiltration of organics remaining in the treatment residuals.

Implementability

This alternative is implementable due to the availability of mobile equipment. Approval of a treatment permit involving soil washing would be expected to be less difficult to obtain than a permit for the thermal destruction process. The disposal of treatment residue into the excavated areas could be implemented with no substantial difficulties. Approval of on-site disposal (permit may be required) will be the most difficult implementation facet of this remedial action.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment of contaminated soils.

Overall Protection of Human Health and the Environment

On-site soil washing of contaminated soil prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated soil. On-site soil washing meets the remedial action objective of treatment of excavated contaminated soil. Placement of the residuals in the excavated areas as fill in conjunction with installation of a soil cover is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 253,000
Annual O&M Cost	$ 0
Present Worth	$ 253,000

Table 5-59 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 4 - Soil Excavation with On-site Soil Washing/On-site Disposal. Backup information for all cost estimates is provided in Appendix A.

TABLE 5-59
SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
SOIL REMEDIATION ALTERNATIVE 4
EXCAVATION WITH ON-SITE SOIL WASHING
AND ON-SITE DISPOSAL

	CAPITAL
EXCAVATION	$5,000
STAGING	$9,000
SOIL WASHING	$169,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$6,800
GRADING	$5,100
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$4,400
SUBTOTAL	$202,000
ALLOWANCES	
CONTINGENCY (25%)	$51,000
TOTAL	$253,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

5.8.1.5 Alternative 5 - Excavation with On-site Soil Washing/Off-site Disposal

Soil remediation Alternative 5 is soil excavation with on-site soil washing of excavated contaminated soil followed by off-site disposal of treatment residuals. Excavated soil would be staged at the treatment unit prior to treatment. On-site soil washing includes the use of a mobile soil washing unit to physically remove the organics from the soil. This alternative involves placement of the treated residue in an off-site chemical waste landfill. A discussion of each of the evaluation criteria for this alternative follows. Excavation and treatment criteria evaluations were discussed in Sections 5.8.1.2 and 5.8.1.5 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

The disposal of treatment residue in an off-site chemical waste landfill will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Off-site disposal into a chemical waste landfill would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume

Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the treatment residue. The toxicity and volume of the contamination in the treatment residue will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

The disposal of treatment residue in a chemical waste landfill could be implemented with no substantial difficulties.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment and disposal of contaminated soils.

Overall Protection of Human Health and the Environment

Placement of the residuals in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues in a chemical waste landfill offers more reliable, long-term protection

TABLE 5-60
SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
SOIL REMEDIATION ALTERNATIVE 5
EXCAVATION WITH ON-SITE SOIL WASHING
AND OFF-SITE DISPOSAL

	CAPITAL
EXCAVATION	$5,000
STAGING	$4,500
SOIL WASHING	$169,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$6,800
LOADING & HAULING TO LANDFILL	$172,000
LANDFILL CHARGES	$45,000
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$4,400
SUBTOTAL	$410,000
ALLOWANCES	
CONTINGENCY (25%)	$103,000
TOTAL	$513,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

since, when properly installed, these landfills will retain their integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of equipment mobilization, excavation, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 513,000
Annual O&M Cost	$ 0
Present Worth	$ 513,000

Table 5-60 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 5 - Soil Excavation with On-site Soil Washing/Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.8.1.6 Alternative 6 - Excavation with Off-site Soil Washing/Off-site Disposal

Soil remediation Alternative 6 is soil excavation with off-site soil washing of excavated contaminated soil and off-site disposal. Off-site soil washing includes transport of excavated soil to an off-site permitted soil washing unit to physically remove the organics in the soil. This alternative involves placement of the treated residue in an off-site chemical waste landfill. Excavation criteria evaluations were discussed in Section 5.8.1.2 and will not be repeated in the following sections.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during treatment of the contaminated soil. Treatment unit operator personnel could be exposed to contaminated dust during soil and treatment residue handling activities and contaminated washing solutions during soil washing operations; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment. The disposal of treatment residue in an off-site chemical waste landfill will not impact the general public during the disposal phase. Disposal personnel could be exposed to contaminated dust; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Reduction in organic concentration in the excavated soil could be expected to be as high as 90 to 99 percent. Off-site disposal into a chemical waste landfill would be an effective method of treatment residue disposal.

Reduction of Toxicity, Mobility, or Volume

A significant reduction in the toxicity of the excavated soil would be the result of washing of the soil. The volume of soil would not change after washing; however, a significant quantity of organic-contaminated solution (water, surfactants, etc.) would be generated. A reduction in mobility is not applicable to the treatment technologies. Off-site disposal in a chemical waste landfill will effectively eliminate the mobility of contaminants in the treatment residue. The toxicity and volume of the contamination in the treatment residue will not be altered by the placement of the residuals in a chemical waste landfill.

Implementability

This alternative is implementable due to the availability of off-site treatment facilities. The disposal of treatment residue in a chemical waste landfill could be implemented with no substantial difficulties.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for treatment and disposal of contaminated soil.

Overall Protection of Human Health and the Environment

Off-site soil washing of contaminated soil prior to land disposal greatly reduces the potential human health and environmental risks associated with exposure to contaminated soil. Off-site soil washing meets the remedial action objective of treatment of excavated contaminated soil. Placement of the residuals in a chemical waste landfill is protective of the human health and the environment in that it would reduce the potential for both direct human contact with the treatment residues and limit infiltration of precipitation. In addition, placement of residues in a chemical waste landfill offers more reliable, long-term protection since, when properly installed, these landfills will retain their integrity for more than 30 years. Thus, this alternative satisfies the remedial action objectives for disposal of treatment residuals.

Cost

Costs for this alternative would be chiefly comprised of soil excavation, transport, treatment and disposal activities. The Capital, Annual O&M, and Present Worth costs for

this alternative are as follows:

Capital Cost	$ 551,000
Annual O&M Cost	$ 0
Present Worth	$ 551,000

Table 5-61 provides a detailed summary of the estimated costs to implement Soil Remediation Alternative 6 - Soil Excavation with Off-site Soil Washing/Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.8.2 Buried Material Remediation Alternative

Off-site Disposal

This alternative involves the disposal of an estimated 50 cubic yards of buried material in an off-site landfill and will be implemented provided that a soil/buried material excavation alternative is also selected. Decontamination of the materials with collection of wash water and any free product may be required prior to disposal. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There are no impacts to the general public during disposal of the buried materials. The disposal of the buried materials off-site will not impact the general public during the disposal phase. Personnel could be exposed to contaminated material or free product during handling and disposal activities; however, these exposure risks are easily addressed through the use of appropriate health and safety procedures and equipment.

Long-Term Effectiveness and Permanence

Off-site disposal would be an effective method of buried material disposal. Human health exposure to buried materials would be eliminated.

Reduction of Toxicity, Mobility, or Volume

Off-site disposal will reduce the toxicity, mobility and volume of wastes at the site. However, decontamination of the materials may be required prior to disposal which would generate potential additional waste streams (i.e., free product, contaminated decontamination water).

TABLE 5-61
SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
SOIL REMEDIATION ALTERNATIVE 6
EXCAVATION WITH OFF-SITE SOIL WASHING AND OFF-SITE DISPOSAL

	CAPITAL
EXCAVATION	$5,000
LOADING & HAULING TO TREATMENT SITE	$104,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$6,800
SOIL WASHING	$101,000
LOADING & HAULING TO LANDFILL	$172,000
LANDFILL CHARGES	$45,000
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$4,400
SUBTOTAL	$441,000
ALLOWANCES	
CONTINGENCY (25%)	$110,000
TOTAL	$551,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

Implementability

The disposal of buried materials in an off-site landfill could be implemented with no substantial difficulties.

Compliance with ARARs

This alternative does comply with the chemical- and action-specific ARARs for disposal of hazardous and solid wastes.

Overall Protection of Human Health and the Environment

Land disposal in an approved chemical waste landfill greatly reduces the potential human health and environmental risks associated with exposure to buried material. Thus, this alternative satisfies the remedial action objectives for proper disposal of buried materials.

Cost

Costs for this alternative would be chiefly comprised of disposal activities. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 33,000
Annual O&M Cost	$ 0
Present Worth	$ 33,000

Table 5-62 provides a detailed summary of the estimated costs to implement Buried Material Disposal Alternative - Off-site Disposal. Backup information for all cost estimates is provided in Appendix A.

5.8.3 Groundwater Remediation Alternatives

5.8.3.1 Alternative 1 - No Action

The no action alternative means that no remedial actions will be implemented to remove or treat the groundwater. Only the natural biodegradation of organic contaminants by indigenous microorganisms would occur. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

With the no action alternative, no remedial construction takes place; therefore, there is no potential for increased short-term risks to human health or the environment. The human health and environmental risks discussed in Section 3.1.7 will remain. Relying on

TABLE 5-62
SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
BURIED WASTE DISPOSAL ALTERNATIVE
OFF-SITE LANDFILL

	CAPITAL
LOADING & HAULING TO LANDFILL	$19,000
LANDFILL	$7,500
SUBTOTAL	$26,500
ALLOWANCES	
CONTINGENCY (25%)	$6,600
TOTAL	$33,000

natural biodegradation as the only means of contaminant reduction makes it unlikely that the no action alternative would be effective in achieving the remedial action objectives for the groundwater.

Long-Term Effectiveness and Permanence

Even if the source of groundwater contamination is removed (excavating the leaching wells), contaminated groundwater would continue to migrate on-site for some period of time with the possibility of migrating on- and off-site towards some receptor (drinking water wells). It is difficult to predict if or when contaminants in the groundwater would be reduced to groundwater standards, through either natural biodegradation or groundwater mixing. Thus, the no action alternative is not effective in achieving the remedial action objectives for the site.

Reduction of Toxicity, Mobility, or Volume

The no action alternative will not reduce the mobility or volume of contaminated groundwater. Toxicity could be reduced somewhat, over time, by natural biodegradation processes.

Implementability

The no action alternative requires no implementation.

Compliance with ARARs

Action-specific ARARs do not apply to the no action alternative. This alternative would not comply with the chemical-specific ARARs.

The no action alternative would comply with location-specific ARARs.

Overall Protection of Human Health and the Environment

The no action alternative will not be protective of human health and the environment because this alternative allows groundwater to freely migrate off-site. Thus, the no action alternative does not meet the remedial action objectives for groundwater.

Cost

Capital costs would include the development of a detailed sampling and analytical plan. Annual O&M costs will include groundwater sampling and analysis of groundwater samples. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 11,000
Annual O&M Cost	$ 6,000
Present Worth	$ 77,000

Table 5-63 provides a detailed summary of the estimated costs to implement Groundwater Remediation Alternative 1 - No Action. Backup information for all cost estimates is provided in Appendix A.

5.8.3.2 Alternative 2 - Extraction Wells with Air Stripping and Discharge to Surface Water

Extraction wells are a viable means of withdrawing groundwater to restrict on-site and potential off-site migration of contaminated groundwater. This alternative involves the collection of contaminated groundwater with extraction wells, ex-situ treatment using a shallow tray air stripper and discharge of treated groundwater to surface water. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness

There is potential for increased short-term risks to human health due to the drilling of extraction wells, handling and disposal of contaminated subsurface soils and groundwater. Site workers would be subject to increased chemical exposure risks during related to installation of utilities and the treatment system foundation due to volatilization of volatile organics from the overburden soils. These risks may be properly managed through the appropriate use of personal protective equipment, site monitoring and/or control measures, if required. Site workers would not be subject to increased chemical exposure risks during related to installation of the piping system for the discharge. The community surrounding the NSWCWODET facility will not be impacted by implementation of this alternative. There are no expected impacts to the environment associated with implementation of this alternative.

Long-Term Effectiveness and Permanence

This alternative would be effective in the long-term remediation of volatile organic contamination. Extraction wells would restrict on- and potential off-site migration of contaminants in the overburden and shallow saprolite units. Groundwater collection would reduce the risks of on- and off-site exposure to contamination through ingestion or dermal contact with groundwater from potential drinking water or irrigation wells.

TABLE 5-63
SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
GROUNDWATER REMEDIATION ALTERNATIVE 1
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$3,200
SUBTOTAL	$9,000	$4,700
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$1,200
ECONOMIC ANALYSIS		
TOTALS	$11,000	$6,000
PRESENT WORTH OF O & M	**$66,000**	
TOTAL PRESENT WORTH	**$77,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

To assure long-term reliability, regularly scheduled maintenance will be performed on the components of the air stripping and discharge system. The trays of the shallow tray air stripper will be cleaned on a monthly basis with a pressure washer to remove accumulated scale. Duplex feed and discharge pumps have been specified for the air stripping system to extend pump life and to provide continuous treatment should one pump fail.

Provided that the groundwater source is removed (excavating the leaching wells), air stripping may provide a permanent reduction in the concentration of volatile organics in the groundwater once the cleanup goals have been achieved. Thus, the alternative does provide a long-term effectiveness in achieving the groundwater remedial action objectives.

Reduction of Toxicity, Mobility, or Volume

The extraction well alternative will significantly reduce the mobility of contaminants in the groundwater at the site. Collection with subsequent treatment will reduce the toxicity of the contaminants in the groundwater. Collection and treatment by air stripping will have no effect on the volume of contamination, since the volatile organics will be transferred from the groundwater to the air, but not destroyed. The collection but not the treatment of the contaminated groundwater reduces the mobility of the contaminants.

Implementability

This alternative would be highly implementable. This technology is technically feasible, administratively feasible and reliable. All required services and materials are readily available. All air stripping system components are readily available from their respective manufacturers. The reliability of the shallow tray air stripper and associated system components have been proven at many prior installations. Implementation of this alternative will require a NPDES permit from the MDE to discharge treated water to the stream.

Compliance with ARARs

This alternative complies with all action- and location-specific ARARs for treatment systems. This alternative complies with all chemical-specific ARARs. The proposed air stripping system is capable of meeting the Maryland surface water quality goals for organics that would be mandated in the NPDES permit.

Overall Protection of Human Health and the Environment

The well extraction system would serve to restrict further groundwater contamination migration in both the overburden and shallow bedrock fractures and would effectively capture a significant volume of contaminated groundwater. This would reduce the

probability that surface water bodies, residential or on-site wells, and regional water supplies could be impacted by site contaminants. During the installation of the extraction wells, the potential exists for exposure of workers to site contaminants via direct contact or inhalation. Therefore, this alternative will require the implementation of health and safety measures during the remedial construction activities.

The operation of a groundwater pump and treat system utilizing air stripping will reduce or eliminate the migration of contaminated groundwater on and off the facility, will reduce the toxicity of the volatile organics in the groundwater and will meet the remedial action objectives for the site. Eliminating or reducing the migration of contaminated groundwater on and off the site will reduce the potential for human or environmental exposure, and thus will be protective of human health and the environment.

Cost

Capital costs would include the installation of a well extraction, air stripping and discharge system, and development of a detailed sampling and analysis plan. The Capital, Annual O&M, and Present Worth costs for this alternative are as follows:

Capital Cost	$ 871,000
Annual O&M Cost	$ 77,000
Present Worth	$ 1,234,000

Table 5-64 provides a detailed summary of the estimated costs to implement Groundwater Remediation Alternative 2 - Extraction wells with Air Stripper and Discharge to Surface Water. Backup information for all cost estimates is provided in Appendix A.

5.8.3.3 Alternative 3 - Extraction wells with Activated Carbon and Discharge to Surface Water

This alternative involves the collection of contaminated groundwater with extraction wells, ex-situ treatment using a GAC system such as a column or bed with subsequent discharge of treated groundwater to the stream that flows adjacent to the landfill. Criteria evaluations for the extraction wells and surface water discharge were discussed in Section 5.8.3.2 for Groundwater Remediation Alternative 2 and will not be repeated in the following sections. A discussion of each of the evaluation criteria for this alternative follows.

TABLE 5-64
SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
GROUNDWATER REMEDIATION ALTERNATIVE 2
EXTRACTION WELLS WITH AIR STRIPPING AND
DISCHARGE TO SURFACE WATER

	CAPITAL	O & M
COLLECTION WITH EXTRACTION WELLS:		
MANHOLES FOR PUMPS & CONTROLS	$8,000	
WELL INSTALLATION & DEVELOPMENT	$56,000	
PIPING	$82,500	
PUMPS	$13,500	
TANK	$20,000	
POWER		$3,000
AIR STRIPPING TREATMENT:		
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$17,500	$2,300
AIR STRIPPER	$60,000	$3,000
SCRUBBER	$28,000	$1,800
LABOR FOR CHECK – UP OPERATIONS		$33,000
DISCHARGE TO SURFACE WATER:		
PUMPS	$10,000	
TANK	$35,000	
POWER		$3,000
PIPING	$20,000	
DISCHARGE MONITORING	$10,000	$5,000
ANALYTICAL		$10,400
SUBTOTAL	$396,000	$61,500
ALLOWANCES		
CONTINGENCY (25%)	$99,000	$15,400
INSTALLATION/CONSTRUCTION (50%)	$198,000	
ENGINEERING (25%)	$99,000	
ELECTRICAL (20%)	$79,200	
ECONOMIC ANALYSIS		
TOTALS	$871,000	$77,000
PRESENT WORTH OF O & M	**$363,000**	
TOTAL PRESENT WORTH	**$1,234,000**	

Notes

1 For present worth calculation; interest rate = 10%; inflation = 6%; and project life = 6 years

2. Contingencies were applied to both capital cost and O & M costs.

3. Totals were rounded to the nearest thousands.

Short-Term Impacts and Effectiveness

Site workers would be subject to increased chemical exposure risks during related to installation of utilities and the treatment system foundation due to volatilization of volatile organics from the overburden soils. These risks may be properly managed through the appropriate use of personal protective equipment, site monitoring and/or control measures, if required. Implementation of this alternative, with provision of appropriate worker health and community safety measures, is not expected to significantly impact public health or the environment immediately adjacent to the site. This alternative would become effective immediately upon start-up of the collection and treatment system.

Long-Term Effectiveness and Permanence

To assure long-term reliability, regularly scheduled maintenance will be performed on the components of the GAC treatment system. The GAC will be checked on a monthly basis to determine if the carbon needs replacement with fresh carbon. A pre-filtration unit will be checked on a monthly basis also to ensure that no clogging of the system has occurred. Duplex feed and discharge pumps have been specified for the GAC system to extend pump life and to provide continuous treatment should one pump fail.

Provided that the groundwater source is controlled or removed (excavating the leaching wells), activated carbon will provide a permanent reduction in the concentration of organics in the groundwater once the cleanup goals have been achieved. At that point, groundwater treatment may cease. Thus, the alternative provides a long-term effectiveness in achieving the groundwater remedial action objectives.

Reduction of Toxicity, Mobility, or Volume

Treatment of contaminated groundwater by activated carbon adsorption will reduce the toxicity of the groundwater. Collection and treatment by activated carbon adsorption will have no effect on the volume of contamination, since the organics will be transferred from the groundwater to the GAC, but not destroyed. The collection but not the treatment of the contaminated groundwater reduces the mobility of the contaminants.

Implementability

GAC treatment columns or bed are typically skid-mounted units which are relatively simple to install and replace and are readily available through numerous manufacturers. The reliability of the GAC columns or beds and associated system components have been proven at many prior installations.

Compliance with ARARs

This alternative complies with all action- and location-specific ARARs for treatment systems. This alternative complies with all chemical-specific ARARs. The proposed GAC treatment system is capable of meeting the Maryland surface water quality goals for organics that would be mandated in the NPDES permit.

Overall Protection of Human Health and the Environment

The operation of a groundwater pump and treat system utilizing GAC adsorption will reduce or eliminate the migration of contaminated groundwater on and off the facility, will reduce the toxicity of the groundwater and will meet the remedial action objectives for the site. Eliminating or reducing the migration of contaminated groundwater on and off the site will reduce the potential for human or environmental exposure, and thus will be protective of human health and the environment.

Cost

The Capital, Annual O&M and Present Worth costs for this alternative are as follows:

Capital Cost	$ 799,000
Annual O&M Cost	$ 75,000
Present Worth	$ 1,152,000

Table 5-65 provides a detailed summary of the estimated costs to implement Groundwater Remediation Alternative 3 - Extraction Wells with Activated Carbon and Discharge to Surface Water. Backup information for all cost estimates is provided in Appendix A.

5.8.4 Comparative Analysis

In the following analysis, the alternatives are evaluated in relation to one another for each of the evaluation criteria. Overall protection of human health and the environment and compliance with ARARs will serve as threshold determinations in that they must be met by any alternative in order for it to be eligible for selection. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative.

TABLE 5-65
SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
GROUNDWATER REMEDIATION ALTERNATIVE 3
EXTRACTION WELLS WITH ACTIVATED CARBON TREATMENT
AND DISCHARGE TO SURFACE WATER

	CAPITAL	O & M
COLLECTION WITH EXTRACTION WELLS:		
MANHOLES FOR PUMPS & CONTROLS	$8,000	
WELL INSTALLATION & DEVELOPMENT	$56,000	
PIPING	$82,500	
PUMPS	$13,500	
TANK	$20,000	
POWER		$3,000
ACTIVATED CARBON TREATMENT:		
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$17,500	$2,300
ACTIVATED CARBON	$55,000	$3,100
LABOR FOR CHECK-UP OPERATIONS		$33,000
DISCHARGE TO SURFACE WATER:		
PUMPS	$10,000	
TANK	$35,000	
POWER		$3,000
PIPING	$20,000	
DISCHARGE MONITORING	$10,000	$5,000
ANALYTICAL		$10,400
SUBTOTAL	$363,000	$59,800
ALLOWANCES		
CONTINGENCY (25%)	$90,750	$15,000
INSTALLATION/CONSTRUCTION (50%)	$181,500	
ENGINEERING (25%)	$90,750	
ELECTRICAL (20%)	$72,600	
ECONOMIC ANALYSIS		
TOTALS	$799,000	$75,000
PRESENT WORTH OF O & M	**$353,000**	
TOTAL PRESENT WORTH	**$1,152,000**	

Notes
1 For present worth calculation; interest rate = 10%; inflation = 6%; and project life = 9 years
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

5.8.4.1 Soil Remediation Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health and the environment. Infiltration of rainwater to the buried wastes would continue to generate leachate and impact groundwater quality. Alternatives 2 through 6 are protective of human health and the environment. Leachate generation would be reduced or eliminated for all alternatives except for Alternative 1.

Compliance with ARARs

Alternative 1 does not comply with ARARs while Alternatives 2 through 6 comply with action- and chemical-specific ARARs.

Short-Term Impacts and Effectiveness

Although no additional exposure risks would occur for implementation of Alternative 1, Alternatives 2 through 6 would be more effective in the short term than Alternative 1. Short-term environmental impacts are the same for Alternatives 2 through 6 because they all require excavation which will remove the contaminants from the environment.

Long-Term Effectiveness and Permanence

Alternatives 2 through 6 will provide long-term effectiveness in achieving the remedial action objectives for the site soils while Alternative 1 would not meet these goals.

Reduction of Toxicity, Mobility, or Volume

Alternative 1 would not reduce the toxicity, mobility, or volume of the contaminated soils at site. Alternatives 2 through 6 will reduce the toxicity and mobility of contaminated soil because of treatment of the soil. The volume of contaminated soil will remain the same for Alternatives 2 through 6.

Implementability

Alternative 1 is implementable because continued sampling would be the only required future action. Alternatives 2, 3, 4, and 5 are highly implementable because of the availability of contractors who perform mobile on-site treatment of contaminated soil. Alternative 6 is implementable but the availability of local fixed treatment facilities is not as prevalent as those contractors who conduct on-site activities.

Cost

With regard to cost for those alternatives that quality for selection as the preferred alternative, Alternative 2 is the least expensive. Alternatives 2 and 4 which include on-site disposal of the treatment residuals are considerably more cost effective than Alternatives

3, 5, and 6 which include off-site disposal.

Summary

Because Alternative 1 is not protective of human health and the environment and does not comply with ARARs, it cannot be selected as the preferred alternative for the soils at the site. Alternative 2, Excavation with On-site Thermal Treatment and On-site Disposal, provides the best balance of tradeoffs with respect to the evaluation criteria, and is proposed as the preferred alternative. A summary of the results of the detailed evaluation for each of the six alternatives is shown below.

Criteria	Soil Alternatives					
	1	2	3	4	5	6
Overall Protection of Human Health and the Environment	-	+	+	+	+	+
Compliance with ARARs	-	+	+	+	+	+
Short-Term Effectiveness	-	0	0	0	0	0
Long-Term Effectiveness	-	+	+	+	+	+
Reduction of Toxicity, Mobility, or Volume	-	+	+	+	+	+
Implementability	+	+	+	+	+	0
Cost (Present Worth in thousands)	$88	$98	$358	$253	$513	$551

Legend:
+ = positive
0 = neutral
- = negative

5.8.4.2 Buried Waste Disposal Remediation Alternatives

Off-site disposal of excavated buried waste materials is the only alternative evaluated for this media, and therefore, no comparative analysis will be provided. Implementation of this alternative will only occur if a soil/buried waste excavation alternative is selected.

5.8.4.3 Groundwater Remediation Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 is not protective of human health and the environment. On- and off-site populations could potentially be exposed to contaminated groundwater and continued migration of contaminants in the groundwater would occur. Alternatives 2 and 3 are protective of human health and the environment due to collection and treatment of contaminated groundwater. Risk through ingestion of and contact with contaminated groundwater are reduced to cancer risk levels less than 10^{-6} for Alternatives 2 and 3.

Compliance with ARARs

Alternative 1 does not comply with ARARs while Alternatives 2 and 3 complies with action- and chemical-specific ARARs for groundwater contamination collection and treatment.

Short-Term Impacts and Effectiveness

Although no additional exposure risks would occur for implementation of Alternative 1, Alternatives 2 and 3 would be more effective in the short term than Alternative 1. Short-term human health and environmental impacts are the same for Alternatives 2 and 3 because they both extract contaminated groundwater and treat it prior to discharge to surface water.

Long-Term Effectiveness and Permanence

Alternatives 2 and 3 will provide long-term effectiveness in achieving the remedial action objectives for the site groundwater. Alternative 1 will not meet the remedial action objectives.

Reduction of Toxicity, Mobility, or Volume

Alternative 1 would not reduce the toxicity, mobility, or volume of the contaminated groundwater at site. Alternatives 2 and 3 will reduce the toxicity, mobility, and volume of contaminated groundwater. However, for Alternatives 2 and 3, contaminants will not be eliminated, just transferred to a different media (air and carbon scrubber for air stripper and activated carbon for GAC system).

Implementability

Alternative 1 is implementable because continued sampling would be the only required future action. Alternatives 2 and 3 are highly implementable because they are commonly implemented remedial actions for groundwater and because of the availability of firms and materials in the local area.

Cost

With regard to cost for those alternatives that quality for selection as the preferred alternative, Alternative 3 is the least expensive.

Summary

Because Alternative 1 is not protective of human health and the environment and does not comply with ARARs, it cannot be selected as the preferred alternative for the soils at the site. Alternative 3, Extraction Wells with Activated Carbon Treatment and Discharge to Surface Water, provides the best balance of tradeoffs with respect to the evaluation criteria, and is proposed as the preferred alternative. A summary of the results of the detailed evaluation for each of the three alternatives is shown below.

Criteria	Groundwater Alternatives		
	1	2	3
Overall Protection of Human Health and the Environment	-	+	+
Compliance with ARARs	-	+	+
Short-Term Effectiveness	-	+	+
Long-Term Effectiveness	-	+	+
Reduction of Toxicity, Mobility, or Volume	-	+	+
Implementability	+	+	+
Cost (Present Worth in thousands)	$77	$1,234	$1,152

Legend:
+ = positive
0 = neutral
- = negative

5.8.5 Summary of Preferred Alternatives

The following alternatives are proposed as the preferred alternatives to meet the remedial action objectives at Site 11:

- Excavation of Contaminated Soils and Buried Materials, On-site Thermal Treatment of soils, On-site Disposal of Treatment Residuals, and Off-site Disposal of Buried Materials

- Groundwater Extraction Wells with Activated Carbon Treatment and Discharge to Surface Water

Conceptual design criteria and drawings will be presented in Section 6.0 of this document.

6.0 DESCRIPTION OF PREFERRED ALTERNATIVES

6.1 SUMMARY OF PREFERRED ALTERNATIVES

Based on the results of the engineering analysis presented in Sections 4.0 and 5.0, the proposed preferred alternatives for each media requiring remedial action, at each of the seven sites, is presented in Table 6-1.

6.2 DESCRIPTION OF PREFERRED ALTERNATIVES

A site-specific description of each alternative with conceptual design criteria, drawings, and costs is provided in the following subsections.

6.2.1 Site 2 - Apple Orchard Landfill

6.2.1.1 Conceptual Design

The proposed preferred alternatives for Site 2 consist of:

- Excavation of Polychlorinated Biphenyl (PCB)-contaminated sediment in the stream on the west end of the landfill from the property boundary to the confluence of the stream and the process water ditch. Figure 6-1 provides the location of the sediment to be excavated. Sediment will be thermally treated on-site, and treatment residuals placed on the landfill surface prior to installation of the cap. Figure 6-2 provides a schematic of a typical thermal treatment process. Because of the varying designs of each commercially available thermal treatment unit, detailed design criteria and specifications will be obtained from the vendor prior to use.

- Installation of a synthetic/soil cap over the entire surface and face of the landfill. Figure 6-3 provides a cross-section of the landfill cap design. The landfill will be regraded so that a synthetic liner can be installed over the face and surface of the landfill. Figure 6-1 provides the area designated to be capped.

<u>Sediment</u>

The majority of the remedial work will include heavy equipment operations. A backhoe will excavate the contaminated sediment and place it in a dump truck. It is estimated that 167 cubic yards (5-foot wide, 3 foot-deep, and 300-foot long section of the

TABLE 6-1

SUMMARY OF PREFERRED ALTERNATIVES

SITE	MEDIA	PREFERRED ALTERNATIVE
Site 2 - Apple Orchard Landfill	Surface Soils/ Buried Materials	Synthetic/Soil Cap over landfill and soils
	Sediment	Excavation of PCB-contaminated sediment, on-site thermal treatment and on-site disposal of treatment residuals
Site 3 - Pistol Range Landfill	Surface Soils/ Buried Materials	Synthetic/Soil Cap over landfill and soils
	Groundwater	Extraction wells with an activated carbon treatment system and discharge to surface water
Site 4 - Chemical Burial Site	Subsurface Soils/ Buried Materials	Excavation with on-site thermal treatment of soils, disposal of treatment residuals on- and off-site disposal of buried waste materials
	Groundwater	Extraction wells with an activated carbon treatment system and discharge to surface water
Site 7 - Ordnance Burn Area	Subsurface Soils	Limited excavation with on-site soil washing/on-site disposal and in-situ soil flushing
	Groundwater	Extraction wells with an activated carbon treatment system and discharge to surface water
Site 8 - Abandoned Chemical Disposal Pit	Surface Soils/ Buried Materials	Excavation with on-site thermal treatment, disposal of treatment residuals on- and off-site disposal of buried waste materials
	Groundwater	Extraction wells with an activated carbon treatment and discharge to surface water
Site 9 - Industrial Wastewater Disposal Area 300	Subsurface Soils/ Buried Materials	Excavation with on-site thermal treatment, disposal of treatment residuals on- and off-site disposal of buried waste materials
	Groundwater	Extraction wells with an activated carbon treatment and discharge to surface water
Site 11 - Industrial Wastewater Disposal Area 100	Subsurface Soils/ Buried Materials	Excavation with on-site thermal treatment, disposal of treatment residuals on- and off-site disposal of buried waste materials
	Groundwater	Extraction wells with an activated carbon treatment system and discharge to surface water

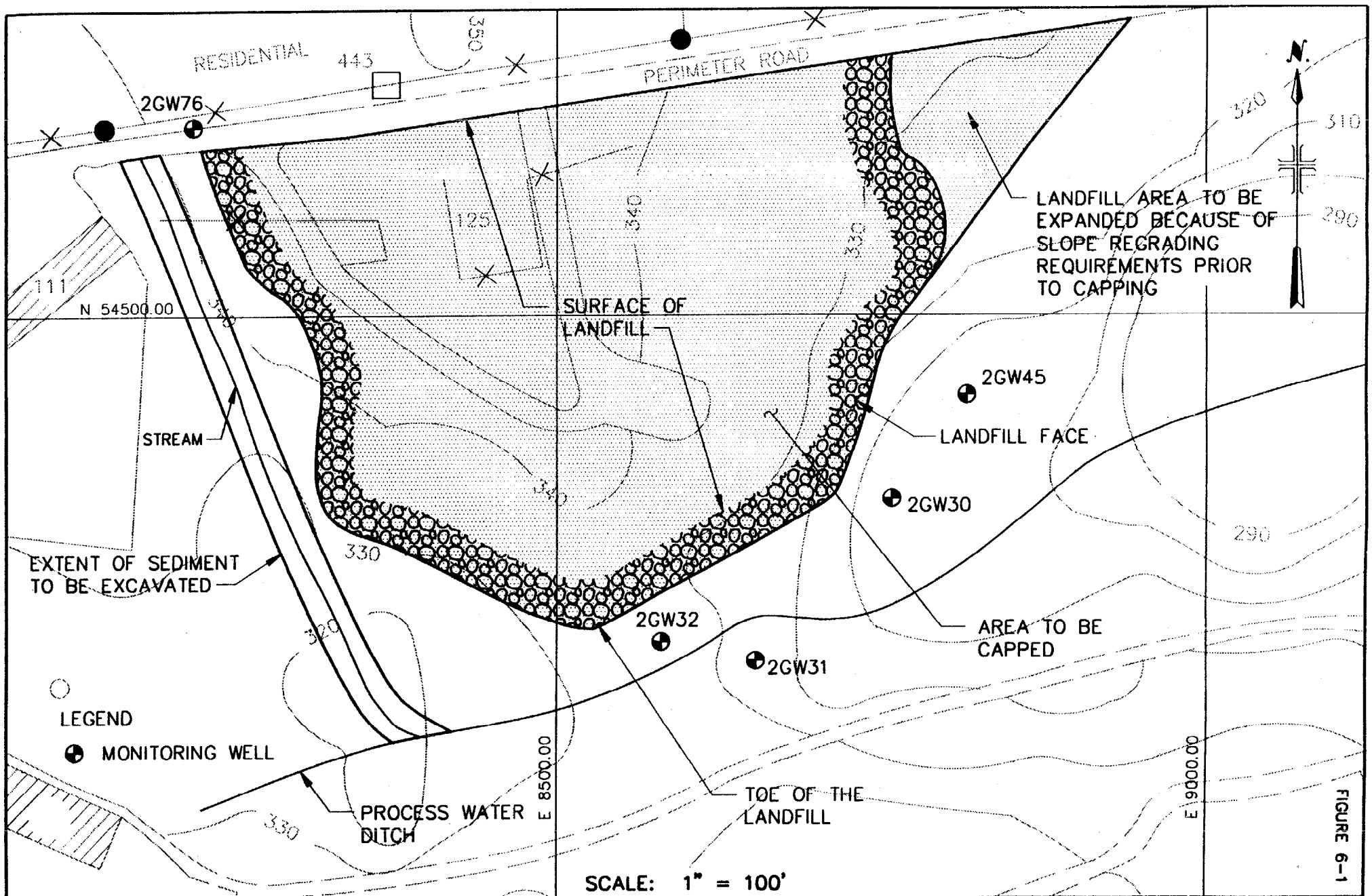


FIGURE 6-1

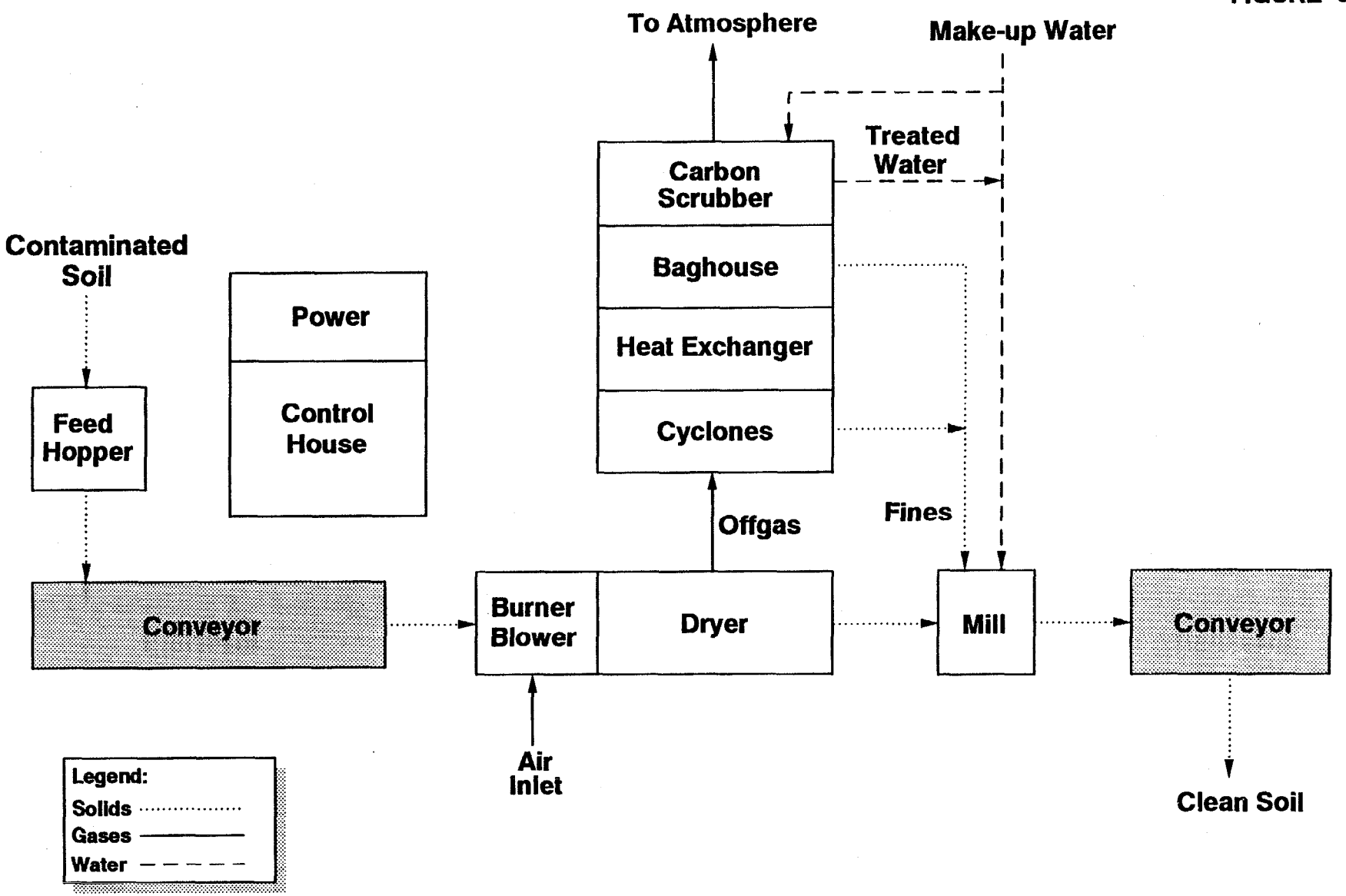
MALCOLM PIRNIE

WHITE OAK, MARYLAND
FEASIBILITY STUDY
SITE 2 – AREAS DESIGNATED FOR CAPPING/EXCAVATION

MALCOLM PIRNIE, INC.

OCTOBER 1993

FIGURE 6-2



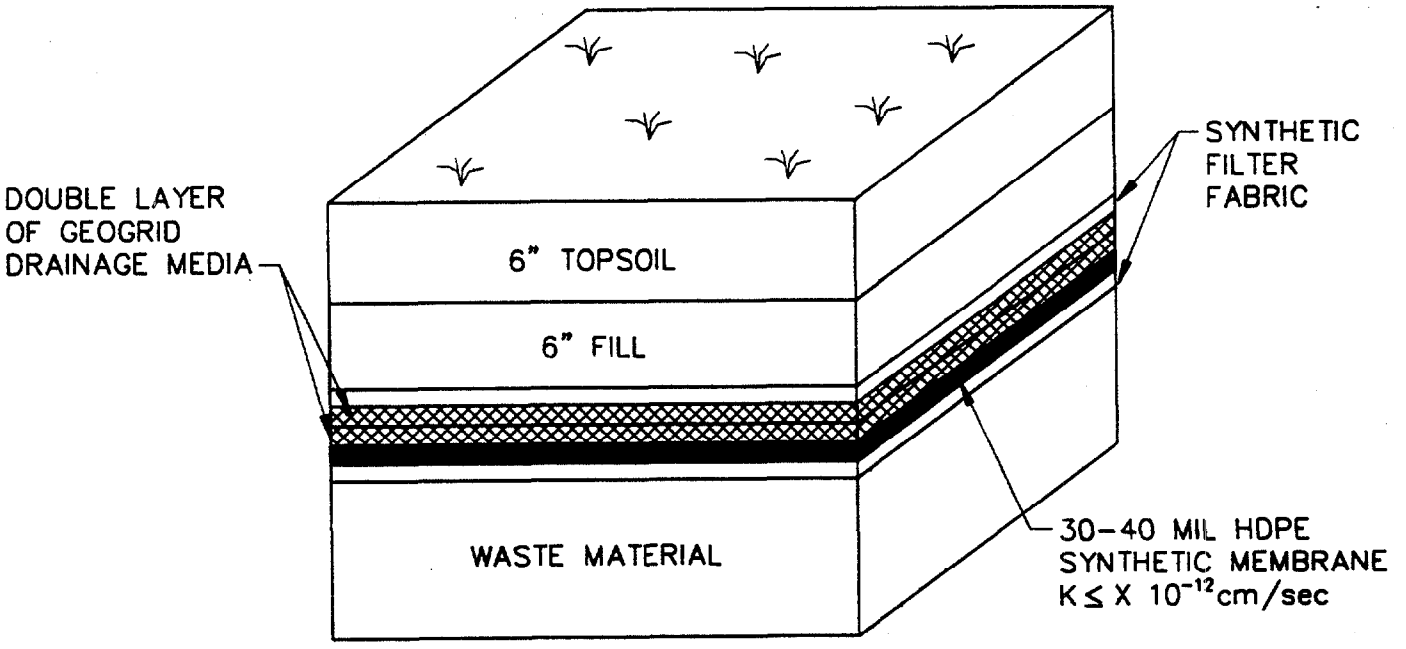
MALCOLM PIRNIE

WHITE OAK, MARYLAND
FEASIBILITY STUDY
THERMAL TREATMENT PROCESS SCHEMATIC

MALCOLM PIRNIE, INC.

OCTOBER 1993

FIGURE 6-3



NOTE:
THIS DESIGN TO BE
USED FOR THE CAPS
FOR SITES 2 AND 3.

NOT TO SCALE

MALCOLM PIRNIE	WHITE OAK, MARYLAND FEASIBILITY STUDY SYNTHETIC/SOIL COVER SYSTEM	MALCOLM PIRNIE, INC. OCTOBER 1993

5830 : 09310481001\: \ACAD\PROJ\09310\31\FIG6-3 SCALE: 1:1 10/21, 1993 at 10:45

stream) of PCB-contaminated sediment will be excavated. Sediment will be removed until remaining PCB concentrations are less than the 19 mg/kg action level. Clean soils may be required to replace excavated sediment in the stream adjacent to the landfill. A road will be established for the dump truck starting from the perimeter road, and working down along the west side of the landfill near the stream bed. The dump truck will transport the sediment to the location of the thermal treatment unit, unload its contents in a staging area, and return to the stream to receive more contaminated sediment.

A mobile thermal treatment unit will be positioned near the site to treat the excavated PCB-contaminated sediment. Sediment will be staged in the area of the treatment unit, and then fed into the unit for removal of PCBs. The PCB concentration will be determined in the treatment residuals to determine the disposition. If the concentrations are less than 2 mg/kg, then the residuals will be placed on the landfill prior to capping. If the concentrations are greater than 2 mg/kg, the residuals will be run back through the treatment unit for further thermal destruction of PCBs.

Sediment excavation, treatment and on site disposal should take approximately 1 month to complete for Site 2.

Surface Soils/Landfill

It is estimated that a 67,000 square foot area will be capped as part of the remedial activities. The landfill will be covered with a synthetic/soil cap to prevent migration of PCB-contaminated soils through surface runoff, and prevent leachate generation which could impact groundwater quality. Site preparation activities include clearing of trees and brush and regrading of the landfill surface and face to allow for a synthetic liner to be installed. Also, approximately 167 cubic yards of residuals from the thermal treatment unit will be placed on the landfill surface prior to installation of the cap.

Capping activities for the Site 2 landfill should take approximately 2 months to complete.

6.2.1.2 Costs

The estimated capital and Operation and Maintenance (O&M) (present worth) costs for design and implementation of the proposed preferred alternatives is $600,000. The costs on a media-specific basis are summarized in Table 6-2. These costs represent engineering, construction, and disposal expenses required in implementing all phases of the preferred alternatives.

TABLE 6-2

SITE 2 PREFERRED ALTERNATIVES - COST ESTIMATE

PREFERRED ALTERNATIVE	ALTERNATIVE COMPONENTS	COST ESTIMATE
Surface Soils/Landfill		
Synthetic/Soil Cap	Placement of a Synthetic/Soil Cap O&M Costs (Present Worth)	$ 506,000 51,000
	Subtotal	**$ 557,000**
Sediment		
Sediment excavation, on-site thermal treatment and on-site disposal	Sediment excavation On-site thermal treatment On-site disposal	$ 7,000 31,000 5,000
	Subtotal	**$ 43,000**
TOTAL ESTIMATED COST FOR PREFERRED ALTERNATIVES		**$ 600,000**

Notes:

1. Capital costs for capping components include allowances for the following:

   Contingency - 25%
   Installation/Construction - 50%
   Engineering - 25%

2. Capital costs for sediment components include allowances for Contingencies (25%).

6.2.2 Site 3 - Pistol Range Landfill

6.2.2.1 Conceptual Design

The proposed preferred alternatives for Site 3 consist of:

- Installation of a synthetic/soil cap over the entire surface and face of the landfill. The landfill will be regraded so that a synthetic liner can be installed over the face and surface. Figure 6-4 provides the area designated to be capped.

- Installation of three extraction wells within the contaminated groundwater plume, followed by treatment of the collected groundwater through a granular activated carbon (GAC) system with discharge of the treated effluent to the stream that flows adjacent to the landfill. Figure 6-5 provides the approximate location of the proposed extraction well and treatment system for Site 3. Figure 6-6 provides a schematic of the GAC treatment system.

Surface Soils/Landfill

An estimated area of 52,000 square feet will require capping. The landfill will be covered with a synthetic/soil cap to prevent migration of contaminated soils through surface runoff, and prevent leachate generation which could further impact groundwater quality. Site preparation activities include clearing of trees and brush and regrading of the landfill surface and face to allow for a synthetic liner to be installed.

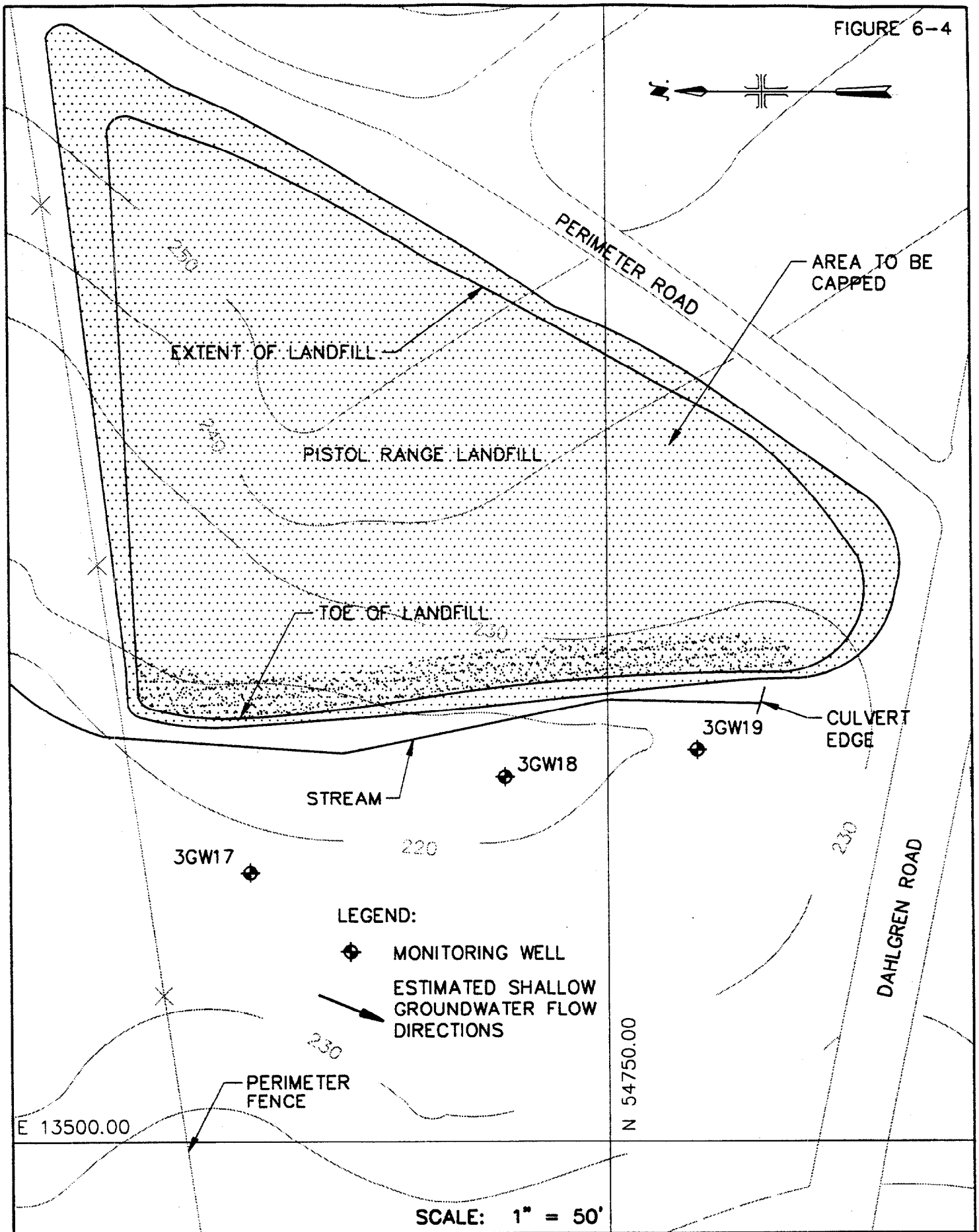
Capping activities for the Site 3 landfill should take approximately 2 months to complete.

Groundwater

The groundwater collection and treatment system will be installed at Site 3 concurrent with or immediately following the capping activities. The collection system will consist of three 6-inch extraction wells drilled to a depth of 15 feet, and screened from 5 to 15 feet below the ground surface. Figure 6-7 provides a schematic of a typical extraction well. In order to begin treatment of the groundwater immediately following installation of the extraction wells, it will be necessary to have the treatment unit operational upon completion of the collection system.

It is estimated that 635,000 gallons of contaminated groundwater will require treatment. However, because uncontaminated water is also removed by the extraction wells, it is estimated that approximately 3,000,000 gallons of water will be extracted, treated, and discharged to surface water at this site to achieve the cleanup goals. Cleanup goals for the

FIGURE 6-4



MALCOLM PIRNIE

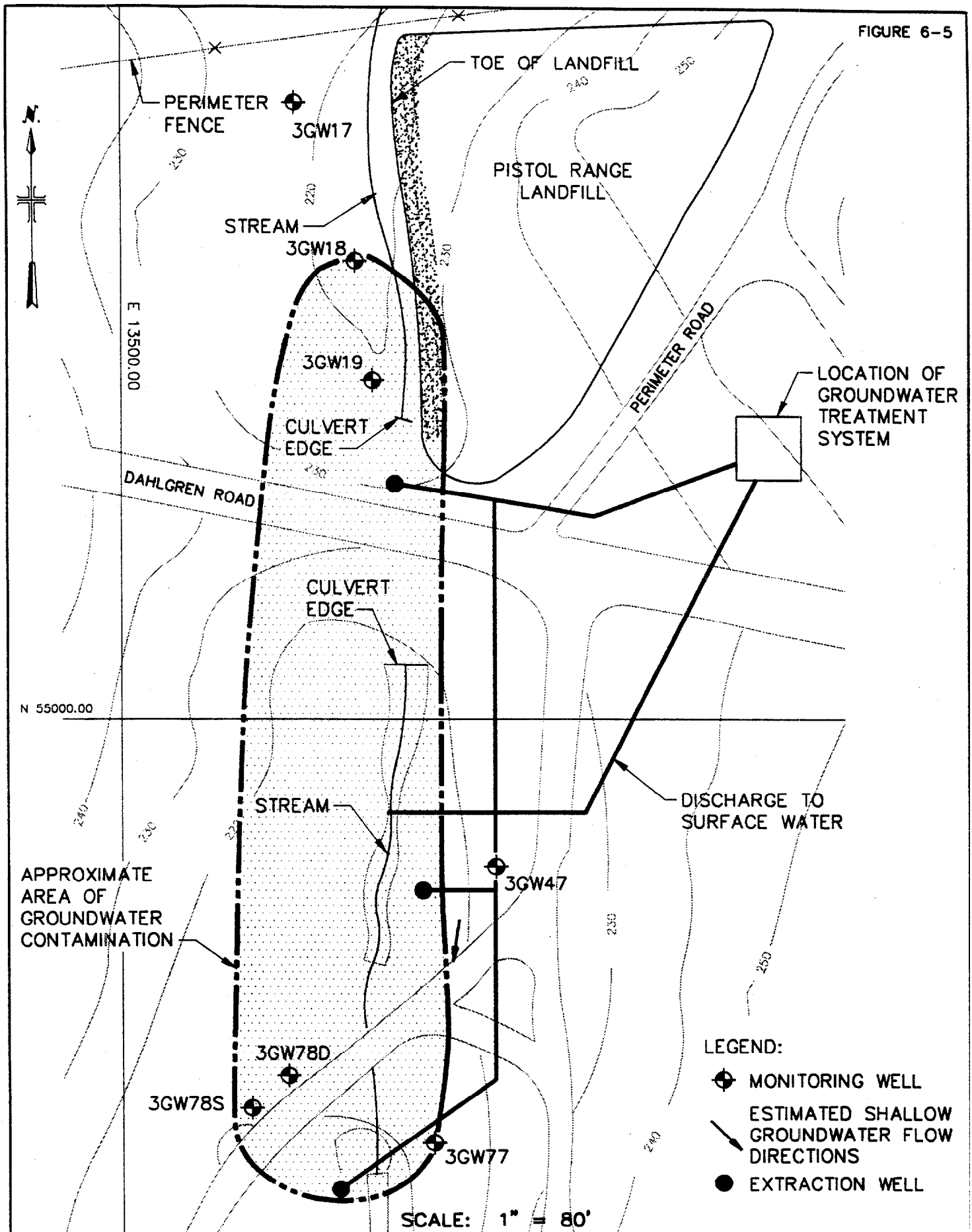
WHITE OAK, MARYLAND
FEASIBILITY STUDY
SITE 3 – AREA DESIGNATED FOR CAPPING

MALCOLM PIRNIE, INC.

OCTOBER 1993

3666 : 0931048000\I:\ACAD\PROJ\0931048\FIG6-4 SCALE: 1:600i 11/03, 1993 at 10:33

FIGURE 6-5



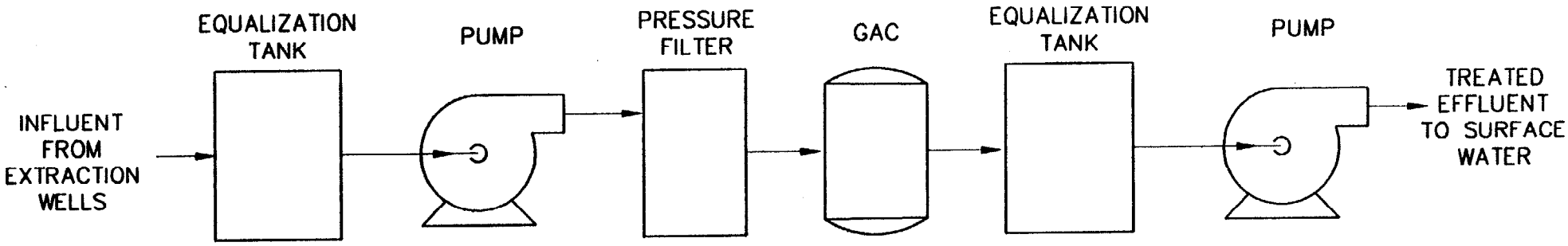
MALCOLM PIRNIE

WHITE OAK, MARYLAND
FEASIBILITY STUDY
SITE 3 – GROUNDWATER COLLECTION/ TREATMENT SYSTEM

MALCOLM PIRNIE, INC.

OCTOBER 1993

3666 : 0931048000\I:\ACAD\PROJ\0931048\FIG6-5 SCALE: 1:960i 11/05, 1993 at 10:33



NOTE:
GAC TREATMENT SYSTEM APPLIES TO SITES 3,4,7,8,9 AND 11.

FIGURE 6-6

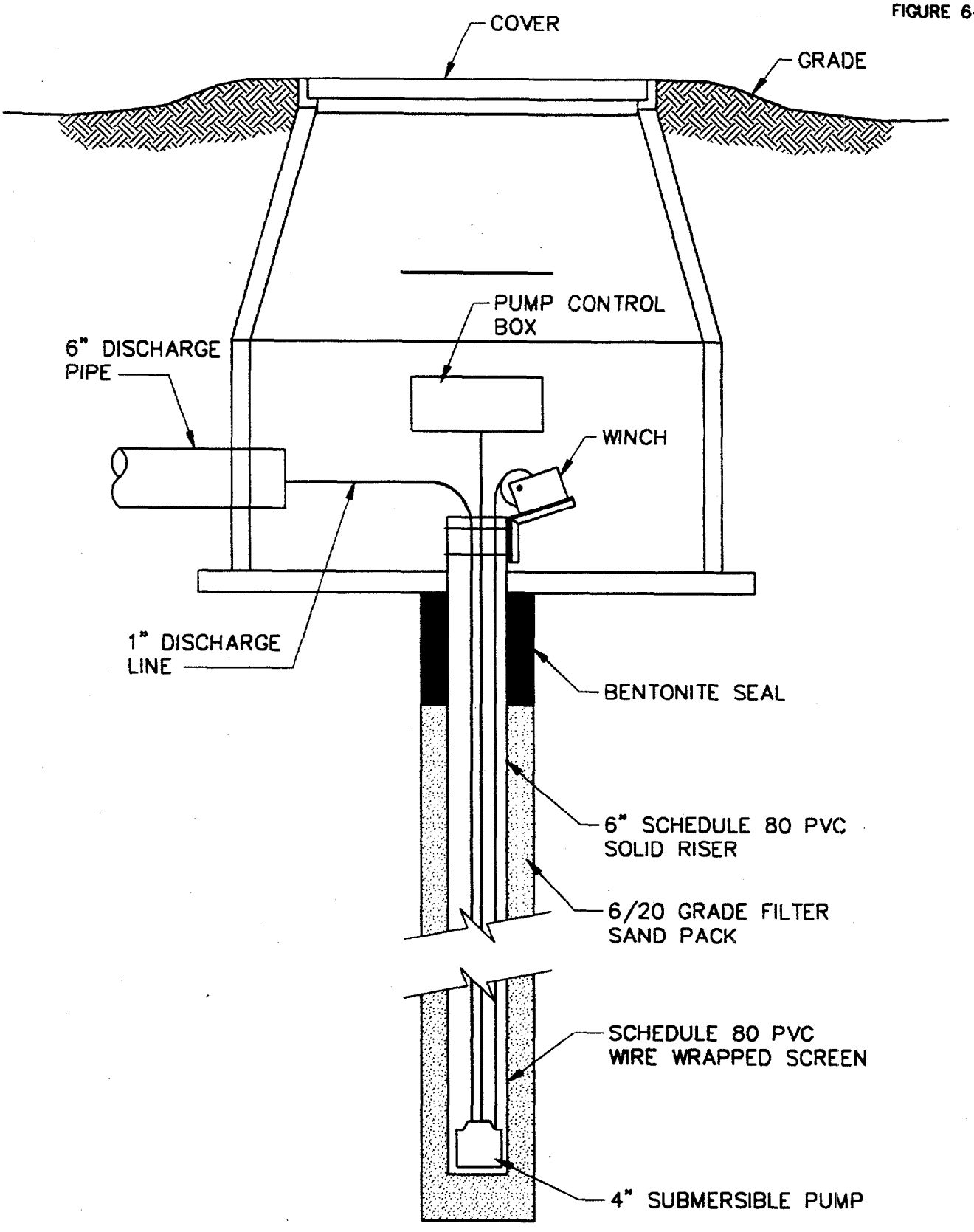
MALCOLM PIRNIE

WHITE OAK, MARYLAND
FEASIBILITY STUDY
GAC TREATMENT SYSTEM SCHEMATIC

MALCOLM PIRNIE, INC.

OCTOBER 1993

FIGURE 6-7



NOT TO SCALE

MALCOLM PIRNIE	WHITE OAK, MARYLAND FEASIBILITY STUDY TYPICAL EXTRACTION WELL	MALCOLM PIRNIE, INC. OCTOBER 1993

5830 : 0931048100\I:\ACAD\PROJ\0931031\FIG6-7 SCALE: 1:1; 10/21, 1993 at 10:46

Volatile Organic Compounds (VOCs) at this site are anticipated to be the U.S. Environmental Protection Agency (USEPA) Maximum Contaminant Levels (MCLs).

The primary treatment will be a GAC bed or column preceded by filtration equipment to reduce the potential for clogging of the carbon unit. Treated groundwater will be discharged to the stream that flows adjacent to the landfill. A National Pollution Discharge Elimination System (NPDES) permit from the Maryland Department of the Environment (MDE) will be required prior to discharge of the treated effluent. Based upon concentrations of volatile organics in the groundwater and the anticipated efficiency of the GAC treatment system, discharge limits for volatile organics should be met without any additional treatment of the effluent.

It is estimated that it will take 1 year to achieve satisfactory cleanup of the groundwater at Site 3.

6.2.2.2 Costs

The estimated capital and O&M (present worth) costs for design and implementation of the proposed preferred alternatives is $891,000. The costs on a media-specific basis are summarized in Table 6-3. These costs represent engineering, construction, and disposal expenses required in implementing all phases of the preferred alternatives.

6.2.3 Site 4 - Chemical Burial Site

6.2.3.1 Conceptual Design

The proposed preferred alternatives for Site 4 consist of:

- Excavation of approximately 5,200 cubic yards of soil and material from four burial areas, thermal treatment of the contaminated soils, and on-site disposal of the treatment residuals. The excavated buried materials will be decontaminated on-site and disposed of in an off-site landfill. Figure 6-8 provides the area designated to be excavated. The burial areas will be excavated until natural soils are encountered on the four walls and bottom of the excavation.

- Installation of eight extraction wells within the contaminated groundwater plume followed by treatment of the collected groundwater through a GAC system with discharge of the treated effluent to the stream that flows to the east of Site 9. Figure 6-9 provides the approximate location of the proposed extraction well and treatment system for Site 4.

TABLE 6-3

SITE 3 PREFERRED ALTERNATIVES - COST ESTIMATE

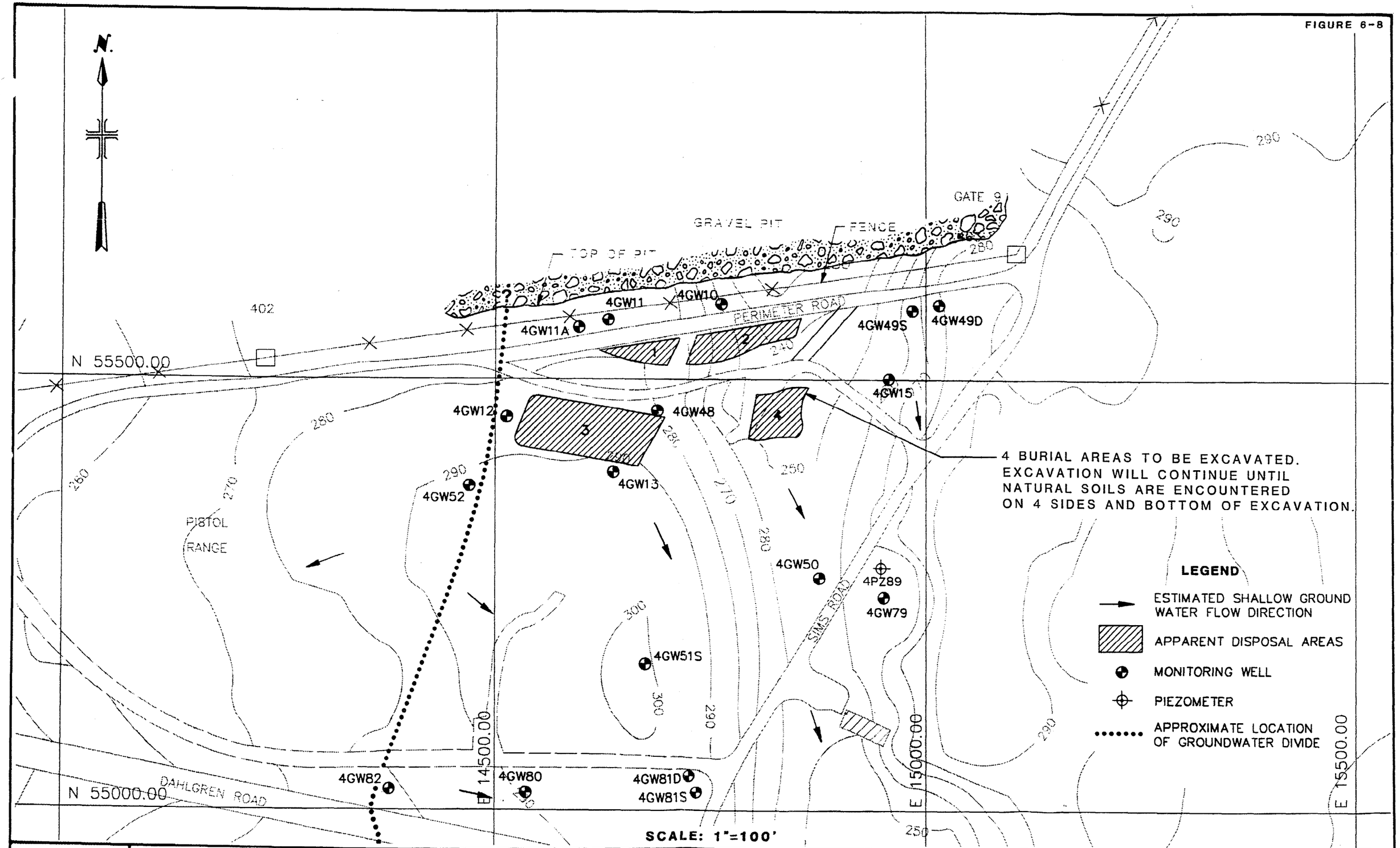
PREFERRED ALTERNATIVE	ALTERNATIVE COMPONENTS	COST ESTIMATE
Surface Soils/Landfill		
Synthetic/Soil Cap	Synthetic/Soil Cap O&M Costs (Present Worth)	$ 388,000 61,000
	Subtotal	**$ 449,000**
Groundwater		
Extraction, activated carbon treatment and discharge to surface water	Groundwater collection Activated carbon treatment Discharge to surface water O&M Costs (Present Worth)	$ 120,000 121,000 148,000 53,000
	Subtotal	**$ 442,000**
TOTAL ESTIMATED COST FOR PREFERRED ALTERNATIVES		**$ 891,000**

Notes:

Capital costs for capping and groundwater components include allowances for the following:

Contingency - 25%
Installation/Construction - 50%
Engineering - 25%
Electrical - 20% (Groundwater components only)

FIGURE 6-8



MALCOLM PIRNIE

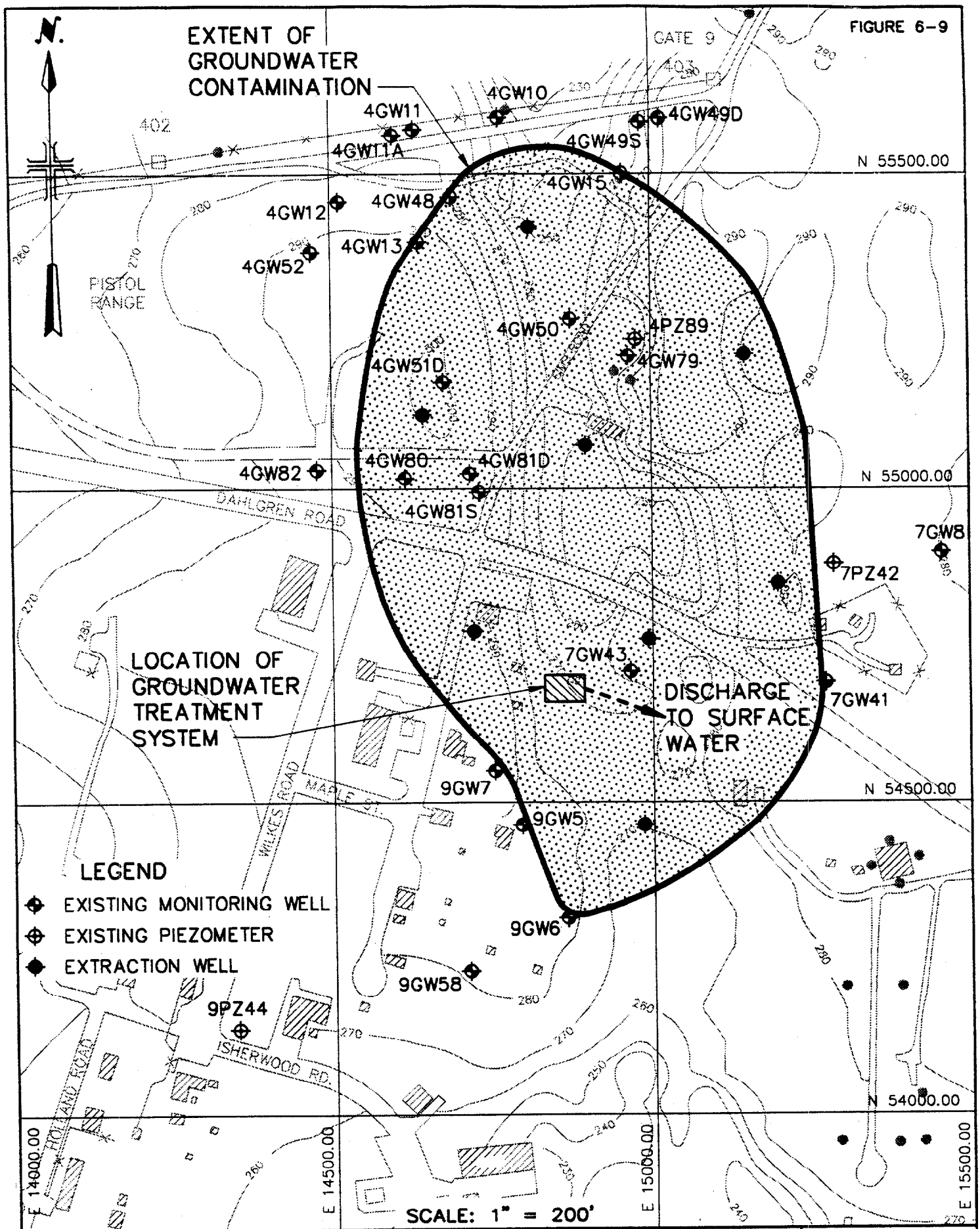
WHITE OAK, MARYLAND
FEASIBILITY STUDY
SITE 4 - AREAS DESIGNATED TO BE EXCAVATED

MALCOLM PIRNIE, INC.

OCTOBER 1993

00144D012

FIGURE 6-9



MALCOLM PIRNIE

WHITE OAK, MARYLAND
FEASIBILITY STUDY
SITE 4 – GROUNDWATER COLLECTION/ TREATMENT SYSTEM LOCATION

MALCOLM PIRNIE, INC.

OCTOBER 1993

5830 : 0931048100\I:\ACAD\PROJ\093103\FIG6-9 SCALE: 1:2400i 10/21, 1993 at 11:17

Soils/Burial Areas

The majority of the remedial work will include heavy equipment operations. A backhoe will excavate the contaminated soil and buried material and place it in a dump truck. The dump truck will transport the soil and excavated material and unload its contents in a staging area where the soil will be separated. The truck will return to the excavation area to receive more contaminated soil and material. A mobile thermal treatment unit will be positioned near the site to treat the excavated contaminated soil. Soil will be staged in the area of the treatment unit, and then fed into the thermal treatment unit. The residuals will be placed in the excavated areas. Although site-specific action levels for soils have yet to be determined, an expected 99 percent removal rate for volatile and semi-volatile organics from the thermal treatment process should meet any action levels established.

Excavation, treatment and disposal activities for contaminated soil and buried material should take approximately 4 months to complete for Site 4.

Groundwater

The groundwater collection and treatment system will be installed at Site 4 immediately following the excavation activities because an extraction well may have to be located at the former location of the burial areas. The collection system will consist of three 6-inch extraction wells drilled to a depth of 80 feet, and screened from 40 to 80 feet below the ground surface. In order to begin treatment of the groundwater immediately following installation of the extraction wells, it will be necessary to have the treatment unit operational upon completion of the collection system.

It is estimated that 50,000,000 gallons of contaminated groundwater will require treatment. However, because uncontaminated water is also removed by the extraction wells, it is estimated that approximately 250,000,000 gallons of water will be extracted, treated, and discharged to surface water to achieve the cleanup goals. Cleanup goals for the VOCs and Semi-volatile Organic Compounds (SVOCs) at this site are anticipated to be the USEPA MCLs.

The primary treatment will be a GAC bed or column preceded by filtration equipment to reduce the potential for clogging of the carbon unit. Treated groundwater will be discharge to the stream that is located just to the east of Site 9. An NPDES permit from MDE will be required prior to discharge of the treated effluent. Based upon concentrations of volatile and semi-volatile organics in the groundwater and the anticipated efficiency of the GAC treatment system, discharge limits for volatile and semi-volatile organics should

be met without any additional treatment (e.g., air stripper for volatile organics) of the effluent.

It is estimated that it will take 10 years to achieve satisfactory cleanup of the groundwater at Site 4.

6.2.3.2 Costs

The estimated capital and O&M (present worth) costs for design and implementation of the proposed preferred alternatives is $2,460,000. The costs on a media-specific basis are summarized in Table 6-4. These costs represent engineering, construction, and disposal expenses required in implementing all phases of the preferred alternatives.

6.2.4 Site 7 - Ordnance Burn Area

6.2.4.1 Conceptual Design

The proposed preferred alternatives for Site 7 consist of:

- Excavation of soils to a depth of 10 feet with on-site soil washing and on-site disposal of treatment residuals, and in-situ soil flushing of nitroaromatic contamination in the subsurface soils from depths of 10 feet to 30 feet within the swale at the site. A surfactant solution will be used to remove the nitroaromatics in the soils. Extraction wells will be used to remove the flushing solution. The solution will be treated and reused, if possible. Figure 6-10 provides the location of the area to be excavated and flushed. A schematic of the in-situ soil flushing process is provided in Figure 6-11.

- Installation of three extraction wells within the contaminated groundwater plume, followed by treatment of the collected groundwater through a GAC system with discharge of the treated effluent to the stream that flows to the east of Site 9. Figure 6-12 provides the approximate location of the proposed extraction well and treatment system for Site 7.

<u>Soils</u>

A mobile ex-situ soil washing unit will be used to treat excavated soils. It is estimated that approximately 3,400 cubic yards of soil will be excavated and treated. Treatment residuals will be placed back on the site. A removal rate of greater than 90 percent is expected for the soil washing process. A mobile in-situ soil washing unit will be set up on the site to treat the contaminated soil in a 30- by 300-foot area from depths of 10 to 30 feet. The surfactant will be sprayed on the soil surface from a feed tank and allowed to infiltrate

TABLE 6-4

SITE 4 PREFERRED ALTERNATIVES - COST ESTIMATE

PREFERRED ALTERNATIVE	ALTERNATIVE COMPONENTS	COST ESTIMATE
Soils/Burial Areas		
Soil/burial area excavation, on-site thermal treatment of soils, on-site diposal of treatment residuals and off-site disposal of buried materials	Soil/burial area excavation On-site thermal treatment of soils On-site disposal of treatment residuals Off-site disposal of buried materials	$ 71,000 759,000 38,000 133,000
	Subtotal	**$ 1,001,000**
Groundwater		
Extraction, activated carbon treatment and discharge to surface water	Groundwater collection Activated carbon treatment Discharge to surface water O&M Costs (Present Worth)	$ 510,000 302,000 171,000 476,000
	Subtotal	**$ 1,459,000**
TOTAL ESTIMATED COST FOR PREFERRED ALTERNATIVES		**$ 2,460,000**

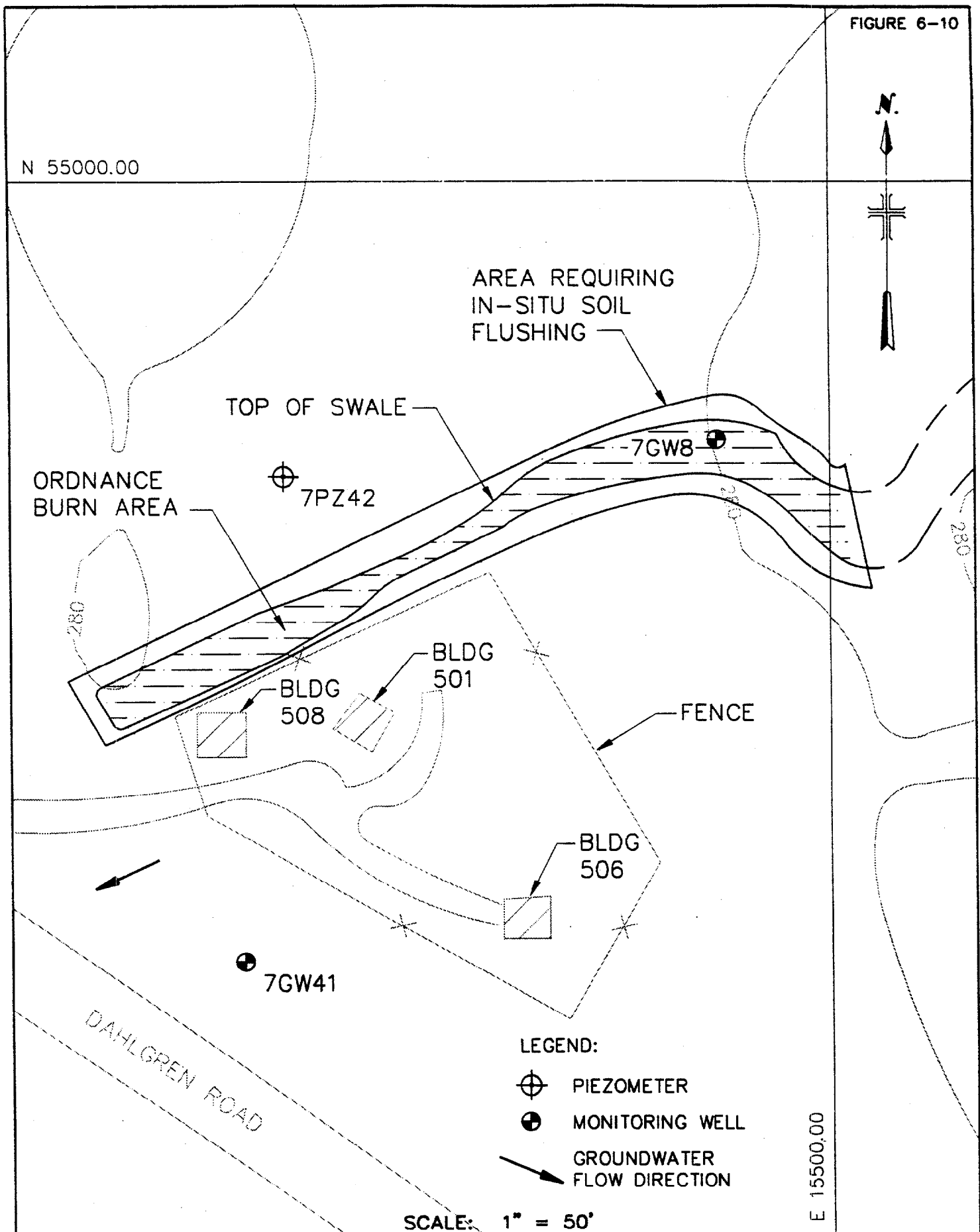
Note:

1. Capital costs listed for each soil/burial area component include allowances for Contingencies (25%).

2. Capital costs listed for each groundwater component include allowances for the following:

   Contingency - 25%
   Installation/Construction - 50%
   Engineering - 25%
   Electrical - 20%

FIGURE 6-10



MALCOLM PIRNIE	WHITE OAK, MARYLAND FEASIBILITY STUDY SITE 7 – AREA TO BE EXCAVATED AND SOIL FLUSHED	MALCOLM PIRNIE, INC. OCTOBER 1993

3666 : 0931048000\I:\ACAD\PROJ\0931048\FIG6-10 SCALE: 1:600i 11/03, 1993 at 10:00

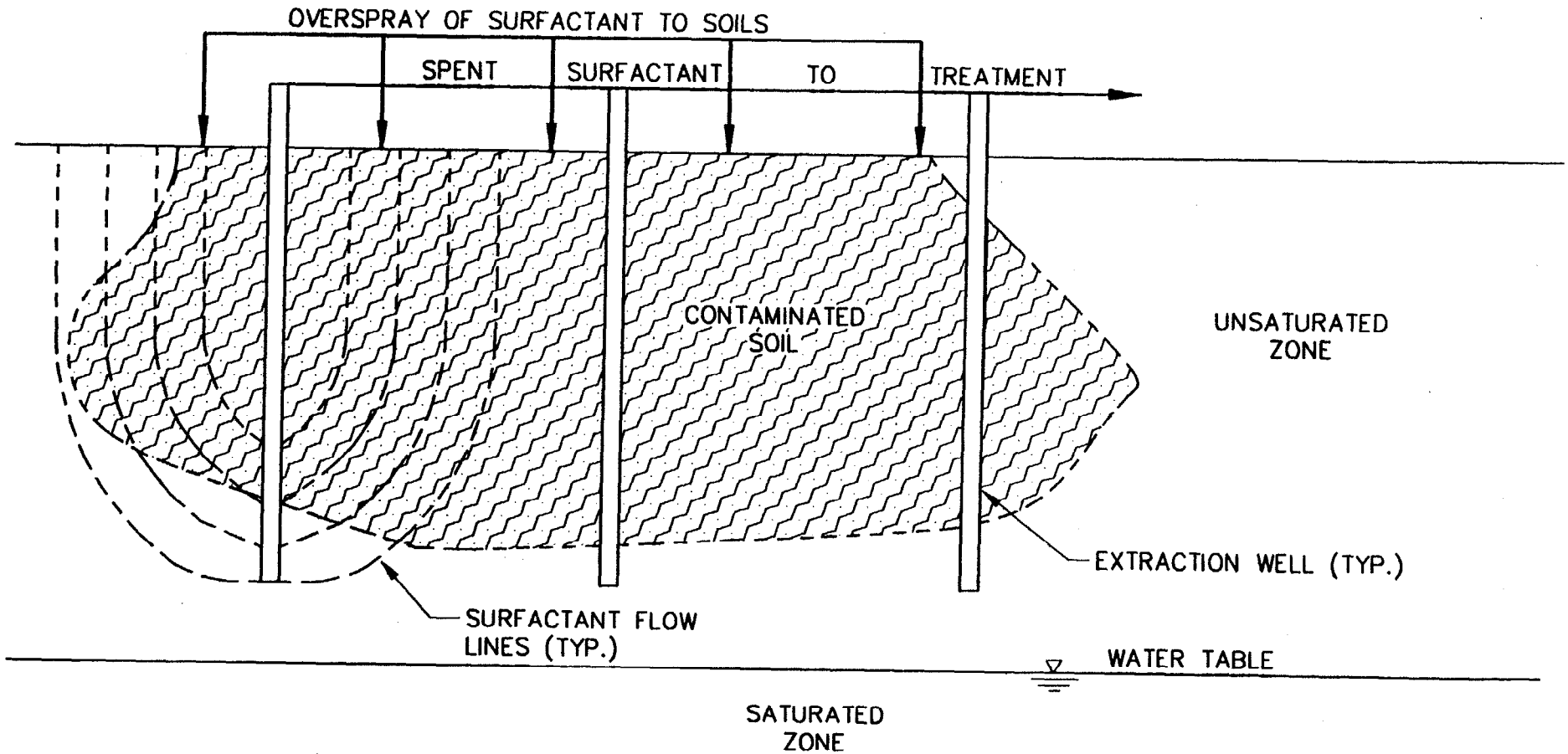


FIGURE 6-11

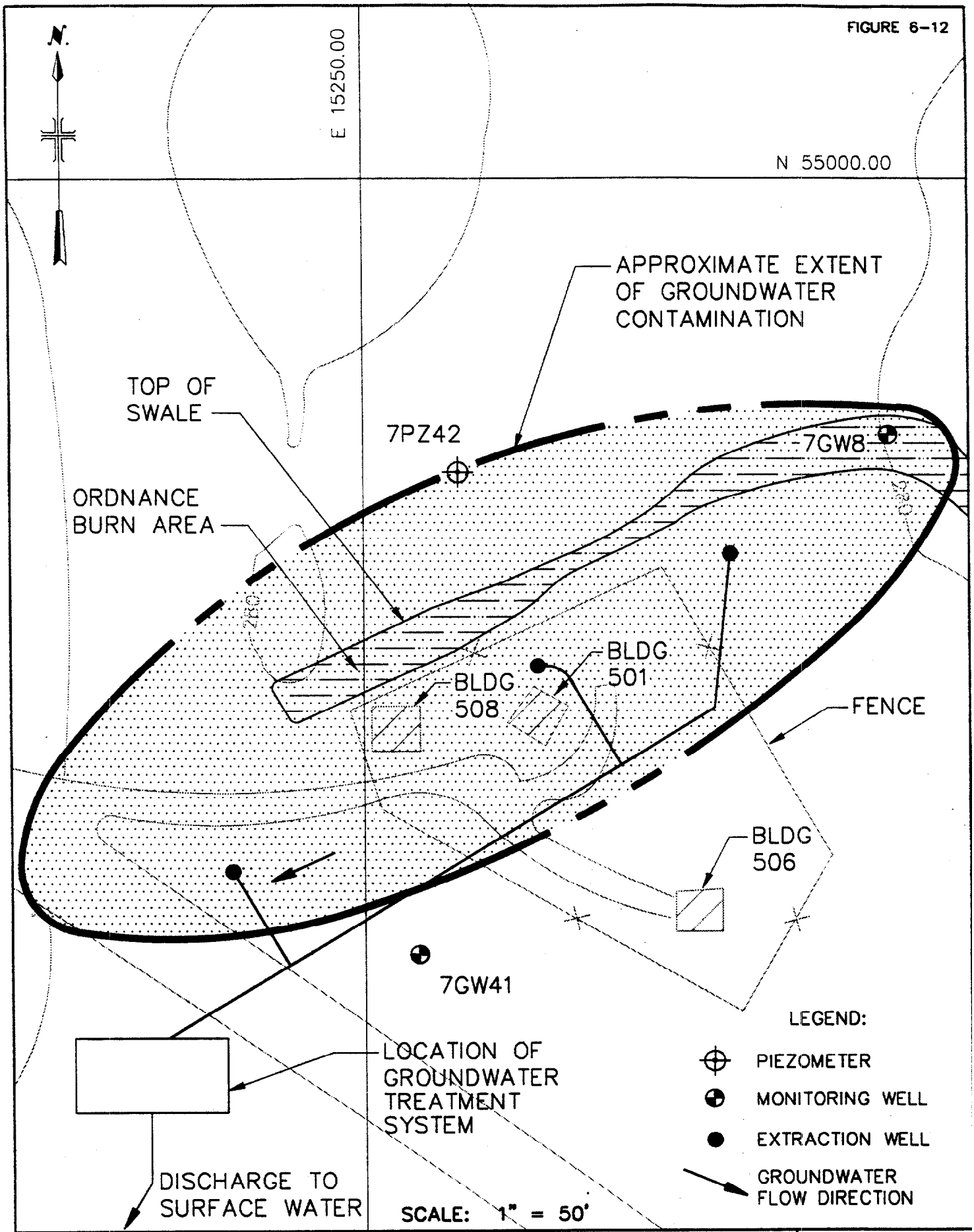
MALCOLM PIRNIE

WHITE OAK, MARYLAND
FEASIBILITY STUDY
SCHEMATIC DIAGRAM OF AN IN-SITU SURFACTANT SOIL FLUSHING SYSTEM

MALCOLM PIRNIE, INC.

OCTOBER 1993

FIGURE 6-12



MALCOLM PIRNIE	WHITE OAK, MARYLAND FEASIBILITY STUDY SITE 7 – GROUNDWATER COLLECTION/ TREATMENT SYSTEM	MALCOLM PIRNIE, INC. OCTOBER 1993

3666 : 09310480 00\I:\ACAD\PROJ\0931048\FIG6-12 SCALE: 1:600i 11/03, 1993 at 12:59

the subsurface and solubilize and mobilize the contaminants. The surfactant solution is then recovered with extraction wells located with the contaminated zone. The recovered surfactant will be pumped through a particulate filter and into a recovery tank. An on-site treatment system then recovers the surfactant for reuse. The on-site treatment system will include a solvent extraction process to remove the nitroaromatics, and a hyperfiltration process to concentrate the recovered surfactant. The surfactant is then returned to the feed tank for reuse.

Estimated time to complete the soil washing and in-situ soil flushing process will be 9 months for Site 7.

Groundwater

The groundwater collection and treatment system will be installed at Site 7 immediately following the soil remedial activities because an extraction well may have to be located at the former location of the burn area. The collection system will consist of three 6-inch extraction wells drilled to a depth of 60 feet, and screened from 40 to 60 feet below the ground surface. In order to begin treatment of the groundwater immediately following installation of the extraction wells, it will be necessary to have the treatment unit operational upon completion of the collection system.

It is estimated that 2,400,000 gallons of contaminated groundwater will require treatment. However, because uncontaminated water is also removed by the extraction wells, it is estimated that approximately 12,000,000 gallons of water will be extracted, treated, and discharged to surface water to achieve the cleanup goals. Cleanup goals for the nitroaromatics at this site have not been established but should be based on a 10^{-6} risk basis.

The primary treatment will be a GAC bed or column preceded by filtration equipment to reduce the potential for clogging of the carbon unit. Treated groundwater will be discharge to the stream that is located just to the east of Site 9. An NPDES permit from MDE will be required prior to discharge of the treated effluent. Based upon concentrations of nitroaromatics in the groundwater and the anticipated efficiency of the GAC treatment system, discharge limits for nitroaromatics should be met without any additional treatment required for the treated effluent.

It is estimated that it will take 1½ years to achieve satisfactory cleanup of the groundwater at Site 7.

6.2.4.2 Costs

The estimated capital and O&M (present worth) costs for design and implementation of the proposed preferred alternatives is $3,384,000. The costs on a media-specific basis are summarized in Table 6-5. These costs represent engineering, construction and disposal expenses required in implementing all phases of the preferred alternatives.

6.2.5 Site 8 - Abandoned Chemical Disposal Pit

6.2.5.1 Conceptual Design

The proposed preferred alternatives for Site 8 consist of:

- Excavation of approximately 1,600 cubic yards of soil and material from the disposal pit, thermal treatment of the contaminated soils, and on-site disposal of the treatment residuals. The excavated buried materials will be decontaminated on-site and disposed of in an off-site landfill. Figure 6-13 provides the area designated to be excavated. The pit will be excavated until natural soils are encountered on the four walls and bottom of the excavation.

- Installation of four extraction wells within the contaminated groundwater plume, followed by treatment of the collected groundwater through a GAC system with discharge of the treated effluent to the stream to the east of the site. Figure 6-14 provides the approximate location of the proposed extraction well and treatment system for Site 8.

Soils/Disposal Pit

The majority of the remedial work will include heavy equipment operations. A backhoe will excavate the contaminated soil and buried material and place it in a dump truck. The dump truck will transport the soil and excavated material and unload its contents in a staging area where the soil will be separated from the excavated solid material. The truck will return to the excavation area to receive more contaminated soil and material. A mobile thermal treatment unit will be positioned near the site to treat the excavated contaminated soil. Soil will be staged in the area of the treatment unit, and then fed into the thermal treatment unit for removal of contaminants. The residuals will be placed in the excavated pit.

Excavation, treatment, and disposal activities should take approximately 2 months to complete for Site 8.

TABLE 6-5

SITE 7 PREFERRED ALTERNATIVES - COST ESTIMATE

PREFERRED ALTERNATIVE	ALTERNATIVE COMPONENTS	COST ESTIMATE
Soils		
Excavation and soil washing In-situ soil flushing	Excavation and soil washing In-situ soil flushing	$ 1,130,000 1,687,000
	Subtotal	**$ 2,817,000**
Groundwater		
Extraction, activated carbon treatment and discharge to surface water	Groundwater collection Activated carbon treatment Discharge to surface water O&M Costs (Present Worth)	$ 130,000 161,000 171,000 105,000
	Subtotal	**$ 567,000**
TOTAL ESTIMATED COST FOR PREFERRED ALTERNATIVES		**$ 3,384,000**

Notes:

1. Capital costs for in-situ soil flushing include allowances for the following:

   Contingency - 25%
   Engineering - 25%

2. Capital costs for groundwater components include allowances for the following:

   Contingency - 25%
   Installation/Construction - 50%
   Engineering - 25%
   Electrical - 20%

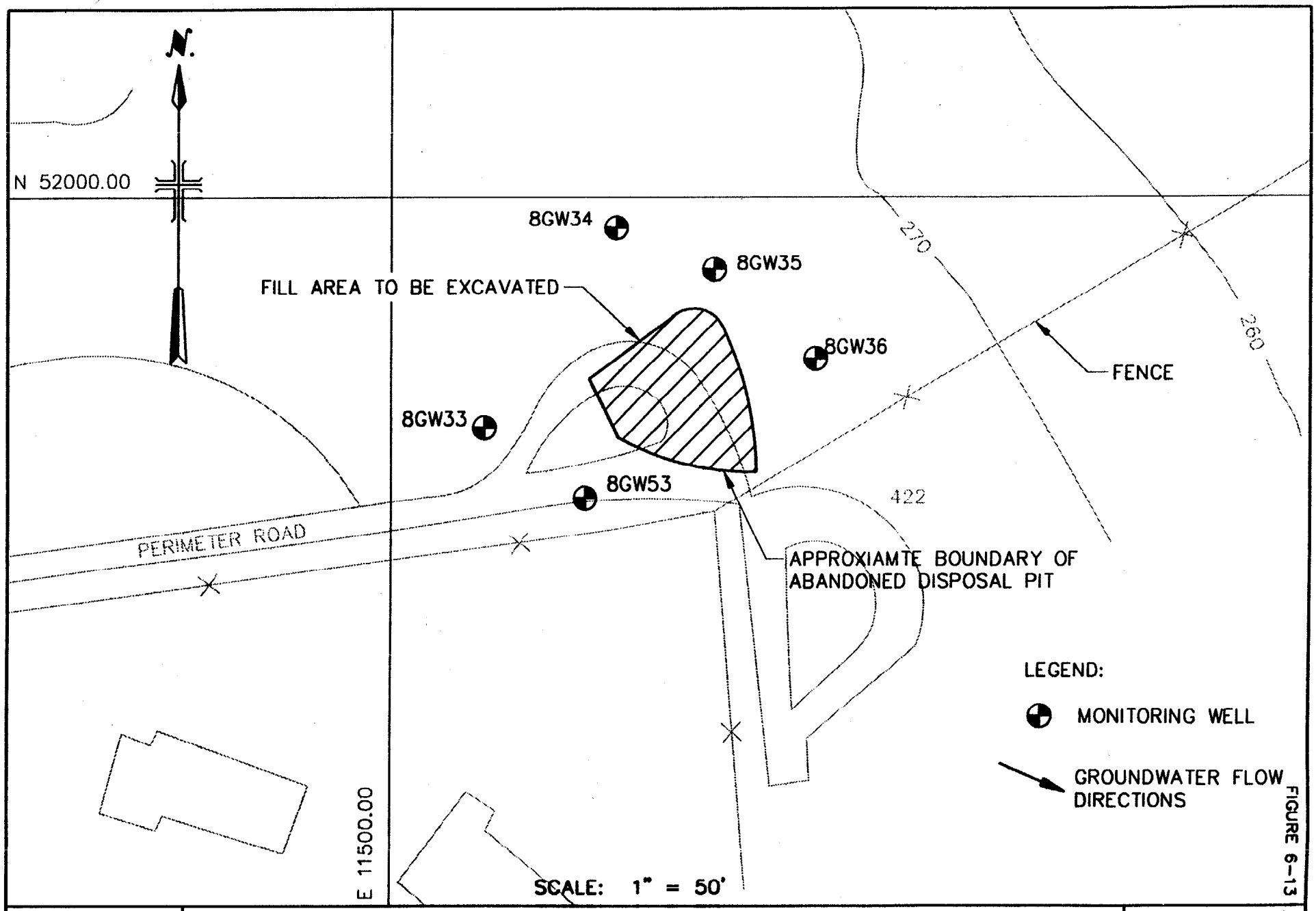


FIGURE 6-13

MALCOLM PIRNIE

WHITE OAK, MARYLAND
FEASIBILITY STUDY
SITE 8 – AREA TO BE EXCAVATED

MALCOLM PIRNIE, INC.

OCTOBER
1993

830 : 0931048100\FIG6-13 SCALE: 1:600: 10/22, 1993 at 12:57

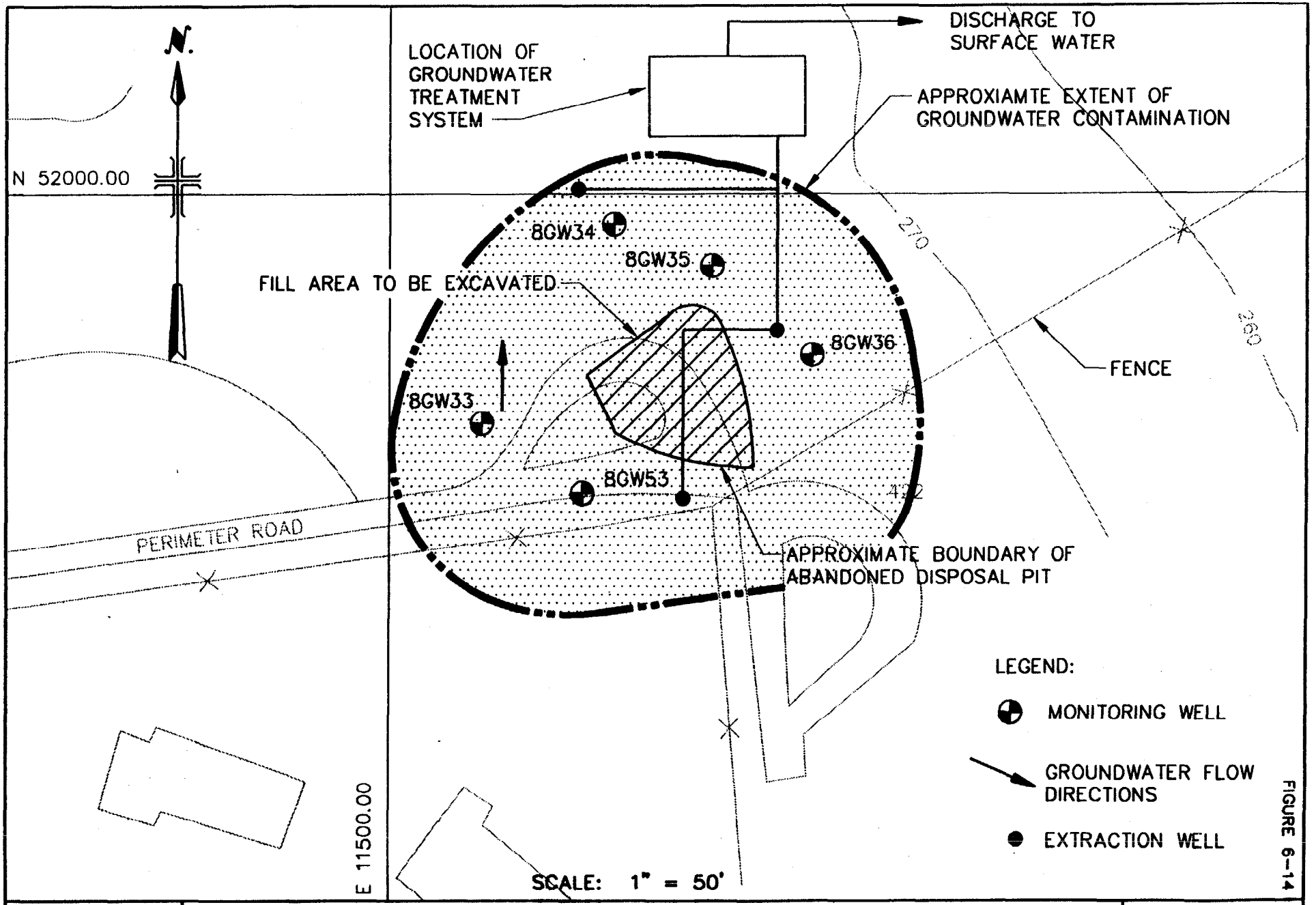


FIGURE 6-14

MALCOLM PIRNIE

WHITE OAK, MARYLAND
FEASIBILITY STUDY
GROUNDWATER COLLECTION/TREATMENT SYSTEM LOCATION

MALCOLM PIRNIE, INC.

OCTOBER 1993

130 : 093104B100\FIG6-14 SCALE: 1:600' 10/22, 1993 at 13:16

Groundwater

The groundwater collection and treatment system will be installed at Site 8 immediately following the excavation activities because an extraction well may have to be located at the former location of the disposal pit. The collection system will consist of three 6-inch extraction wells drilled to a depth of 55 feet, and screened from 35 to 55 feet below the ground surface. In order to begin treatment of the groundwater immediately following installation of the extraction wells, it will be necessary to have the treatment unit operational upon completion of the collection system.

It is estimated that 200,000 gallons of contaminated groundwater will require treatment. However, because uncontaminated water is also removed by the extraction wells, it is estimated that approximately 1,000,000 gallons of water will be extracted, treated, and discharged to surface water to achieve the cleanup goals. Cleanup goals for the VOCs and SVOCs are anticipated to be the USEPA MCLs.

The primary treatment will be a GAC bed or column preceded by filtration equipment to reduce the potential for clogging of the carbon unit. Treated groundwater will be discharge to the stream that is located to the east of the site. An NPDES permit from MDE will be required prior to discharge of the treated effluent. Based upon concentrations of volatile and semi-volatile organics in the groundwater and the anticipated efficiency of the GAC treatment system, discharge limits for volatile and semi-volatile organics should be met without any additional treatment (e.g., air stripper for volatile organics) of the effluent.

It is estimated that it will take ½ year to achieve satisfactory cleanup of the groundwater at Site 8.

6.2.5.2 Costs

The estimated capital and O&M (present worth) costs for design and implementation of the proposed preferred alternatives is $857,000. The costs on a media-specific basis are summarized in Table 6-6. These costs represent engineering, construction, and disposal expenses required in implementing all phases of the preferred alternatives.

TABLE 6-6

SITE 8 PREFERRED ALTERNATIVES - COST ESTIMATE

PREFERRED ALTERNATIVE	ALTERNATIVE COMPONENTS	COST ESTIMATE
Soils/Disposal Pit		
Soil/disposal pit excavation, on-site thermal treatment of soils, on-site diposal of treatment residuals and off-site disposal of buried materials	Soil/disposal pit excavation On-site thermal treatment of soils On-site disposal of treatment residuals Off-site disposal of buried materials	$ 23,000 213,000 13,000 133,000
	Subtotal	**$ 382,000**
Groundwater		
Extraction, activated carbon treatment and discharge to surface water	Groundwater collection Activated carbon treatment Discharge to surface water O&M Costs (Present Worth)	$ 142,000 121,000 179,000 31,000
	Subtotal	**$ 475,000**
TOTAL ESTIMATED COST FOR PREFERRED ALTERNATIVES		**$ 857,000**

Notes:

1. Capital costs for soil/disposal pit components include a Contingency allowance of 25%.

2. Capital costs for groundwater components include allowances for the following:

   Contingency - 25%
   Installation/Construction - 50%
   Engineering - 25%
   Electrical - 20%

6.2.6 Site 9 - Industrial Wastewater Disposal Area 300

6.2.6.1 Conceptual Design

The proposed preferred alternatives for Site 9 consist of:

- Excavation of approximately 1,050 cubic yards of soil and material from the six leaching wells and one leaching field with thermal treatment of the contaminated soils and on-site disposal of the treatment residuals. The excavated buried materials will be decontaminated on-site and disposed of in an off-site landfill. Figure 6-15 provides the area designated to be excavated. The leaching wells and field will be excavated until natural soils are encountered on the four walls and bottom of the excavation.

- Installation of eight extraction wells within the contaminated groundwater plumes, followed by treatment of the collected groundwater through a GAC system with discharge of the treated effluent to the stream to the east of the site. Figures 6-16 and 6-17 provide the approximate locations of the proposed extraction well and treatment system for the plumes at Site 9.

Soils/Leaching Wells and Field

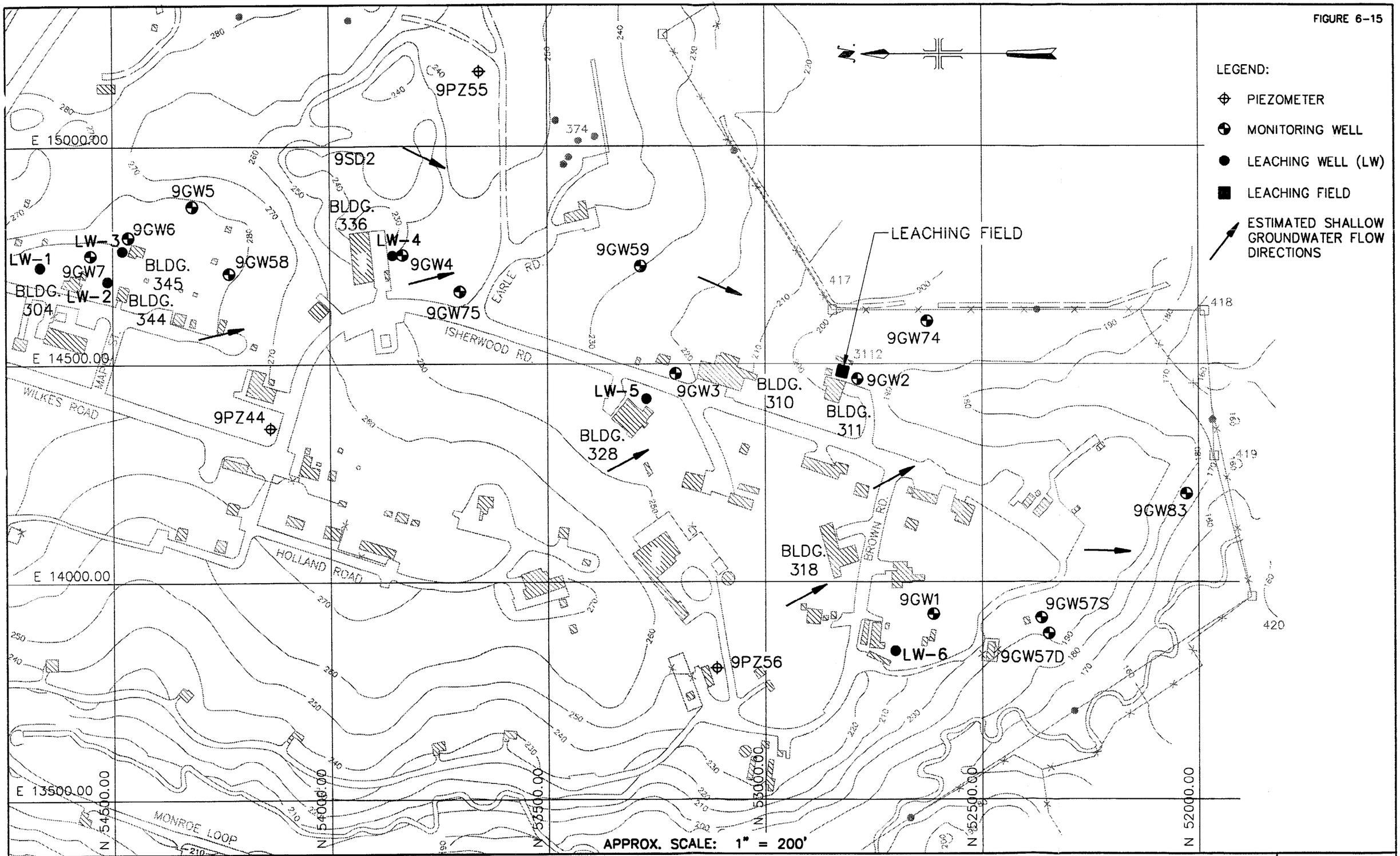
The majority of the remedial work will include heavy equipment operations. A backhoe will excavate the contaminated soil and buried material and place it in a dump truck. The dump truck will transport the soil and excavated material and unload its contents in a staging area where the soil will be separated from the excavated solid material. The truck will return to the excavation area to receive more contaminated soil and material. A mobile thermal treatment unit will be positioned near the site to treat the excavated contaminated soil. Soil will be staged in the area of the treatment unit, and then fed into the thermal treatment unit for removal of contaminants. The residuals will be placed in the excavated areas as fill.

Soil and buried waste excavation, treatment and disposal activities should be completed in 1 month for Site 9.

Groundwater

The groundwater collection and treatment system will be installed at Site 9 concurrently with or immediately following the excavation activities. The collection system will consist of eight 6-inch extraction wells drilled to a depths of 15 feet (shallow wells) and 30 feet (deep wells). The deep wells will be screened from 10 to 30 feet below the ground surface while the shallow wells will be screened from 5 to 15 feet. In order to begin treatment of the groundwater immediately following installation of the extraction wells, it

FIGURE 6-15



MALCOLM PIRNIE

WHITE OAK, MARYLAND
FEASIBILITY STUDY

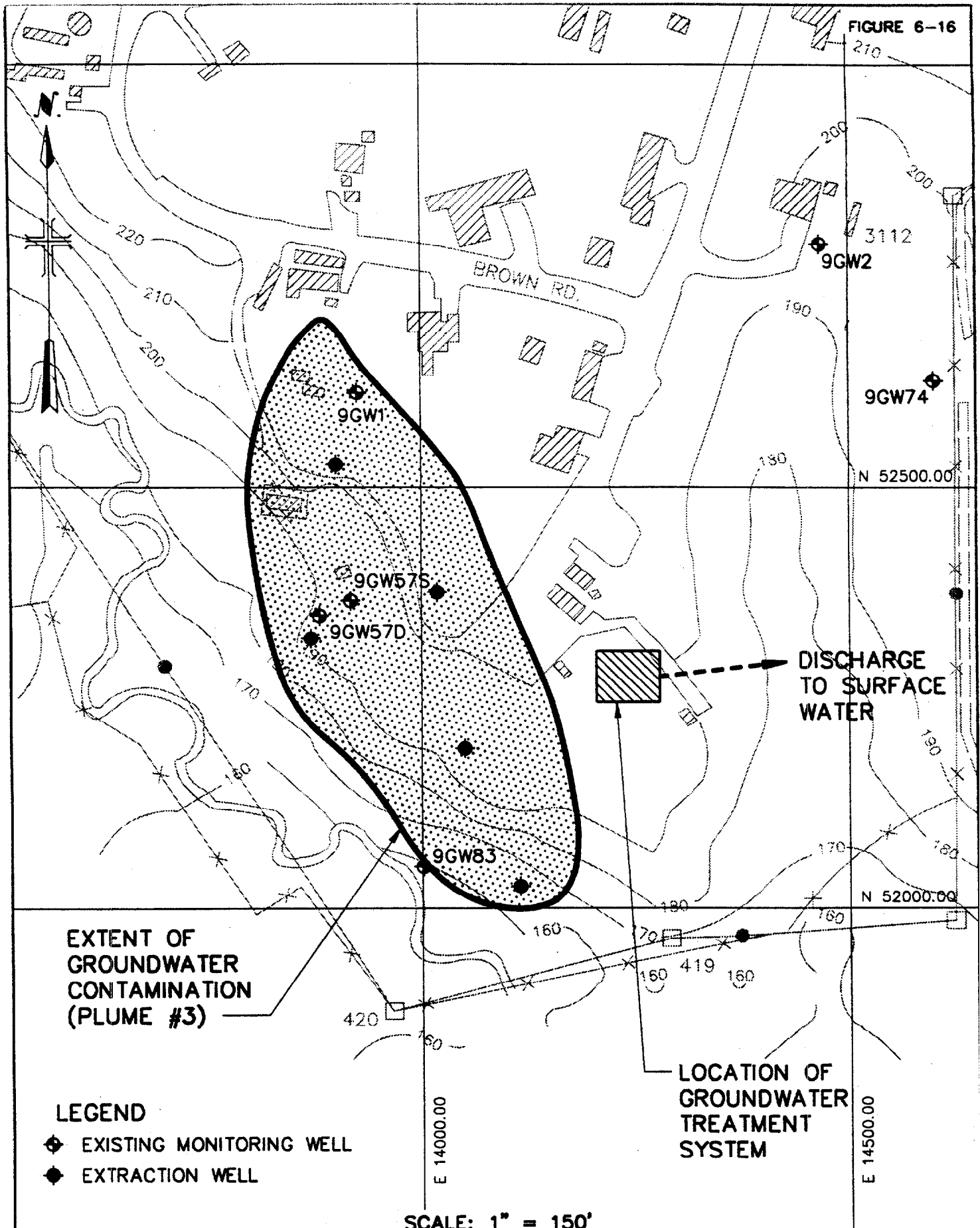
SITE 9 – AREAS DESIGNATED FOR EXCAVATION

MALCOLM PIRNIE, INC.

OCTOBER 1993

00144D02Z

FIGURE 6-16



MALCOLM PIRNIE

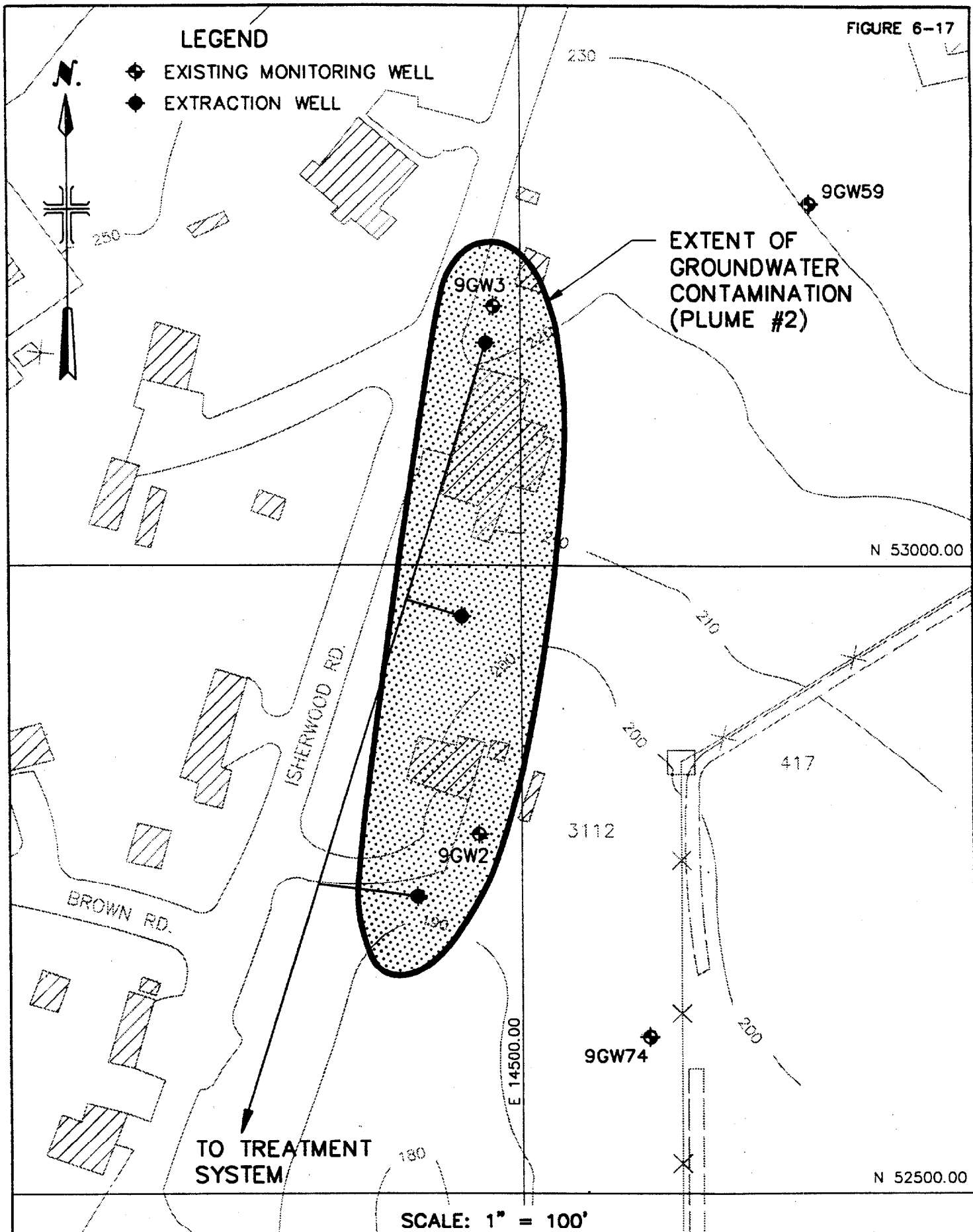
WHITE OAK, MARYLAND
FEASIBILITY STUDY
SITE 9 – GROUNDWATER COLLECTION/ TREATMENT SYSTEM LOCATION

MALCOLM PIRNIE, INC.

OCTOBER 1993

5830 : 0931048100\I:\ACAD\PROJ\0931031\FIG6-16 SCALE: 1:1800; 10/21, 1993 at 11:19

FIGURE 6-17



SCALE: 1" = 100'

MALCOLM PIRNIE	WHITE OAK, MARYLAND FEASIBILITY STUDY SITE 9 – GROUNDWATER COLLECTION/ TREATMENT SYSTEM LOCATION	MALCOLM PIRNIE, INC. OCTOBER 1993

3666 : 0931048000\I:\ACAD\PROJ\0931048\FIG6-17 SCALE: 1:1200i 11/02, 1993 at 08:45

will be necessary to have the treatment unit operational upon completion of the collection system.

It is estimated that 14,400,000 gallons of contaminated groundwater will require treatment. However, because uncontaminated water is also removed by the extraction wells, it is estimated that approximately 72,000,000 gallons of water will be extracted, treated, and discharged to surface water to achieve the cleanup goals. Cleanup goals for the VOCs are anticipated to be the USEPA MCLs. Cleanup goals for the nitroaromatics at this site have not been established but should be based on a 10^{-6} risk basis.

The primary treatment will be a GAC bed or column preceded by filtration equipment to reduce the potential for clogging of the carbon unit. Treated groundwater will be discharge to the stream that is located to the east of the site. An NPDES permit from MDE will be required prior to discharge of the treated effluent. Based upon concentrations of volatile organics and nitroaromatics in the groundwater and the anticipated efficiency of the GAC treatment system, discharge limits for volatile organics and nitroaromatics should be met without any additional treatment (e.g., air stripper for volatile organics) of the effluent.

It is estimated that it will take 9 years to achieve satisfactory cleanup of the groundwater at Site 9.

6.2.6.2 Costs

The estimated capital and O&M (present worth) costs for design and implementation of the proposed preferred alternatives is $1,499,000. The costs on a media-specific basis are summarized in Table 6-7. These costs represent engineering, construction and disposal expenses required in implementing all phases of the preferred alternatives.

6.2.7 Site 11 - Industrial Wastewater Disposal Area 100

6.2.7.1 Conceptual Design

The proposed preferred alternatives for Site 11 consist of:

- Excavation of approximately 500 cubic yards of soil and material from the 13 leaching wells with thermal treatment of the contaminated soils and on-site disposal of the treatment residuals. The excavated buried materials will be decontaminated on-site and disposed of in an off-site landfill. Figure 6-18 provides the area designated to be excavated. The leaching wells will be

TABLE 6-7

SITE 9 PREFERRED ALTERNATIVES - COST ESTIMATE

PREFERRED ALTERNATIVE	ALTERNATIVE COMPONENTS	COST ESTIMATE
Soils/Leaching Wells and Field		
Soil/leaching wells/field excavation, on-site thermal treatment of soils, on-site diposal of treatment residuals and off-site disposal of buried materials	Soil/leaching wells/field excavation On-site thermal treatment of soils On-site disposal of treatment residuals Off-site disposal of buried materials	$ 24,000 162,000 17,000 33,000
	Subtotal	**$ 236,000**
Groundwater		
Extraction, activated carbon treatment and discharge to surface water	Groundwater collection Activated carbon treatment Discharge to surface water O&M Costs (Present Worth)	$ 296,000 161,000 146,000 660,000
	Subtotal	**$ 1,263,000**
TOTAL ESTIMATED COST FOR PREFERRED ALTERNATIVES		**$ 1,499,000**

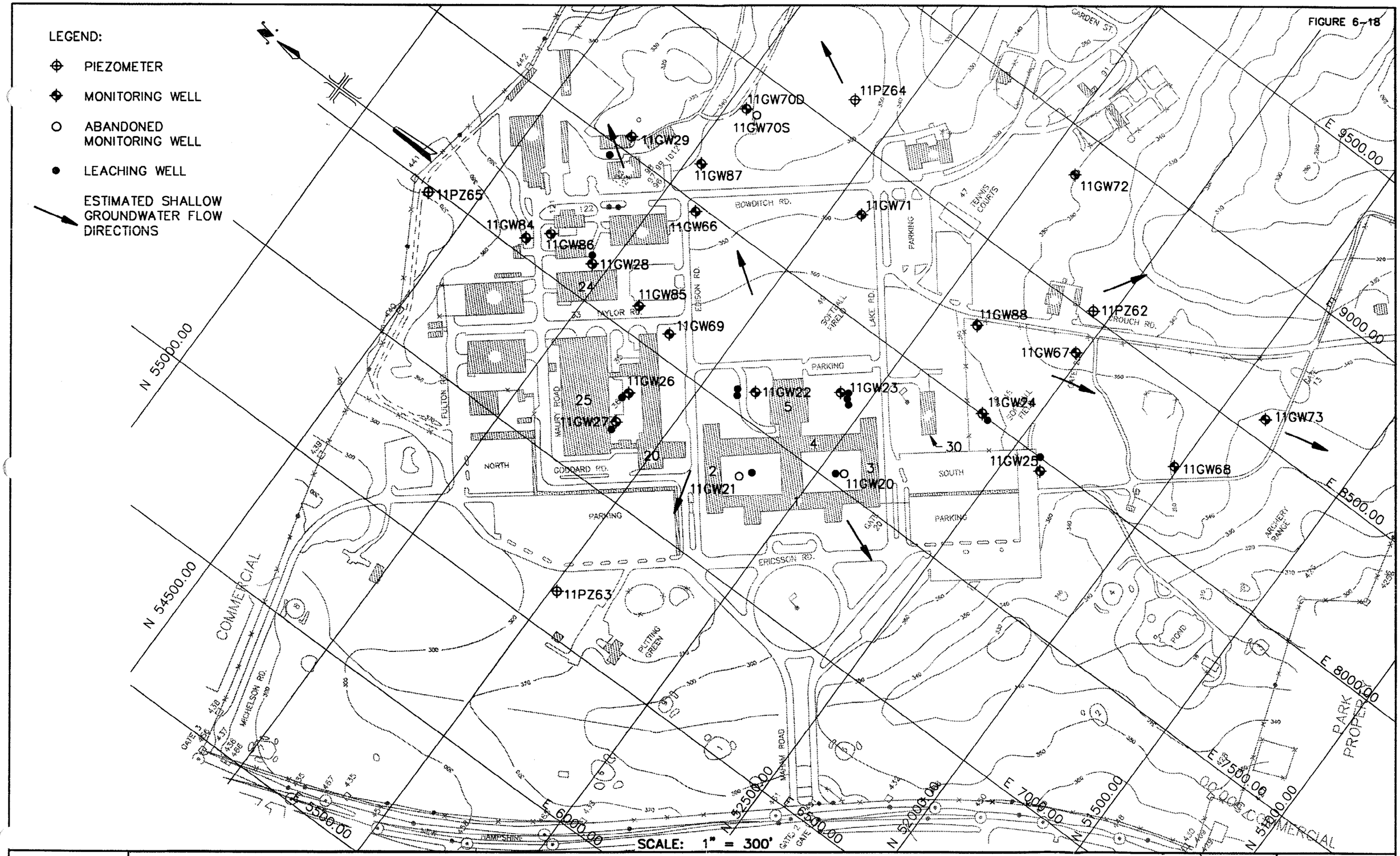
Notes:

1. Capital costs for soil components include a Contingency allowance (25%).

2. Capital costs for groundwater components include allowances for the following:

   Contingency - 25%
   Installation/Construction - 50%
   Engineering - 25%
   Electrical - 20%

FIGURE 6-18



SCALE: 1" = 300'

MALCOLM PIRNIE

WHITE OAK, MARYLAND
FEASIBILITY STUDY

SITE 11 – AREAS DESIGNATED FOR EXCAVATION (LEACHING WELLS)

MALCOLM PIRNIE, INC.

OCTOBER 1993

00144D032

excavated until natural soils are encountered on the four walls and bottom of the excavation.

- Installation of eight extraction wells within the contaminated groundwater plume, followed by treatment of the collected groundwater through a GAC system with discharge of the treated effluent to the stream that flows adjacent to the Site 2 landfill. Figures 6-19 and 6-20 provide the approximate locations of the proposed extraction well and treatment system for Site 11.

Soils/Leaching Wells

The majority of the remedial work will include heavy equipment operations. A backhoe will excavate the contaminated soil and buried material and place it in a dump truck. The dump truck will transport the soil and excavated material and unload its contents in a staging area where the soil will be separated from the excavated solid material. The truck will return to the excavation area to receive more contaminated soil and material. A mobile thermal treatment unit will be positioned near the site to treat the excavated contaminated soil. Soil will be staged at the treatment unit, and then fed into the thermal treatment unit for removal of contaminants. The residuals will be placed in the excavated areas as fill.

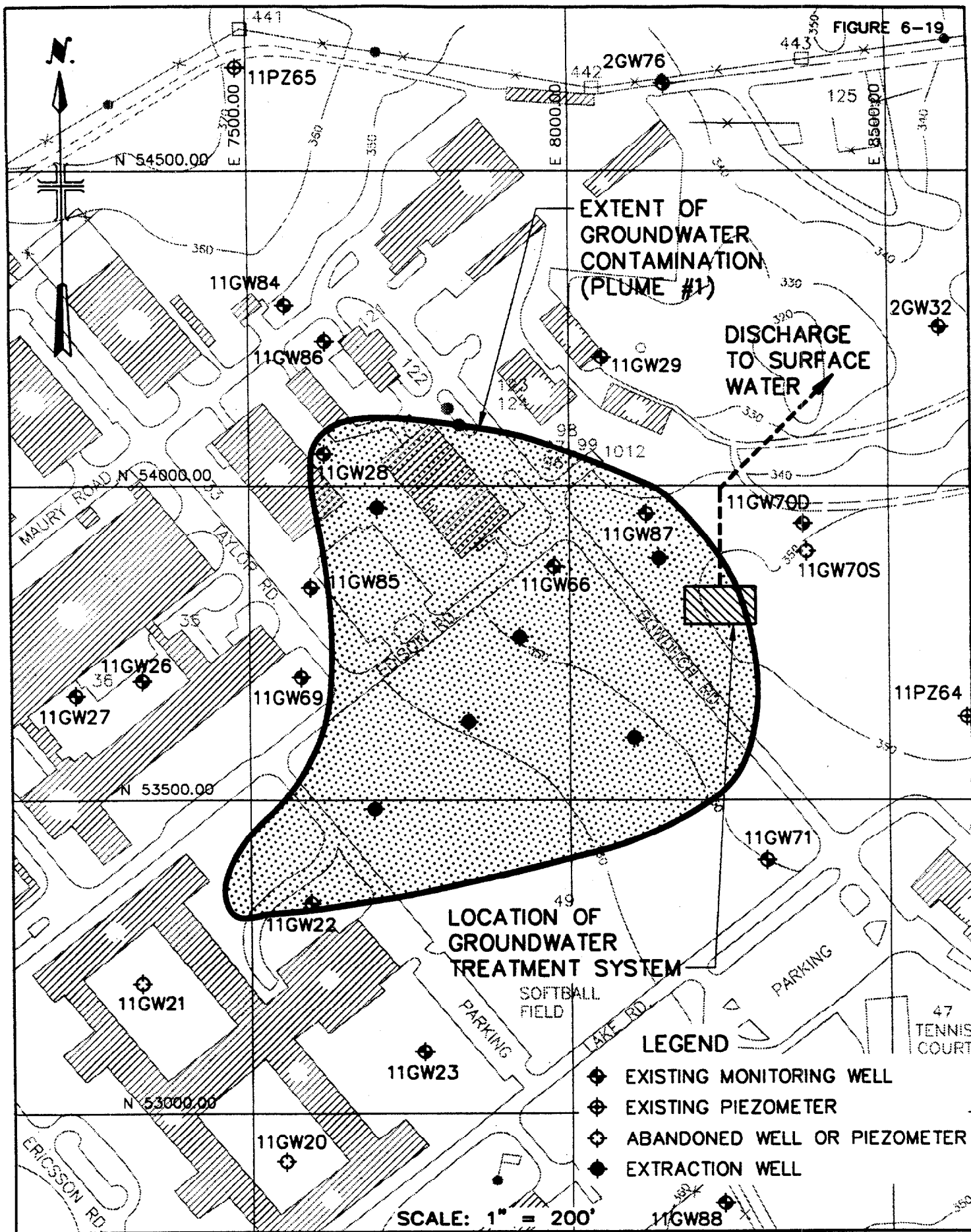
Soil and buried waste excavation, treatment and disposal activities should be completed in 1 month for Site 11.

Groundwater

The groundwater collection and treatment system will be installed at Site 11 concurrently with or immediately following the excavation activities. The collection system will consist of eight 6-inch extraction wells drilled to a depth of 50 feet. The wells will be screened from 30 to 50 feet below the ground surface. In order to begin treatment of the groundwater immediately following installation of the extraction wells, it will be necessary to have the treatment unit operational upon completion of the collection system.

It is estimated that 23,500,000 gallons of contaminated groundwater will require treatment. However, because uncontaminated water is also removed by the extraction wells, it is estimated that approximately 118,000,000 gallons of water will be extracted, treated, and discharged to surface water to achieve the cleanup goals. Cleanup goals for the VOCs are anticipated to be the USEPA MCLs.

FIGURE 6-19



MALCOLM PIRNIE

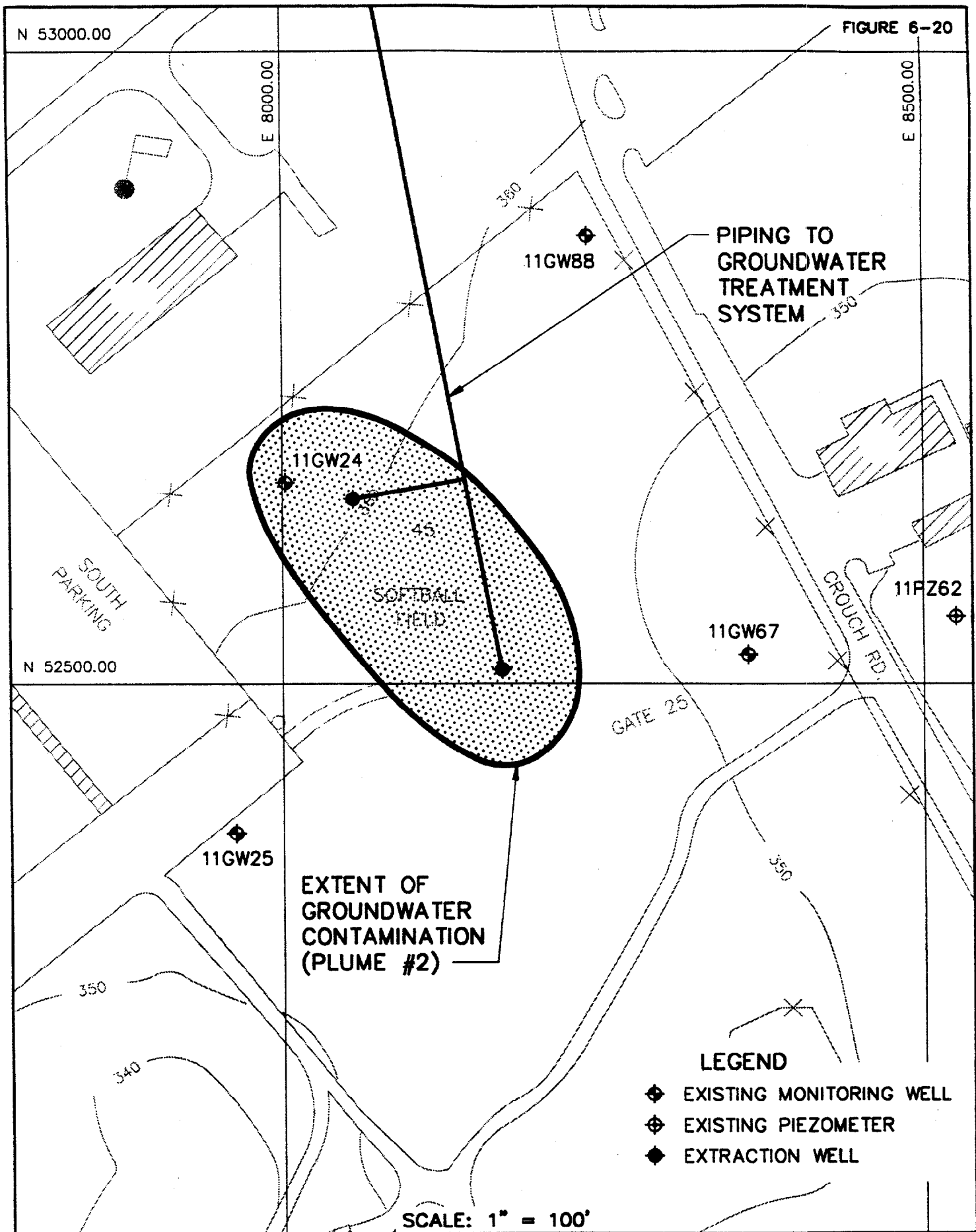
WHITE OAK, MARYLAND
FEASIBILITY STUDY
SITE 11 – GROUNDWATER COLLECTION/ TREATMENT SYSTEM LOCATION

MALCOLM PIRNIE, INC.

OCTOBER 1993

5830 : 0931048100\I:\ACAD\PROJ\0931031\FIG6-19 SCALE: 1:2400i 10/21, 1993 at 11:20

FIGURE 6-20



MALCOLM PIRNIE

WHITE OAK, MARYLAND
FEASIBILITY STUDY
SITE 11 – GROUNDWATER COLLECTION/ TREATMENT SYSTEM LOCATION

MALCOLM PIRNIE, INC.

OCTOBER 1993

5830 : 0931048100\I:\ACAD\PROJ\0931031\FIG6-20 SCALE: 1:1200i 10/21, 1993 at 11:21

The primary treatment will be a GAC treatment system preceded by filtration equipment to reduce the potential for clogging of the GAC column or bed. Treated groundwater will be discharge to the stream that is located adjacent to Site 2. An NPDES permit from MDE will be required prior to discharge of the treated effluent. Based upon concentrations of volatile organics in the groundwater and the anticipated efficiency of the GAC treatment system, discharge limits for volatile organics should be met without any additional treatment required for the treated effluent.

It is estimated that it will take 6 years to achieve satisfactory cleanup of the groundwater at Site 11.

6.2.7.2 Costs

The estimated capital and O&M (present worth) costs for design and implementation of the proposed preferred alternatives is $1,283,000. The costs on a media-specific basis are summarized in Table 6-8. These costs represent engineering, construction, and disposal expenses required in implementing all phases of the preferred alternatives.

6.3 COST SUMMARY

Total estimated costs for the proposed preferred alternatives are provided in the following table:

Site	Cost Estimate
Site 2 - Apple Orchard Landfill	$ 600,000
Site 3 - Pistol Range Landfill	$ 891,000
Site 4 - Chemical Burial Site	$ 2,460,000
Site 7 - Ordnance Burn Area	$ 3,384,000
Site 8 - Abandoned Chemical Disposal Pit	$ 857,000
Site 9 - Industrial Wastewater Disposal Area 300	$ 1,499,000
Site 11 - Industrial Wastewater Disposal Area 100	$ 1,283,000
TOTAL COSTS	**$ 10,974,000**

TABLE 6-8

SITE 11 PREFERRED ALTERNATIVES - COST ESTIMATE

PREFERRED ALTERNATIVE	ALTERNATIVE COMPONENTS	COST ESTIMATE
Soils/Leaching Wells		
Soil/leaching wells excavation, on-site thermal treatment of soils, on-site diposal of treatment residuals and off-site disposal of buried materials	Soil/leaching wells excavation On-site thermal treatment of soils On-site disposal of treatment residuals Off-site disposal of buried materials	$ 11,000 75,000 12,000 33,000
	Subtotal	**$ 131,000**
Groundwater		
Extraction, activated carbon treatment and discharge to surface water	Groundwater collection Activated carbon treatment Discharge to surface water O&M Costs (Present Worth)	$ 397,000 237,000 165,000 353,000
	Subtotal	**$ 1,152,000**
TOTAL ESTIMATED COST FOR PREFERRED ALTERNATIVES		**$ 1,283,000**

Notes:

1. Capital costs for soil components include a Contingency allowance (25%).

2. Capital costs for groundwater components include allowances for the following:

   Contingency - 25%
   Installation/Construction - 50%
   Engineering - 25%
   Electrical - 20%

Costs were estimated for each site on a basis independent of the existence of the other sites on the facility. However, if the remedial actions for each site are initiated concurrent with each other using the same remedial contractors, then factors such as the following will decrease the overall estimated remedial costs:

- Decrease in mobilization/demobilization fees.
- Decrease in unit rates for items such as soil treatment costs and groundwater drilling rates.
- Combining of alternatives for sites such as only requiring one activated carbon treatment system to treat the groundwater from Sites 4 and 7 instead of having dedicated systems for each site.

APPENDIX A

COST ESTIMATES

SITE #2 APPLE ORCHARD LANDFILL
SOIL REMEDIATION
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$2,200
SUBTOTAL	$9,000	$3,700
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$900
ECONOMIC ANALYSIS		
TOTALS	$11,000	$5,000
PRESENT WORTH OF O & M	**$51,000**	
TOTAL PRESENT WORTH	**$62,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #2 APPLE ORCHARD LANDFILL
SOIL REMEDIATION
CAPPING (TOP SOIL)

	CAPITAL	O & M
SITE CLEARING	$2,400	
GRADING (INCLUDES ADDITIONAL FILL COST)	$62,000	
TOP SOIL CAP (@ 6-INCH THICKNESS)	$20,000	
SYNTHETIC FILTER FABRIC	$12,000	
SEDIMENT AND EROSION CONTROL	$4,000	
SLOPE PROTECTION	$24,400	
SEEDING	$2,800	
SEED PROTECTION	$3,200	
TOP SOIL FOR SEEDING (@ 3-INCH THICKNESS)	$10,000	
GROUNDWATER MONITORING	$9,000	$1,500
ANALYTICAL		$2,200
SUBTOTAL	$150,000	$3,700
ALLOWANCES		
CONTINGENCY (25%)	$37,500	$900
INSTALLATION/CONSTRUCTION (50%)	$75,000	
ENGINEERING (25%)	$37,500	
ECONOMIC ANALYSIS		
TOTALS	$300,000	$5,000
PRESENT WORTH OF O & M	**$51,000**	
TOTAL PRESENT WORTH	**$351,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE # 2 APPLE ORCHARD LANDFILL
SOIL REMEDIATION
CAPPING (CLAY)

	CAPITAL	O & M
SITE CLEARING	$2,400	
GRADING (INCLUDES ADDITIONAL FILL COST)	$62,000	
CLAY CAP (@ 6-INCH THICKNESS)	$16,000	
SYNTHETIC FILTER FABRIC	$12,000	
SEDIMENT AND EROSION CONTROL	$4,000	
SLOPE PROTECTION	$24,400	
SEEDING	$2,800	
SEED PROTECTION	$3,200	
TOP SOIL FOR SEEDING (@ 3-INCH THICKNESS)	$10,000	
GROUNDWATER MONITORING	$9,000	$1,500
ANALYTICAL		$2,200
SUBTOTAL	$146,000	$3,700
ALLOWANCES		
CONTINGENCY (25%)	$36,500	$900
INSTALLATION/CONSTRUCTION (50%)	$73,000	
ENGINEERING (25%)	$36,500	
ECONOMIC ANALYSIS		
TOTALS	$292,000	$5,000
PRESENT WORTH OF O & M	**$51,000**	
TOTAL PRESENT WORTH	**$343,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE#2 APPLE ORCHARD LANDFILL
SOIL REMEDIATION
CAPPING (SYNTHETIC MATERIAL)

	CAPITAL	O & M
SITE CLEARING	$2,400	
GRADING (INCLUDES ADDITIONAL FILL COST)	$62,000	
HDPE SYNTHETIC MEMBRANE	$64,000	
SYNTHETIC FILTER FABRIC (2 LAYERS)	$24,000	
DRAINAGE NET	$26,800	
TOP SOIL FOR CAPPING (@ 6 – INCHES THICKNESS)	$20,000	
SEDIMENT AND EROSION CONTROL	$4,000	
SLOPE PROTECTION	$24,400	
SEEDING	$2,800	
SEED PROTECTION	$3,200	
TOP SOIL FOR SEEDING (@ 3–INCH THICKNESS)	$10,000	
GROUNDWATER MONITORING	$9,000	$1,500
ANALYTICAL		$2,200
SUBTOTAL	$253,000	$3,700
ALLOWANCES		
CONTINGENCY (25%)	$63,250	$900
INSTALLATION/CONSTRUCTION (50%)	$126,500	
ENGINEERING (25%)	$63,250	
ECONOMIC ANALYSIS		
TOTALS	$506,000	$5,000
PRESENT WORTH OF O & M	$51,000	
TOTAL PRESENT WORTH	$557,000	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi–annual basis.

SITE #2 APPLE ORCHARD LANDFILL
SEDIMENT REMEDIATION
NO ACTION

	CAPITAL	O & M
SOIL SEDIMENT SAMPLING AND MONITORING ON SITE WELLS	$9,000	$1,500
ANALYTICAL		$2,200
SUBTOTAL	$9,000	$3,700
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$900
ECONOMIC ANALYSIS		
TOTALS	$11,000	$5,000
PRESENT WORTH OF O & M	**$51,000**	
TOTAL PRESENT WORTH	**$62,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #2 APPLE ORCHARD LANDFILL
SEDIMENT REMEDIATION
EXCAVATION

	CAPITAL
EXCAVATION	$1,800
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$2,200
SUBTOTAL	$5,500
ALLOWANCES	
CONTINGENCY (25%)	$1,375
TOTAL	$7,000

NOTES:

1. Analytical cost reflects two sampling phases after excavation is completed.
2. Totals were rounded to the nearest thousands.

SITE #2 APPLE ORCHARD LANDFILL
SEDIMENT REMEDIATION
ON – SITE THERMAL TREATMENT

	CAPITAL
STAGING	$1,700
THERMAL TREATMENT	$16,700
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$2,500
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$2,100
SUBTOTAL	$25,000
ALLOWANCES	
CONTINGENCY (25%)	$6,000
TOTAL	$31,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #2 APPLE ORCHARD LANDFILL
SEDIMENT REMEDIATION
OFF – SITE INCINERATION

	CAPITAL
LOADING & HAULING TO TREATMENT SITE	$64,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$2,500
INCINERATION	$551,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$2,200
SUBTOTAL	$621,000
ALLOWANCES	
CONTINGENCY (25%)	$155,000
TOTAL	$776,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #2 APPLE ORCHARD LANDFILL
SEDIMENT REMEDIATION
ON – SITE SOIL WASHING

	CAPITAL
STAGING	$1,700
SOIL WASHING	$62,500
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$2,500
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$2,200
SUBTOTAL	$70,400
ALLOWANCES	
CONTINGENCY (25%)	$18,000
TOTAL	$88,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #2 APPLE ORCHARD LANDFILL
SEDIMENT REMEDIATION
OFF – SITE SOIL WASHING

	CAPITAL
LOADING & HAULING TO TREATMENT SITE	$39,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$2,500
SOIL WASHING	$37,500
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$2,200
SUBTOTAL	$83,000
ALLOWANCES	
CONTINGENCY (25%)	$21,000
TOTAL	$104,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #2 APPLE ORCHARD LANDFILL
SEDIMENT REMEDIATION
ON – SITE GLYCOLATE DECHLORINATION

	CAPITAL
STAGING	$1,700
DECHLORINATION	$73,500
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$2,500
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$2,200
SUBTOTAL	$81,400
ALLOWANCES	
CONTINGENCY (25%)	$20,000
TOTAL	$101,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #2 APPLE ORCHARD LANDFILL
SEDIMENT REMEDIATION
OFF – SITE GLYCOLATE DECHLORINATION

	CAPITAL
LOADING & HAULING TO TREATMENT SITE	$39,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$2,500
DECHLORINATION	$50,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$2,200
SUBTOTAL	$95,000
ALLOWANCES	
CONTINGENCY (25%)	$24,000
TOTAL	$119,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #2 APPLE ORCHARD LANDFILL
TREATMENT RESIDUE DISPOSAL
ON – SITE DISPOSAL

	CAPITAL
STAGING	$1,700
GRADING	$2,500
SUBTOTAL	$4,200
ALLOWANCES	
CONTINGENCY (25%)	$1,000
TOTAL	$5,000

SITE #2 APPLE ORCHARD LANDFILL
TREATMENT RESIDUE DISPOSAL
LANDFILL

	CAPITAL
LOADING & HAULING TO LANDFILL	$64,000
LANDFILL	$17,000
SUBTOTAL	$81,000
ALLOWANCES	
CONTINGENCY (25%)	$20,000
TOTAL	$101,000

SITE #2 APPLE ORCHARD LANDFILL
OFF - SITE SEDIMENT DISPOSAL
LANDFILL

	CAPITAL
LOADING & HAULING TO LANDFILL	$64,000
LANDFILL	$25,000
SUBTOTAL	$89,000
ALLOWANCES	
CONTINGENCY (25%)	$22,000
TOTAL	$111,000

SITE #3 PISTOL RANGE LANDFILL
SOIL REMEDIATION
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$2,800
SUBTOTAL	$9,000	$4,300
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$1,100
ECONOMIC ANALYSIS		
TOTALS	$11,000	$5,000
PRESENT WORTH OF O & M	**$61,000**	
TOTAL PRESENT WORTH	**$72,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #3 PISTOL RANGE LANDFILL
SOIL REMEDIATION
CAPPING (TOP SOIL)

	CAPITAL	O & M
SITE CLEARING	$1,200	
GRADING (INCLUDES ADDITIONAL FILL COST)	$53,000	
TOP SOIL CAP (@ 6-INCH THICKNESS)	$14,500	
SYNTHETIC FILTER FABRIC	$9,400	
SEDIMENT AND EROSION CONTROL	$2,500	
SLOPE PROTECTION	$13,800	
SEEDING	$2,200	
SEED PROTECTION	$2,500	
TOP SOIL FOR SEEDING (@ 3-INCH THICKNESS)	$7,300	
GROUNDWATER MONITORING	$9,000	$1,500
ANALYTICAL COST		$2,800
SUBTOTAL	$115,000	$4,300
ALLOWANCES		
CONTINGENCY (25%)	$28,750	$1,100
INSTALLATION/CONSTRUCTION (50%)	$57,500	
ENGINEERING (25%)	$28,750	
ECONOMIC ANALYSIS		
TOTALS	$230,000	$5,000
PRESENT WORTH OF O & M	**$61,000**	
TOTAL PRESENT WORTH	**$291,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #3 PISTOL RANGE LANDFILL
SOIL REMEDIATION
CAPPING (CLAY)

	CAPITAL	O & M
SITE CLEARING	$550	
GRADING (INCLUDES ADDITIONAL FILL COST)	$53,000	
CLAY CAP (@ 6-INCH THICKNESS)	$12,000	
SYNTHETIC FILTER FABRIC	$9,400	
SEDIMENT AND EROSION CONTROL	$2,500	
SLOPE PROTECTION	$13,800	
SEEDING	$2,200	
SEED PROTECTION	$2,500	
TOP SOIL FOR SEEDING (@ 3-INCH THICKNESS)	$7,300	
GROUNDWATER MONITORING	$9,000	$1,500
ANALYTICAL COST		$2,800
SUBTOTAL	$112,000	$4,300
ALLOWANCES		
CONTINGENCY (25%)	$28,000	$1,100
INSTALLATION/CONSTRUCTION (50%)	$56,000	
ENGINEERING (25%)	$28,000	
ECONOMIC ANALYSIS		
TOTALS	$224,000	$5,000
PRESENT WORTH OF O & M	**$61,000**	
TOTAL PRESENT WORTH	**$285,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #3 PISTOL RANGE LANDFILL
SOIL REMEDIATION
CAPPING (SYNTHETIC MATERIAL)

	CAPITAL	O & M
SITE CLEARING	$550	
GRADING (INCLUDES ADDITIONAL FILL COST)	$53,000	
HDPE SYNTHETIC MEMBRANE	$49,500	
SYNTHETIC FILTER FABRIC (2 LAYERS)	$18,700	
DRAINAGE NET	$20,800	
TOP SOIL FOR CAPPING (@ 6 – INCHES THICKNESS)	$14,500	
SEDIMENT AND EROSION CONTROL	$2,500	
SLOPE PROTECTION	$13,800	
SEEDING	$2,200	
SEED PROTECTION	$2,500	
TOP SOIL FOR SEEDING (@ 3–INCH THICKNESS)	$7,300	
GROUNDWATER MONITORING	$9,000	$1,500
ANALYTICAL COST		$2,800
SUBTOTAL	$194,000	$4,300
ALLOWANCES		
CONTINGENCY (25%)	$48,500	$1,100
INSTALLATION/CONSTRUCTION (50%)	$97,000	
ENGINEERING (25%)	$48,500	
ECONOMIC ANALYSIS		
TOTALS	$388,000	$5,000
PRESENT WORTH OF O & M	**$61,000**	
TOTAL PRESENT WORTH	**$449,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi–annual basis.

SITE #3 PISTOL RANGE LANDFILL
GROUNDWATER REMEDIATION
NO ACTION

	CAPITAL	O & M
MONITORING ON SITE WELLS	$9,000	$3,000
ANALYTICAL		$3,200
SUBTOTAL	$9,000	$6,200
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$1,550
ECONOMIC ANALYSIS		
TOTALS	$11,000	$8,000
PRESENT WORTH OF O & M	**$87,000**	
TOTAL PRESENT WORTH	**$98,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #3 PISTOL RANGE LANDFILL
GROUNDWATER COLLECTION

	CAPITAL	O & M
MANHOLES FOR PUMPS & CONTROLS	$3,000	
WELL INSTALLATION & DEVELOPMENT	$12,600	
PIPING	$23,000	
PUMPS	$4,000	
TANK	$12,000	
POWER		$1,200
LABOR FOR PUMPS & WELLS CHECK-UP OPERATIONS		$20,000
SUBTOTAL	$55,000	$21,200
ALLOWANCES		
CONTINGENCY (25%)	$13,750	$5,300
INSTALLATION/CONSTRUCTION (50%)	$27,500	
ENGINEERING (25%)	$13,750	
ELECTRICAL (20%)	$11,000	
ECONOMIC ANALYSIS		
TOTALS	$121,000	$27,000
PRESENT WORTH OF O & M	**$27,000**	
TOTAL PRESENT WORTH	**$148,000**	

Notes

1 For present worth calculation; interest rate = 10%; inflation = 6%; and project life = 1 year

2. Contingencies were applied to both capital cost and O & M costs.

3. Totals were rounded to the nearest thousands.

SITE #3 PISTOL RANGE LANDFILL
GROUNDWATER REMEDIATION
AIR STRIPPING

	CAPITAL	O & M
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$4,000	$1,000
AIR STRIPPER	$20,000	$2,100
SCRUBBER	$7,200	$1,300
LABOR FOR CHECK – UP OPERATIONS		$20,000
SUBTOTAL	$66,000	$24,400
ALLOWANCES		
CONTINGENCY (25%)	$16,500	$6,100
INSTALLATION/CONSTRUCTION (50%)	$33,000	
ENGINEERING (25%)	$16,500	
ELECTRICAL (20%)	$13,200	
ECONOMIC ANALYSIS		
TOTALS	$145,000	$31,000
PRESENT WORTH OF O & M	**$31,000**	
TOTAL PRESENT WORTH	**$176,000**	

Notes

1 For present worth calculation; interest rate = 10%; inflation = 6%; and project life = 1 year

2. Contingencies were applied to both capital cost and O & M costs.

3. Totals were rounded to the nearest thousands.

SITE #3 PISTOL RANGE LANDFILL
GROUNDWATER REMEDIATION
ACTIVATED CARBON

	CAPITAL	O & M
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$4,000	$1,000
ACTIVATED CARBON	$16,000	$2,000
LABOR FOR CHECK-UP OPERATIONS		$20,000
SUBTOTAL	$55,000	$23,000
ALLOWANCES		
CONTINGENCY (25%)	$13,750	$5,800
INSTALLATION/CONSTRUCTION (50%)	$27,500	
ENGINEERING (25%)	$13,750	
ELECTRICAL (20%)	$11,000	
ECONOMIC ANALYSIS		
TOTALS	$121,000	$29,000
PRESENT WORTH OF O & M	**$29,000**	
TOTAL PRESENT WORTH	**$150,000**	

NOTES:

1 For present worth calculation; interest rate = 10%; inflation = 6%; and project life = 1 year

2. Contingencies were applied to both capital cost and O & M costs.

3. Totals were rounded to the nearest thousands.

SITE #3 PISTOL RANGE LANDFILL
TREATED GROUNDWATER DISPOSAL

	CAPITAL	O & M
PUMPS	$10,000	
TANK	$35,000	
POWER		$3,000
PIPING	$12,000	
DISCHARGE MONITORING	$10,000	$5,000
ANALYTICAL		$10,400
SUBTOTAL	$67,000	$18,400
ALLOWANCES		
CONTINGENCY (25%)	$16,750	$4,600
INSTALLATION/CONSTRUCTION (50%)	$33,500	
ENGINEERING (25%)	$16,750	
ELECTRIAL (20%)	$13,400	
ECONOMIC ANALYSIS		
TOTALS	$147,000	$23,000
PRESENT WORTH OF O & M	**$23,000**	
TOTAL PRESENT WORTH	**$170,000**	

Notes

1 For present worth calculation; interest rate = 10%; inflation = 6%; and project life = 1 year

2. Contingencies were applied to both capital cost and O & M costs.

3. Totals were rounded to the nearest thousands.

SITE #4 CHEMICAL BURIAL SITE
SOIL REMEDIATION
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$2,800
SUBTOTAL	$9,000	$4,300
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$1,100
ECONOMIC ANALYSIS		
TOTALS	$11,000	$5,000
PRESENT WORTH OF O & M	**$61,000**	
TOTAL PRESENT WORTH	**$72,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #4 CHEMICAL BURIAL SITE
SOIL REMEDIATION
CAPPING (TOP SOIL)

	CAPITAL	O & M
SITE CLEARING	$1,000	
GRADING	$8,500	
TOP SOIL CAP (@ 6-INCH THICKNESS)	$18,000	
SYNTHETIC FILTER FABRIC	$12,000	
SEDIMENT AND EROSION CONTROL	$5,000	
SEEDING	$2,800	
SEED PROTECTION	$3,200	
TOP SOIL FOR SEEDING (@ 3-INCH THICKNESS)	$9,000	
GROUNDWATER MONITORING	$9,000	$1,500
ANALYTICAL		$2,800
SUBTOTAL	**$69,000**	**$4,300**
ALLOWANCES		
CONTINGENCY (25%)	$17,250	$1,100
INSTALLATION/CONSTRUCTION (50%)	$34,500	
ENGINEERING (25%)	$17,250	
ECONOMIC ANALYSIS		
TOTALS	**$138,000**	**$5,000**
PRESENT WORTH OF O & M	**$61,000**	
TOTAL PRESENT WORTH	**$199,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #4 CHEMICAL BURIAL SITE
SOIL REMEDIATION
CAPPING (CLAY)

	CAPITAL	O & M
SITE CLEARING	$1,000	
GRADING	$8,500	
CLAY CAP (@ 6-INCH THICKNESS)	$15,000	
SYNTHETIC FILTER FABRIC	$12,000	
SEDIMENT AND EROSION CONTROL	$5,000	
SEEDING	$2,800	
SEED PROTECTION	$3,200	
TOP SOIL FOR SEEDING (@ 3-INCH THICKNESS)	$9,000	
GROUNDWATER MONITORING	$9,000	$1,500
ANALYTICAL		$2,800
SUBTOTAL	$66,000	$4,300
ALLOWANCES		
CONTINGENCY (25%)	$16,500	$1,100
INSTALLATION/CONSTRUCTION (50%)	$33,000	
ENGINEERING (25%)	$16,500	
ECONOMIC ANALYSIS		
TOTALS	$132,000	$5,000
PRESENT WORTH OF O & M	**$61,000**	
TOTAL PRESENT WORTH	**$193,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #4 CHEMICAL BURIAL SITE
SOIL REMEDIATION
CAPPING (SYNTHETIC MATERIAL)

	CAPITAL	O & M
SITE CLEARING	$1,000	
GRADING	$8,500	
HDPE SYNTHETIC MEMBRANE	$63,000	
SYNTHETIC FILTER FABRIC (2 LAYERS) (2 LAYERS)	$24,000	
DRAINAGE NET	$26,400	
TOP SOIL FOR CAPPING (@ 6 – INCHES THICKNESS)	$18,000	
SEDIMENT AND EROSION CONTROL	$5,000	
SEEDING	$2,800	
SEED PROTECTION	$3,200	
TOP SOIL FOR SEEDING (@ 3–INCH THICKNESS)	$9,000	
GROUNDWATER MONITORING	$9,000	$1,500
ANALYTICAL		$2,800
SUBTOTAL	$170,000	$4,300
ALLOWANCES		
CONTINGENCY (25%)	$43,000	$1,100
INSTALLATION/CONSTRUCTION (50%)	$85,000	
ENGINEERING (25%)	$43,000	
ECONOMIC ANALYSIS		
TOTALS	$341,000	$5,000
PRESENT WORTH OF O & M	**$61,000**	
TOTAL PRESENT WORTH	**$402,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi–annual basis.

SITE #4 CHEMICAL BURIAL SITE
SOIL REMEDIATION
EXCAVATION

	CAPITAL
EXCAVATION	$53,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$2,200
SUBTOTAL	$57,000
ALLOWANCES	
CONTINGENCY (25%)	$14,000
TOTAL	$71,000

NOTES:

1. Analytical cost reflects two sampling phases after excavation is completed.
2. Totals were rounded to the nearest thousands.

SITE #4 CHEMICAL BURIAL SITE
SOIL REMEDIATION
ON-SITE THERMAL TREATMENT

	CAPITAL
STAGING	$25,000
THERMAL TREATMENT	$500,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$75,000
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$4,200
SUBTOTAL	$607,000
ALLOWANCES	
CONTINGENCY (25%)	$152,000
TOTAL	$759,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #4 CHEMICAL BURIAL SITE
SOIL REMEDIATION
OFF-SITE INCINERATION

	CAPITAL
HAULING MATERIAL TO TREATMENT SITE	$1,910,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$75,000
INCINERATION	$16,500,000
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$4,200
SUBTOTAL	$18,492,000
ALLOWANCES	
CONTINGENCY (25%)	$4,623,000
TOTAL	$23,115,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #4 CHEMICAL BURIAL SITE
SOIL REMEDIATION
ON-SITE SOIL WASHING

	CAPITAL
STAGING	$25,000
SOIL WASHING	$1,125,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$75,000
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$4,200
SUBTOTAL	$1,232,000
ALLOWANCES	
CONTINGENCY (25%)	$308,000
TOTAL	$1,540,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #4 CHEMICAL BURIAL SITE
SOIL REMEDIATION
OFF-SITE SOIL WASHING

	CAPITAL
LOADING & HAULING TO TREATMENT SITE	$1,160,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$75,000
SOIL WASHING	$750,000
CONFIRMATION SAMPLING	$3,000
ANALYTICAL	$4,200
SUBTOTAL	$1,992,000
ALLOWANCES	
CONTINGENCY (25%)	$498,000
TOTAL	$2,490,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #4 CHEMICAL BURIAL SITE
TREATMENT RESIDUE DISPOSAL
ON-SITE DISPOSAL

	CAPITAL
STAGING	$25,000
GRADING	$5,000
SUBTOTAL	$30,000
ALLOWANCES	
CONTINGENCY (25%)	$7,500
TOTAL	**$38,000**

SITE #4 CHEMICAL BURIAL SITE
TREATMENT RESIDUE DISPOSAL
LANDFILL

	CAPITAL
LOADING & HAULING TO LANDFILL	$1,910,000
LANDFILL	$500,000
SUBTOTAL	$2,410,000
ALLOWANCES	
CONTINGENCY (25%)	$603,000
TOTAL	$3,013,000

SITE #4 CHEMICAL BURIAL SITE
BURIED WASTE DISPOSAL
LANDFILL

	CAPITAL
LOADING & HAULING TO LANDFILL	$76,000
LANDFILL	$30,000
SUBTOTAL	$106,000
ALLOWANCES	
CONTINGENCY (25%)	$27,000
TOTAL	$133,000

SITE #4 CHEMICAL BURIAL SITE
GROUNDWATER REMEDIATION
NO ACTION

	CAPITAL	O & M
MONITORING ON SITE WELLS	$9,000	$3,000
ANALYTICAL		$3,200
SUBTOTAL	$9,000	$6,200
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$1,550
ECONOMIC ANALYSIS		
TOTALS	$11,000	$8,000
PRESENT WORTH OF O & M	**$87,000**	
TOTAL PRESENT WORTH	**$98,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #4 CHEMICAL BURIAL SITE
GROUNDWATER COLLECTION

	CAPITAL	O & M
MANHOLES FOR PUMPS & CONTROLS	$8,000	
WELL INSTALLATION & DEVELOPMENT	$76,000	
PIPING	$115,500	
PUMPS	$12,000	
TANK	$20,000	
POWER		$2,800
LABOR FOR PUMPS & WELLS CHECK-UP OPERATIONS		$33,000
SUBTOTAL	$231,500	$35,800
ALLOWANCES		
CONTINGENCY (25%)	$57,875	$8,950
INSTALLATION/CONSTRUCTION (50%)	$115,750	
ENGINEERING (25%)	$57,875	
ELECTRICAL (20%)	$46,300	
ECONOMIC ANALYSIS		
TOTALS	$509,000	$45,000
PRESENT WORTH OF O & M	**$302,000**	
TOTAL PRESENT WORTH	**$811,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 10 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

SITE #4 CHEMICAL BURIAL SITE
GROUNDWATER REMEDIATION
AIR STRIPPING

	CAPITAL	O & M
BUILDING	$35,000	
FENCE	$10,000	
FILTRATION	$20,000	$2,500
AIR STRIPPER	$75,000	$3,150
SCRUBBER	$36,000	$2,000
LABOR FOR CHECK-UP OPERATIONS		$33,000
SUBTOTAL	$176,000	$40,650
ALLOWANCES		
CONTINGENCY (25%)	$44,000	$10,160
INSTALLATION/CONSTRUCTION (50%)	$88,000	
ENGINEERING (25%)	$44,000	
ELECTRICAL (20%)	$35,200	
ECONOMIC ANALYSIS		
TOTALS	$387,000	$51,000
PRESENT WORTH OF O & M	**$343,000**	
TOTAL PRESENT WORTH	**$730,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 10 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

SITE #4 CHEMICAL BURIAL SITE
GOUNDWATER REMEDIATION
ACTIVATED CARBON

	CAPITAL	O & M
BUILDING	$35,000	
FENCE	$10,000	
FILTRATION	$20,000	$2,500
ACTIVATED CARBON	$72,000	$3,500
LABOR FOR CHECK-UP OPERATIONS		$33,000
SUBTOTAL	$137,000	$39,000
ALLOWANCES		
CONTINGENCY (25%)	$34,250	$9,750
INSTALLATION/CONSTRUCTION (50%)	$68,500	
ENGINEERING (25%)	$34,250	
ELECTRICAL (20%)	$27,400	
ECONOMIC ANALYSIS		
TOTALS	$301,000	$49,000
PRESENT WORTH OF O & M	**$329,000**	
TOTAL PRESENT WORTH	**$630,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 10 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

SITE #4 CHEMICAL BURIAL SITE
TREATED GROUNDWATER DISPOSAL

	CAPITAL	O & M
PUMPS	$10,000	
TANK	$35,000	
POWER		$3,000
PIPING	$23,000	
DISCHARGE MONITORING	$10,000	$5,000
ANALYTICAL		$10,400
SUBTOTAL	$78,000	$18,400
ALLOWANCES		
CONTINGENCY (25%)	$19,500	$5,000
INSTALLATION/CONSTRUCTION (50%)	$39,000	
ENGINEERING (25%)	$19,500	
ELECTRICAL (20%)	$15,600	
ECONOMIC ANALYSIS		
TOTALS	$172,000	$23,000
PRESENT WORTH OF O & M	**$167,000**	
TOTAL PRESENT WORTH	**$339,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 10 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

SITE #7 ORDNANCE BURN AREA
SOIL REMEDIATION
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$6,000
SUBTOTAL	$9,000	$7,500
ALLOWANCES		
CONTINGENCY (25%)	$2,300	$1,900
ECONOMIC ANALYSIS		
TOTALS	$11,000	$9,000
PRESENT WORTH OF O & M	**$106,000**	
TOTAL PRESENT WORTH	**$117,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #7 ORDNANCE BURN AREA
SOIL REMEDIATION
CAPPING (TOP SOIL)

	CAPITAL	O & M
SITE CLEARING	$550	
GRADING (INCLUDES ADDITIONAL FILL COST)	$20,000	
TOP SOIL CAP (@ 6-INCH THICKNESS)	$4,200	
SYNTHETIC FILTER FABRIC	$2,700	
SEDIMENT AND EROSION CONTROL	$3,500	
SEEDING	$600	
SEED PROTECTION	$700	
TOP SOIL FOR SEEDING (@ 3-INCH THICKNESS)	$2,100	
GROUNDWATER MONITORING	$9,000	$1,500
ANALYTICAL		$5,000
SUBTOTAL	$43,400	$6,500
ALLOWANCES		
CONTINGENCY (25%)	$10,900	$1,600
INSTALLATION/CONSTRUCTION (50%)	$21,700	
ENGINEERING (25%)	$10,900	
ECONOMIC ANALYSIS		
TOTALS	$87,000	$8,000
PRESENT WORTH OF O & M	**$90,000**	
TOTAL PRESENT WORTH	**$177,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #7 ORDNANCE BURN AREA
SOIL REMEDIATION
CAPPING (CLAY)

	CAPITAL	O & M
SITE CLEARING	$550	
GRADING (INCLUDES ADDITIONAL FILL COST)	$20,000	
CLAY CAP (@ 6-INCH THICKNESS)	$3,500	
SYNTHETIC FILTER FABRIC	$2,700	
SEDIMENT AND EROSION CONTROL	$3,500	
SEEDING	$600	
SEED PROTECTION	$700	
TOP SOIL FOR SEEDING (@ 3-INCH THICKNESS)	$2,100	
GROUNDWATER MONITORING	$9,000	$1,500
ANALYTICAL		$5,000
SUBTOTAL	$42,700	$6,500
ALLOWANCES		
CONTINGENCY (25%)	$10,700	$1,600
INSTALLATION/CONSTRUCTION (50%)	$21,400	
ENGINEERING (25%)	$10,700	
ECONOMIC ANALYSIS		
TOTALS	$86,000	$8,000
PRESENT WORTH OF O & M	**$90,000**	
TOTAL PRESENT WORTH	**$176,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #7 ORDNANCE BURN AREA
SOIL REMEDIATION
CAPPING (SYNTHETIC MATERIAL)

	CAPITAL	O & M
SITE CLEARING	$550	
GRADING (INCLUDES ADDITONAL FILL COST)	$20,000	
HDPE SYNTHETIC MEMBRANE	$14,300	
SYNTHETIC FILTER FABRIC (2 LAYERS)	$5,400	
DRAINAGE NET	$6,000	
TOP SOIL FOR CAPPING (@ 6 – INCHES THICKNESS)	$4,200	
SEDIMENT AND EROSION CONTROL	$3,500	
SEEDING	$600	
SEED PROTECTION	$700	
TOP SOIL FOR SEEDING (@ 3–INCH THICKNESS)	$2,100	
GROUNDWATER MONITORING	$9,000	$1,500
ANALYTICAL		$5,000
SUBTOTAL	$66,400	$6,500
ALLOWANCES		
CONTINGENCY (25%)	$16,600	$1,600
INSTALLATION/CONSTRUCTION (50%)	$33,200	
ENGINEERING (25%)	$16,600	
ECONOMIC ANALYSIS		
TOTALS	$133,000	$8,000
PRESENT WORTH OF O & M	**$90,000**	
TOTAL PRESENT WORTH	**$223,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi–annual basis.

SITE #7 ORDNANCE BURN AREA
SOIL REMEDIATION
EXCAVATION

	CAPITAL
EXCAVATION	$36,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$6,000
SUBTOTAL	$43,500
ALLOWANCES	
CONTINGENCY (25%)	$11,000
TOTAL	$55,000

NOTES:

1. Analytical cost reflects two sampling phases after excavation is completed.
2. Totals were rounded to the nearest thousands.

SITE #7 ORDNANCE BURN AREA
SOIL REMEDIATION
ON-SITE SOIL WASHING

	CAPITAL
STAGING	$17,000
SOIL WASHING	$765,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$51,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$6,000
SUBTOTAL	$840,500
ALLOWANCES	
CONTINGENCY (25%)	$210,000
TOTAL	$1,051,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #7 ORDNANCE BURN AREA
SOIL REMEDIATION
OFF-SITE SOIL WASHING

	CAPITAL
LOADING & HAULING TO TREATMENT SITE	$789,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$510,000
SOIL WASHING	$51,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$6,000
SUBTOTAL	$1,357,500
ALLOWANCES	
CONTINGENCY (25%)	$339,000
TOTAL	$1,697,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #7 ORDNANCE BURN AREA
SOIL REMEDIATION
IN-SITU FLUSHING

	CAPITAL
MOBILIZATION AND DEMOBILIZATION OF RECOVERY SYSTEM PROCESS TRAILER	$15,000
SOIL FLUSHING	$1,670,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$6,000
SUBTOTAL	$1,692,500
ALLOWANCES	
CONTINGENCY (25%)	$423,000
ENGINEERING (25%)	$423,000
TOTAL	$2,539,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #7 ORDNANCE BURN AREA
SOIL REMEDIATION
IN-SITU FIXATION

	CAPITAL
FIXATION	$2,917,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$6,000
SUBTOTAL	$2,924,500
ALLOWANCES	
CONTINGENCY (25%)	$731,000
ENGINEERING (25%)	$731,000
TOTAL	$4,387,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #7 ORDNANCE BURN AREA
TREATMENT RESIDUE DISPOSAL
ON – SITE DISPOSAL

	CAPITAL
STAGING	$17,000
GRADING	$3,400
SUBTOTAL	$20,400
ALLOWANCES	
CONTINGENCY (25%)	$5,100
TOTAL	$26,000

SITE #7 ORDNANCE BURN AREA
TREATMENT RESIDUE DISPOSAL
LANDFILL

	CAPITAL
LOADING & HAULING TO LANDFILL	$1,299,000
LANDFILL	$340,000
SUBTOTAL	$1,639,000
ALLOWANCES	
CONTINGENCY (25%)	$410,000
TOTAL	$2,049,000

SITE #7 ORDNANCE BURN AREA
GROUNDWATER REMEDIATION
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$6,000
SUBTOTAL	$9,000	$7,500
ALLOWANCES		
CONTINGENCY (25%)	$2,300	$1,900
ECONOMIC ANALYSIS		
TOTALS	$11,000	$9,000
PRESENT WORTH OF O & M	**$106,000**	
TOTAL PRESENT WORTH	**$117,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #7 ORDNANCE BURN AREA
GROUNDWATER COLLECTION

	CAPITAL	O & M
MANHOLES FOR PUMPS & CONTROLS	$3,000	
WELL INSTALLATION & DEVELOPMENT	$23,400	
PIPING	$15,000	
PUMPS	$6,000	
TANK	$12,000	
POWER		$1,300
LABOR FOR PUMPS & WELLS CHECK-UP OPERATIONS		$20,000
SUBTOTAL	$59,400	$21,300
ALLOWANCES		
CONTINGENCY (25%)	$14,850	$5,300
INSTALLATION/CONSTRUCTION (50%)	$29,700	
ENGINEERING (25%)	$14,850	
ELECTRICAL (20%)	$11,900	
ECONOMIC ANALYSIS		
TOTALS	$131,000	$27,000
PRESENT WORTH OF O & M	**$38,000**	
TOTAL PRESENT WORTH	**$169,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 1.5 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

SITE #7 ORDNANCE BURN AREA
GROUNDWATER REMEDIATION
AIR STRIPPING

	CAPITAL	O & M
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$6,000	$1,500
AIR STRIPPER	$30,000	$2,600
SCRUBBER	$14,000	$1,600
LABOR FOR CHECK–UP OPERATIONS		$20,000
SUBTOTAL	$85,000	$25,700
ALLOWANCES		
CONTINGENCY (25%)	$21,250	$6,400
INSTALLATION/CONSTRUCTION (50%)	$42,500	
ENGINEERING (25%)	$21,250	
ELECTRICAL (20%)	$17,000	
ECONOMIC ANALYSIS		
TOTALS	$187,000	$32,000
PRESENT WORTH OF O & M	**$45,000**	
TOTAL PRESENT WORTH	**$232,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 1.5 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

SITE #7 ORDNANCE BURN AREA
GOUNDWATER REMEDIATION
ACTIVATED CARBON

	CAPITAL	O & M
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$6,000	$1,500
ACTIVATED CARBON	$32,000	$2,400
LABOR FOR CHECK-UP OPERATIONS		$20,000
SUBTOTAL	$73,000	$23,900
ALLOWANCES		
CONTINGENCY (25%)	$18,250	$6,000
INSTALLATION/CONSTRUCTION (50%)	$36,500	
ENGINEERING (25%)	$18,250	
ELECTRICAL (20%)	$14,600	
ECONOMIC ANALYSIS		
TOTALS	$161,000	$30,000
PRESENT WORTH OF O & M	**$42,000**	
TOTAL PRESENT WORTH	**$203,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 1.5 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

SITE #7 ORDNANCE BURN AREA
TREATED GROUNDWATER DISPOSAL

	CAPITAL	O & M
PUMPS	$10,000	
TANK	$35,000	
POWER		$3,000
PIPING	$23,000	
DISCHARGE MONITORING	$10,000	$5,000
ANALYTICAL		$26,000
SUBTOTAL	$78,000	$34,000
ALLOWANCES		
CONTINGENCY (25%)	$19,500	$8,500
INSTALLATION/CONSTRUCTION (50%)	$39,000	
ENGINEERING (25%)	$19,500	
ELECTRICAL (20%)	$15,600	
ECONOMIC ANALYSIS		
TOTALS	$172,000	$43,000
PRESENT WORTH OF O & M	**$60,000**	
TOTAL PRESENT WORTH	**$232,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 1.5 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
SOIL REMEDIATION
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$2,200
SUBTOTAL	$9,000	$3,700
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$900
ECONOMIC ANALYSIS		
TOTALS	$11,000	$5,000
PRESENT WORTH OF O & M	**$51,000**	
TOTAL PRESENT WORTH	**$62,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
SOIL REMEDIATION
CAPPING (TOP SOIL)

	CAPITAL	O & M
SITE CLEARING	$550	
GRADING (INCLUDES ADDITIONAL FILL COST)	$8,000	
TOP SOIL CAP (@ 6-INCH THICKNESS)	$1,500	
SYNTHETIC FILTER FABRIC	$940	
SEDIMENT AND EROSION CONTROL	$2,500	
SEEDING	$300	
SEED PROTECTION	$300	
TOP SOIL FOR SEEDING (@ 3-INCH THICKNESS)	$750	
GROUNDWATER MONITORING	$9,000	$1,000
ANALYTICAL		$1,600
SUBTOTAL	$24,000	$2,600
ALLOWANCES		
CONTINGENCY (25%)	$6,000	$650
INSTALLATION/CONSTRUCTION (50%)	$12,000	
ENGINEERING (25%)	$6,000	
ECONOMIC ANALYSIS		
TOTALS	$48,000	$3,000
PRESENT WORTH OF O & M	$37,000	
TOTAL PRESENT WORTH	$85,000	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
SOIL REMEDIATION
CAPPING (CLAY)

	CAPITAL	O & M
SITE CLEARING	$550	
GRADING (INCLUDES ADDITIONAL FILL COST)	$8,000	
CLAY CAP (@ 6-INCH THICKNESS)	$1,200	
SYNTHETIC FILTER FABRIC	$940	
SEDIMENT AND EROSION CONTROL	$2,500	
SEEDING	$300	
SEED PROTECTION	$300	
TOP SOIL FOR SEEDING (@ 3-INCH THICKNESS)	$750	
GROUNDWATER MONITORING	$9,000	$1,000
ANALYTICAL		$1,600
SUBTOTAL	$24,000	$2,600
ALLOWANCES		
CONTINGENCY (25%)	$6,000	$650
INSTALLATION/CONSTRUCTION (50%)	$12,000	
ENGINEERING (25%)	$6,000	
ECONOMIC ANALYSIS		
TOTALS	$48,000	$3,000
PRESENT WORTH OF O & M	**$37,000**	
TOTAL PRESENT WORTH	**$85,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
SOIL REMEDIATION
CAPPING (SYNTHETIC MATERIAL)

	CAPITAL	O & M
SITE CLEARING	$550	
GRADING (INCLUDES ADDITONAL FILL COST)	$8,000	
HDPE SYNTHETIC MEMBRANE	$5,000	
SYNTHETIC FILTER FABRIC (2 LAYERS)	$1,900	
DRAINAGE NET	$2,100	
TOP SOIL FOR CAPPING (@ 6 – INCHES THICKNESS)	$1,500	
SEDIMENT AND EROSION CONTROL	$2,500	
SEEDING	$300	
SEED PROTECTION	$300	
TOP SOIL FOR SEEDING (@ 3–INCH THICKNESS)	$750	
GROUNDWATER MONITORING	$9,000	$1,000
ANALYTICAL		$1,600
SUBTOTAL	$32,000	$2,600
ALLOWANCES		
CONTINGENCY (25%)	$8,000	$650
INSTALLATION/CONSTRUCTION (50%)	$16,000	
ENGINEERING (25%)	$8,000	
ECONOMIC ANALYSIS		
TOTALS	$64,000	$3,000
PRESENT WORTH OF O & M	**$37,000**	
TOTAL PRESENT WORTH	**$101,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi–annual basis.

SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
SOIL REMEDIATION
EXCAVATION

	CAPITAL
EXCAVATION	$15,000
CONFIRMATION SAMPLING	$1,000
ANALYTICAL	$1,600
SUBTOTAL	$18,000
ALLOWANCES	
CONTINGENCY (25%)	$4,500
TOTAL	$23,000

NOTES:

1. Analytical cost reflects two sampling phases after excavation is completed.
2. Totals were rounded to the nearest thousands.

SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
SOIL REMEDIATION
ON–SITE THERMAL TREATMENT

	CAPITAL
STAGING	$7,000
THERMAL TREATMENT	$140,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$21,000
CONFIRMATION SAMPLING	$1,000
ANALYTICAL	$1,600
SUBTOTAL	$171,000
ALLOWANCES	
CONTINGENCY (25%)	$43,000
TOTAL	$214,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
SOIL REMEDIATION
OFF-SITE INCINERATION

	CAPITAL
HAULING MATERIAL TO TREATMENT SITE	$535,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$21,000
INCINERATION	$4,620,000
CONFIRMATION SAMPLING	$1,000
ANALYTICAL	$1,600
SUBTOTAL	$5,179,000
ALLOWANCES	
CONTINGENCY (25%)	$1,295,000
TOTAL	$6,474,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
SOIL REMEDIATION
ON-SITE SOIL WASHING

	CAPITAL
STAGING	$7,000
SOIL WASHING	$315,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$21,000
CONFIRMATION SAMPLING	$1,000
ANALYTICAL	$1,600
SUBTOTAL	$346,000
ALLOWANCES	
CONTINGENCY (25%)	$87,000
TOTAL	$433,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
SOIL REMEDIATION
OFF-SITE SOIL WASHING

	CAPITAL
LOADING & HAULING TO TREATMENT SITE	$325,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$21,000
SOIL WASHING	$210,000
CONFIRMATION SAMPLING	$1,000
ANALYTICAL	$1,600
SUBTOTAL	$559,000
ALLOWANCES	
CONTINGENCY (25%)	$140,000
TOTAL	$699,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
TREATMENT RESIDUE DISPOSAL
ON – SITE DISPOSAL

	CAPITAL
STAGING	$7,000
GRADING	$3,400
SUBTOTAL	$10,400
ALLOWANCES	
CONTINGENCY (25%)	$2,600
TOTAL	$13,000

SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
TREATMENT RESIDUE DISPOSAL
LANDFILL

	CAPITAL
LOADING & HAULING TO LANDFILL	$535,000
LANDFILL	$140,000
SUBTOTAL	$675,000
ALLOWANCES	
CONTINGENCY (25%)	$168,750
TOTAL	$844,000

SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
BURIED WASTE DISPOSAL
LANDFILL

	CAPITAL
LOADING & HAULING TO LANDFILL	$76,000
LANDFILL	$30,000
SUBTOTAL	$106,000
ALLOWANCES	
CONTINGENCY (25%)	$27,000
TOTAL	$133,000

SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
GROUNDWATER REMEDIATION
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$2,800
SUBTOTAL	$9,000	$4,300
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$1,100
ECONOMIC ANALYSIS		
TOTALS	$11,000	$5,000
PRESENT WORTH OF O & M	**$61,000**	
TOTAL PRESENT WORTH	**$72,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
GROUNDWATER COLLECTION

	CAPITAL	O & M
MANHOLES FOR PUMPS & CONTROLS	$4,000	
WELL INSTALLATION & DEVELOPMENT	$30,000	
PIPING	$13,200	
PUMPS	$6,000	
TANK	$12,000	
POWER		$1,300
LABOR FOR PUMPS & WELLS CHECK-UP OPERATIONS		$27,000
SUBTOTAL	$65,200	$28,300
ALLOWANCES		
CONTINGENCY (25%)	$16,300	$7,100
INSTALLATION/CONSTRUCTION (50%)	$32,600	
ENGINEERING (25%)	$16,300	
ELECTRICAL (20%)	$13,040	
ECONOMIC ANALYSIS		
TOTALS	$143,000	$35,000
PRESENT WORTH OF O & M	**$18,000**	
TOTAL PRESENT WORTH	**$161,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 0.5 years.

2. Contingencies were applied to both capital cost and O & M costs.

3. Totals were rounded to the nearest thousands.

SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
GROUNDWATER REMEDIATION
AIR STRIPPING

	CAPITAL	O & M
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$4,000	$1,000
AIR STRIPPER	$20,000	$2,100
SCRUBBER	$7,200	$1,300
LABOR FOR CHECK-UP OPERATIONS		$27,000
SUBTOTAL	$66,000	$31,400
ALLOWANCES		
CONTINGENCY (25%)	$16,500	$7,900
INSTALLATION/CONSTRUCTION (50%)	$33,000	
ENGINEERING (25%)	$16,500	
ELECTRICAL (20%)	$13,200	
ECONOMIC ANALYSIS		
TOTALS	$145,000	$39,000
PRESENT WORTH OF O & M	**$20,000**	
TOTAL PRESENT WORTH	**$165,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 0.5 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
GOUNDWATER REMEDIATION
ACTIVATED CARBON

	CAPITAL	O & M
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$4,000	$1,000
ACTIVATED CARBON	$16,000	$2,000
LABOR FOR CHECK-UP OPERATIONS		$27,000
SUBTOTAL	$55,000	$30,000
ALLOWANCES		
CONTINGENCY (25%)	$13,750	$7,500
INSTALLATION/CONSTRUCTION (50%)	$27,500	
ENGINEERING (25%)	$13,750	
ELECTRICAL (20%)	$11,000	
ECONOMIC ANALYSIS		
TOTALS	$121,000	$38,000
PRESENT WORTH OF O & M	**$19,000**	
TOTAL PRESENT WORTH	**$140,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 0.5 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

SITE #8 ABANDONED CHEMICAL DISPOSAL PIT
TREATED GROUNDWATER DISPOSAL

	CAPITAL	O & M
PUMPS	$10,000	
TANK	$35,000	
POWER		$3,000
PIPING	$20,000	
DISCHARGE MONITORING	$16,500	$5,000
ANALYTICAL		$10,400
SUBTOTAL	$82,000	$18,400
ALLOWANCES		
CONTINGENCY (25%)	$20,500	$4,600
INSTALLATION/CONSTRUCTION (50%)	$41,000	
ENGINEERING (25%)	$20,500	
ELECTRICAL (20%)	$16,400	
ECONOMIC ANALYSIS		
TOTALS	$180,000	$23,000
PRESENT WORTH OF O & M	**$12,000**	
TOTAL PRESENT WORTH	**$192,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 0.5 years.

2. Contingencies were applied to both capital cost and O & M costs.

3. Totals were rounded to the nearest thousands.

SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
SOIL REMEDIATION
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$12,600
SUBTOTAL	$9,000	$14,100
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$3,500
ECONOMIC ANALYSIS		
TOTALS	$11,000	$18,000
PRESENT WORTH OF O & M	**$198,000**	
TOTAL PRESENT WORTH	**$209,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
SOIL REMEDIATION
EXCAVATION

	CAPITAL
EXCAVATION	$11,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$7,000
SUBTOTAL	$19,500
ALLOWANCES	
CONTINGENCY (25%)	$4,900
TOTAL	$24,000

NOTES:

1. Analytical cost reflects two sampling phases after excavation is completed.
2. Totals were rounded to the nearest thousands.

SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
SOIL REMEDIATION
ON-SITE THERMAL TREATMENT

	CAPITAL
STAGING	$5,000
THERMAL TREATMENT	$100,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$15,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$7,000
SUBTOTAL	$129,000
ALLOWANCES	
CONTINGENCY (25%)	$32,000
TOTAL	$161,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
SOIL REMEDIATION
OFF-SITE INCINERATION

	CAPITAL
HAULING MATERIAL TO TREATMENT SITE	$382,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$15,000
INCINERATION	$3,300,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$7,000
SUBTOTAL	$3,706,000
ALLOWANCES	
CONTINGENCY (25%)	$927,000
TOTAL	$4,633,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
SOIL REMEDIATION
ON-SITE SOIL WASHING

	CAPITAL
STAGING	$5,000
SOIL WASHING	$225,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$15,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$7,000
SUBTOTAL	$254,000
ALLOWANCES	
CONTINGENCY (25%)	$64,000
TOTAL	$318,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
SOIL REMEDIATION
OFF-SITE SOIL WASHING

	CAPITAL
LOADING & HAULING TO TREATMENT SITE	$232,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$15,000
SOIL WASHING	$150,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$7,000
SUBTOTAL	$406,000
ALLOWANCES	
CONTINGENCY (25%)	$102,000
TOTAL	$508,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
TREATMENT RESIDUE DISPOSAL
ON – SITE DISPOSAL

	CAPITAL
STAGING	$5,000
GRADING	$8,500
SUBTOTAL	$13,500
ALLOWANCES	
CONTINGENCY (25%)	$3,400
TOTAL	$17,000

SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
TREATMENT RESIDUE DISPOSAL
LANDFILL

	CAPITAL
LOADING & HAULING TO LANDFILL	$382,000
LANDFILL	$100,000
SUBTOTAL	$482,000
ALLOWANCES	
CONTINGENCY (25%)	$120,500
TOTAL	$603,000

SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
BURIED WASTE DISPOSAL
LANDFILL

	CAPITAL
LOADING & HAULING TO LANDFILL	$19,000
LANDFILL	$7,500
SUBTOTAL	$26,500
ALLOWANCES	
CONTINGENCY (25%)	$6,600
TOTAL	$33,000

SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
GROUNDWATER REMEDIATION
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$12,600
SUBTOTAL	$9,000	$14,100
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$3,500
ECONOMIC ANALYSIS		
TOTALS	$11,000	$18,000
PRESENT WORTH OF O & M	**$198,000**	
TOTAL PRESENT WORTH	**$209,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
GROUNDWATER COLLECTION

	CAPITAL	O & M
MANHOLES FOR PUMPS & CONTROLS	$8,000	
WELL INSTALLATION & DEVELOPMENT	$38,000	
PIPING	$66,000	
PUMPS	$10,400	
TANK	$12,000	
POWER		$2,500
LABOR FOR PUMPS & WELLS CHECK-UP OPERATIONS		$33,000
SUBTOTAL	$134,400	$35,500
ALLOWANCES		
CONTINGENCY (25%)	$33,600	$8,900
INSTALLATION/CONSTRUCTION (50%)	$67,200	
ENGINEERING (25%)	$33,600	
ELECTRICAL (20%)	$26,880	
ECONOMIC ANALYSIS		
TOTALS	$296,000	$44,000
PRESENT WORTH OF O & M	**$280,000**	
TOTAL PRESENT WORTH	**$576,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 9 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
GROUNDWATER REMEDIATION
AIR STRIPPING

	CAPITAL	O & M
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$6,000	$1,500
AIR STRIPPER	$30,000	$2,500
SCRUBBER	$14,000	$1,500
LABOR FOR CHECK–UP OPERATIONS		$33,000
SUBTOTAL	$85,000	$38,500
ALLOWANCES		
CONTINGENCY (25%)	$21,250	$9,600
INSTALLATION/CONSTRUCTION (50%)	$42,500	
ENGINEERING (25%)	$21,250	
ELECTRICAL (20%)	$17,000	
ECONOMIC ANALYSIS		
TOTALS	$187,000	$48,000
PRESENT WORTH OF O & M	**$303,000**	
TOTAL PRESENT WORTH	**$490,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 9 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
GOUNDWATER REMEDIATION
ACTIVATED CARBON

	CAPITAL	O & M
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$6,000	$1,500
ACTIVATED CARBON	$32,000	$2,300
LABOR FOR CHECK-UP OPERATIONS		$33,000
SUBTOTAL	$73,000	$36,800
ALLOWANCES		
CONTINGENCY (25%)	$18,250	$9,200
INSTALLATION/CONSTRUCTION (50%)	$36,500	
ENGINEERING (25%)	$18,250	
ELECTRICAL (20%)	$14,600	
ECONOMIC ANALYSIS		
TOTALS	$161,000	$46,000
PRESENT WORTH OF O & M	**$290,000**	
TOTAL PRESENT WORTH	**$451,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 9 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

SITE #9 INDUSTRIAL WASTEWATER DISPOSAL AREA 300
TREATED GROUNDWATER DISPOSAL

	CAPITAL	O & M
PUMPS	$10,000	
TANK	$35,000	
POWER		$3,000
PIPING	$5,000	
DISCHARGE MONITORING	$16,500	$5,000
ANALYTICAL		$36,400
SUBTOTAL	$67,000	$44,400
ALLOWANCES		
CONTINGENCY (25%)	$16,750	$11,100
INSTALLATION/CONSTRUCTION (50%)	$33,500	
ENGINEERING (25%)	$16,750	
ELECTRICAL (20%)	$13,400	
ECONOMIC ANALYSIS		
TOTALS	$147,000	$55,500
PRESENT WORTH OF O & M	**$350,000**	
TOTAL PRESENT WORTH	**$497,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 9 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
SOIL REMEDIATION
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$4,000
SUBTOTAL	$9,000	$5,500
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$1,400
ECONOMIC ANALYSIS		
TOTALS	$11,000	$7,000
PRESENT WORTH OF O & M	**$77,000**	
TOTAL PRESENT WORTH	**$88,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
SOIL REMEDIATION
EXCAVATION

	CAPITAL
EXCAVATION	$5,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$2,200
SUBTOTAL	$9,000
ALLOWANCES	
CONTINGENCY (25%)	$2,000
TOTAL	$11,000

NOTES:

1. Analytical cost reflects two sampling phases after excavation is completed.
2. Totals were rounded to the nearest thousands.

SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
SOIL REMEDIATION
ON-SITE THERMAL TREATMENT

	CAPITAL
STAGING	$4,500
THERMAL TREATMENT	$45,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$6,800
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$2,200
SUBTOTAL	$60,000
ALLOWANCES	
CONTINGENCY (25%)	$15,000
TOTAL	$75,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
SOIL REMEDIATION
OFF-SITE INCINERATION

	CAPITAL
HAULING MATERIAL TO TREATMENT SITE	$172,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$6,800
INCINERATION	$1,485,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$2,200
SUBTOTAL	$1,668,000
ALLOWANCES	
CONTINGENCY (25%)	$417,000
TOTAL	$2,085,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
SOIL REMEDIATION
ON-SITE SOIL WASHING

	CAPITAL
STAGING	$4,500
SOIL WASHING	$169,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$6,800
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$2,200
SUBTOTAL	$184,000
ALLOWANCES	
CONTINGENCY (25%)	$46,000
TOTAL	$230,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
SOIL REMEDIATION
OFF-SITE SOIL WASHING

	CAPITAL
LOADING & HAULING TO TREATMENT SITE	$104,000
TOP SOIL REPLACEMENT FOR EXCAVATED SOIL	$6,800
SOIL WASHING	$101,000
CONFIRMATION SAMPLING	$1,500
ANALYTICAL	$2,200
SUBTOTAL	$216,000
ALLOWANCES	
CONTINGENCY (25%)	$54,000
TOTAL	$270,000

NOTES:

1. Analytical cost reflects two sampling phases after treatment is completed.
2. Totals were rounded to the nearest thousands.

SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
TREATMENT RESIDUE DISPOSAL
ON – SITE DISPOSAL

	CAPITAL
STAGING	$4,500
GRADING	$5,100
SUBTOTAL	$9,600
ALLOWANCES	
CONTINGENCY (25%)	$2,400
TOTAL	$12,000

SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
TREATMENT RESIDUE DISPOSAL
LANDFILL

	CAPITAL
LOADING & HAULING TO LANDFILL	$172,000
LANDFILL	$45,000
SUBTOTAL	$217,000
ALLOWANCES	
CONTINGENCY (25%)	$54,000
TOTAL	$271,000

SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
BURIED WASTE DISPOSAL
LANDFILL

	CAPITAL
LOADING & HAULING TO LANDFILL	$19,000
LANDFILL	$7,500
SUBTOTAL	$26,500
ALLOWANCES	
CONTINGENCY (25%)	$6,600
TOTAL	$33,000

SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
GROUNDWATER REMEDIATION
NO ACTION

	CAPITAL	O & M
SOIL SAMPLING	$9,000	$1,500
ANALYTICAL		$3,200
SUBTOTAL	$9,000	$4,700
ALLOWANCES		
CONTINGENCY (25%)	$2,250	$1,200
ECONOMIC ANALYSIS		
TOTALS	$11,000	$6,000
PRESENT WORTH OF O & M	**$66,000**	
TOTAL PRESENT WORTH	**$77,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and monitoring period = 30 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.
4. Analytical cost reflects sampling performed on a semi-annual basis.

SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
GROUNDWATER COLLECTION

	CAPITAL	O & M
MANHOLES FOR PUMPS & CONTROLS	$8,000	
WELL INSTALLATION & DEVELOPMENT	$56,000	
PIPING	$82,500	
PUMPS	$13,500	
TANK	$20,000	
POWER		$3,000
LABOR FOR PUMPS & WELLS CHECK-UP OPERATIONS		$33,000
SUBTOTAL	$180,000	$36,000
ALLOWANCES		
CONTINGENCY (25%)	$45,000	$9,000
INSTALLATION/CONSTRUCTION (50%)	$90,000	
ENGINEERING (25%)	$45,000	
ELECTRICAL (20%)	$36,000	
ECONOMIC ANALYSIS		
TOTALS	$396,000	$45,000
PRESENT WORTH OF O & M	**$212,000**	
TOTAL PRESENT WORTH	**$608,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 6 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
GROUNDWATER REMEDIATION
AIR STRIPPING

	CAPITAL	O & M
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$17,500	$2,300
AIR STRIPPER	$60,000	$3,000
SCRUBBER	$28,000	$1,800
LABOR FOR CHECK-UP OPERATIONS		$33,000
SUBTOTAL	$140,500	$40,000
ALLOWANCES		
CONTINGENCY (25%)	$35,100	$10,000
INSTALLATION/CONSTRUCTION (50%)	$70,300	
ENGINEERING (25%)	$35,100	
ELECTRICAL (20%)	$28,100	
ECONOMIC ANALYSIS		
TOTALS	$309,000	$50,000
PRESENT WORTH OF O & M	**$236,000**	
TOTAL PRESENT WORTH	**$545,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 6 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
GOUNDWATER REMEDIATION
ACTIVATED CARBON

	CAPITAL	O & M
BUILDING	$25,000	
FENCE	$10,000	
FILTRATION	$17,500	$2,300
ACTIVATED CARBON	$55,000	$3,100
LABOR FOR CHECK-UP OPERATIONS		$33,000
SUBTOTAL	$107,500	$38,400
ALLOWANCES		
CONTINGENCY (25%)	$26,900	$9,600
INSTALLATION/CONSTRUCTION (50%)	$53,800	
ENGINEERING (25%)	$26,900	
ELECTRICAL (20%)	$21,500	
ECONOMIC ANALYSIS		
TOTALS	$237,000	$48,000
PRESENT WORTH OF O & M	**$226,000**	
TOTAL PRESENT WORTH	**$463,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 6 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

SITE #11 INDUSTRIAL WASTEWATER DISPOSAL AREA 100
TREATED GROUNDWATER DISPOSAL

	CAPITAL	O & M
PUMPS	$10,000	
TANK	$35,000	
POWER		$3,000
PIPING	$20,000	
DISCHARGE MONITORING	$10,000	$5,000
ANALYTICAL		$10,400
SUBTOTAL	$75,000	$18,400
ALLOWANCES		
CONTINGENCY (25%)	$18,750	$4,600
INSTALLATION/CONSTRUCTION (50%)	$37,500	
ENGINEERING (25%)	$18,750	
ELECTRICAL (20%)	$15,000	
ECONOMIC ANALYSIS		
TOTALS	$165,000	$23,000
PRESENT WORTH OF O & M	**$108,000**	
TOTAL PRESENT WORTH	**$273,000**	

NOTES:

1. For present worth calculation: interest rate = 10%; inflation = 6%; and project life = 6 years.
2. Contingencies were applied to both capital cost and O & M costs.
3. Totals were rounded to the nearest thousands.

KEY COST ASSUMPTIONS (GROUNDWATER REMEDIATION)

ITEM	DESIGN CRITERIA	COST ASSUMPTIONS	REFERENCES
MANHOLES FOR PUMPS & CONTROLS	PRECAST CONCRETE	$1000.0 @ 1 MANHOLE FOR EACH WELL	VIRGINIA PRECAST CORP.
WELL INSTALLATION & DEVELOPMENT		$1500.0 FOR EQUIPMENT MOBILIZATION PLUS $40/FT. DEPTH PLUS 100% OF TOTAL FOR DURATION OF WELL DEVELOPMENT	PREVIOUS MPI WORK
PIPING	PVC SCHEDULE-40 PIPE AND FITTINGS	$33.0/LINEAR FT.	PREVIOUS MPI WORK
PUMP	SUBMERSIBLE	$1000.0 – $1500.0 DEPENDING ON HEAD AND CAPACITY REQUIREMENTS	PREVIOUS MPI WORK
TANK	STEEL TANK WITH ACCESSORIES	10,000 GAL @ $12,000.0 20,000 GAL @ $20,000.0 40,000 GAL @ $35,000.0	PITT DES MOINES
FENCE	6 FT. HIGH WITH 3 STRANS BARBED WIRE	$15.45 PER LINEAR FOOT ADD $1000.0 FOR GATE	MEANS (SITE WORK 1992)
AIR STRIPPER	SHALLOW TRAY		PREVIOUS MPI WORK
GRANULAR ACTIVATED CARBON (GAC) FOR GROUNDWATER AND AIR TREATMENT	2000.0 LB. GAC UNIT	Carbon O&M costs include regeneration & profiling.	CARBTROL

KEY COST ASSUMPTIONS (GROUNDWATER REMEDIATION)

ITEM	DESIGN CRITERIA	COST ASSUMPTIONS	REFERENCES
DISCHARGE MONITORING			
EQUIPMENT	(BAILERS, BOTTLES, FLOW METERS)	CAPITAL @ $10,000.0	PREVIOUS MPI WORK
LABOR	1 PERSON	$5,000.0 PER YEAR	PREVIOUS MPI WORK
ANALYTICAL	SITE #3; $200.0 PER SAMPLE		MPI LABORATORY
	SITE #4; $200.0 PER SAMPLE		MPI LABORATORY
	SITE #8; $200.0 PER SAMPLE		MPI LABORATORY
	SITE #11; $200.0 PER SAMPLE		MPI LABORATORY
	SITE #7; $500.0 PER SAMPLE		MPI LABORATORY
	SITE #9; $700.0 PER SAMPLE		MPI LABORATORY

KEY COST ASSUMPTIONS (SOIL REMEDIATION)

ITEM	DESIGN CRITERIA	COST ASSUMPTIONS	REFERENCES
SITE CLEARING	SITE #2; AREA = 57,000 FT^2 SITE #3; AREA = 20,000 FT^2	CLEARING SMALL TREES & BRUSHES @ $1800/ACRE	PREVIOUS MPI WORK
	SITE #3; AREA = 20,000 FT^2 SITE #4; AREA = 60,000 FT^2 SITE #7; AREA = 15,000 FT^2 SITE #8; AREA = 4,000 FT^2	CLEARING GRASSED AREA @ $550/ACRE	
GRADING	1/3 C.YARDS DOZER	$17,000 PER DAY	PREVIOUS MPI WORK
COMMON EARTH BACKFILL	SITE #2; 1,300 C. YARDS SITE #3; 963 C. YARDS SITE #4; 1,223 C. YARDS SITE #7; 280 C. YARDS SITE #8; 97 C. YARDS	$11.50 PER CUBIC YARD	PREVIOUS MPI WORK
CLAY	SITE #2; 1,300 C. YARDS SITE #3; 963 C. YARDS SITE #4; 1,223 C. YARDS SITE #7; 280 C. YARDS SITE #8; 97 C. YARDS	$12.50 PER CUBIC YARD	PREVIOUS MPI WORK
TOP SOIL	SITE #2; 1,300 C. YARDS SITE #3; 963 C. YARDS SITE #4; 1,223 C. YARDS SITE #7; 280 C. YARDS SITE #8; 97 C. YARDS	$15.00 PER CUBIC YARD	PREVIOUS MPI WORK

KEY COST ASSUMPTIONS (SOIL REMEDIATION)

ITEM	DESIGN CRITERIA	COST ASSUMPTIONS	REFERENCES
SLOPE PROTECTION	ENKAMAT "S"	$12.40 PER SQUARE YARD	EROSION CONTROL SYSTEMS, INC.
SEDIMENT & EROSION CONTROL	SILT FENCE	$5.0 PER LINEAR FOOT	PREVIOUS MPI WORK
HDPE SYNTHETIC MEMBRANE	SITE #2; AREA = 67,000 FT^2 SITE #3; AREA = 52,000 FT^2 SITE #4; AREA = 66,000 FT^2 SITE #7; AREA = 15,000 FT^2 SITE #8; AREA = 5,200 FT^2	$0.95 PER SQUARE FOOT	GUNDLE LINING SYSTEMS, INC.
SYNTHETIC FILTER FABRIC	SITE #2; AREA = 67,000 FT^2 SITE #3; AREA = 52,000 FT^2 SITE #4; AREA = 66,000 FT^2 SITE #7; AREA = 15,000 FT^2 SITE #8; AREA = 5,200 FT^2	$0.18 PER SQUARE FOOT	GUNDLE LINING SYSTEMS, INC.
DRAINAGE NET	SITE #2; AREA = 67,000 FT^2 SITE #3; AREA = 52,000 FT^2 SITE #4; AREA = 66,000 FT^2 SITE #7; AREA = 15,000 FT^2 SITE #8; AREA = 5,200 FT^2	$0.4 PER SQUARE FOOT	GUNDLE LINING SYSTEMS, INC.
SEEDING	SITE #2; AREA = 67,000 FT^2 SITE #3; AREA = 52,000 FT^2 SITE #4; AREA = 66,000 FT^2 SITE #7; AREA = 15,000 FT^2 SITE #8; AREA = 5,200 FT^2	$42.0 PER THOUSAND SQUARE FOOT	MEANS (SITE WORK 1992)

KEY COST ASSUMPTIONS (SOIL REMEDIATION)

ITEM	DESIGN CRITERIA	COST ASSUMPTIONS	REFERENCES
SEED PROTECTION	SITE #2; AREA = 67,000 FT^2 SITE #3; AREA = 52,000 FT^2 SITE #4; AREA = 66,000 FT^2 SITE #7; AREA = 15,000 FT^2 SITE #8; AREA = 5,200 FT^2	$0.43 PER SQUARE YARD	EROSION CONTROL SYSTEMS, INC.
EXCAVATION	SITE #2; VOLUME = 167 C. YARDS SITE #4; VOLUME = 5,000 C. YARDS SITE #7; VOLUME = 3,400 C. YARDS SITE #8; VOLUME = 1,400 C. YARDS SITE #9; VOLUME = 1,000 C. YARDS SITE #11; VOLUME = 450 C. YARDS	$10.55 PER CUBIC YARD	PREVIOUS MPI WORK
ON – SITE SOIL WASHING	SITE #2; VOLUME = 167 C. YARDS SITE #4; VOLUME = 5,000 C. YARDS SITE #7; VOLUME = 3,400 C. YARDS SITE #8; VOLUME = 1,400 C. YARDS SITE #9; VOLUME = 1,000 C. YARDS SITE #11; VOLUME = 450 C. YARDS	$250/TON FOR < 1,000 TONS $150/TON FOR ≥ 1,000 TONS	WESTINGHOUSE REMEDIATION SERVICES INC.
OFF – SITE SOIL WASHING	SITE #2; VOLUME = 167 C. YARDS SITE #4; VOLUME = 5,000 C. YARDS SITE #7; VOLUME = 3,400 C. YARDS SITE #8; VOLUME = 1,400 C. YARDS SITE #9; VOLUME = 1,000 C. YARDS SITE #11; VOLUME = 450 C. YARDS	$150/TON FOR < 1,000 TONS $100/TON FOR ≥ 1,000 TONS	WESTINGHOUSE REMEDIATION SERVICES INC.

KEY COST ASSUMPTIONS (SOIL REMEDIATION)

ITEM	DESIGN CRITERIA	COST ASSUMPTIONS	REFERENCES
OFF – SITE SOIL WASHING (TRANSPORTATION)	MILEAGE IS BASED ON 300 MILES ROUND TRIP	$7.0/C.Y FOR HAULING $0.75/C.Y./MILE FOR TRANSPORTATION	PREVIOUS MPI WORK
ON – SITE THERMAL TREATMENT	SITE #2; VOLUME = 167 C. YARDS SITE #4; VOLUME = 5,000 C. YARDS SITE #7; VOLUME = 3,400 C. YARDS SITE #8; VOLUME = 1,400 C. YARDS SITE #9; VOLUME = 1,000 C. YARDS SITE #11; VOLUME = 450 C. YARDS	$60.0 PER CUBIC YARD (Treatment costs include mob/demob costs)	SOILEX CORPORATION
OFF – SITE INCINERATION	SITE #2; VOLUME = 167 C. YARDS SITE #4; VOLUME = 5,000 C. YARDS SITE #7; VOLUME = 3,400 C. YARDS SITE #8; VOLUME = 1,400 C. YARDS SITE #9; VOLUME = 1,000 C. YARDS SITE #11; VOLUME = 450 C. YARDS	$2,200.0 PER TON	PREVIOUS MPI WORK
OFF – SITE INCINERATION (TRANSPORTATION)	MILEAGE IS BASED ON 500 MILES ROUND TRIP	$7.0/C.Y. FOR HAULING $0.75/C.Y./MILE FOR TRANSPORTATION	WESTINGHOUSE REMEDIATION SERVICES INC.
ON – SITE GLYCOLATE DECHLORINATION	SITE #2; VOLUME = 167 C. YARDS	$380.0 PER CUBIC YARD	THE HAZARDOUS WASTE CONSULTANT (MAY/JUNE 1992)
OFF – SITE GLYCOLATE DECHLORINATION	SITE #2; VOLUME = 167 C. YARDS	$380.0 PER CUBIC YARD (Costs based on pilot study)	THE HAZARDOUS WASTE CONSULTANT (MAY/JUNE 1992)

KEY COST ASSUMPTIONS (SOIL REMEDIATION)

ITEM	DESIGN CRITERIA	COST ASSUMPTIONS	REFERENCES
OFF – SITE GLYCOLATE DECHLORINATION (TRANSPORTATION)	MILEAGE IS BASED ON 300 MILES ROUND TRIP	$7/C.Y. FOR HAULING $0.75/C.Y./MILE FOR TRANSPORTATION	PREVIOUS MPI WORK
IN – SITU FLUSHING	SITE # 7; VOLUME=10,000 C. YARDS	$167.0 PER CUBIC YARD	THE HAZARDOUS WASTE CONSULTANT (SEPT./OCT. 1992)
IN – SITU FIXATION	SITE # 7; VOLUME=10,000 C. YARDS	$194.45 PER TON	(EPA) INTERNATIONAL WASTE TECHNOLOGIES / GEO–CON IN SITU STABILIZATION / SOLIDIFICATION (AUGUST 1990)
LANDFILL	NON–HAZARDOUS	$100.0 PER CUBIC YARD	CHAMBERS LANDFILL
HAZARDOUS WASTE LANDFILL	HAZARDOUS	$150.0 PER CUBIC YARD	PREVIOUS MPI WORK
SOIL SAMPLING			
EQUIPMENT	OVER 30 YEARS PERIOD	CAPITAL @ $9000.0	PREVIOUS MPI WORK
LABOR	1 PERSON	$375.0 PER DAY (SALARY, HOTEL & TRANS.)	PREVIOUS MPI WORK
ANALYTICAL	SITE #2; $200.0 PER SAMPLE		MPI LABORATORY
	SITE #3; $200.0 PER SAMPLE		MPI LABORATORY
	SITE #4; $200.0 PER SAMPLE		MPI LABORATORY
	SITE #7; $500.0 PER SAMPLE		MPI LABORATORY
	SITE #8; $200.0 PER SAMPLE		MPI LABORATORY
	SITE #9; $700.0 PER SAMPLE		MPI LABORATORY
	SITE #11; $200.0 PER SAMPLE		MPI LABORATORY

APPENDIX B

CALCULATIONS FOR EXTENT OF CONTAMINATION

APPENDIX B
CALCULATIONS FOR EXTENT OF CONTAMINATION

1.0 SITE 2 - APPLE ORCHARD LANDFILL

Surface Soils/Landfill

Area of landfill surface = 0.8 acres = 35,280 square feet

Area of landfill face = (600' length) x (36' height) = 21,600 square feet

Total area of landfill = 56,880 square feet

Stream Sediment

300' of stream sediment to be removed (property boundary to junction of stream with process water ditch).

Volume of sediment to be removed = (300' length) x (3' depth) x (5' width) = 4500 cubic feet = 167 cubic yards

2.0 SITE 3 - PISTOL RANGE LANDFILL

Surface Soils/Landfill

Area of landfill = 0.9 acres = 40,000 square feet

Groundwater

Est plume volume = (650' length) x (50' width) x (10' depth) = 325,000 cubic feet

Volume in gallons = (325,000 cubic feet) x (7.48 gals/cubic foot) x (0.261 effective porosity) = 635,000 gallons

3.0 SITE 4 - CHEMICAL BURIAL SITE

Soils/Burial Areas

Area of burial areas to be capped = (400' length) x (150' width) = 60,000 square feet

Volume to be excavated:

Burial area #1 = (100' l) x (20' w) x (20' d) = 40,000 cubic feet = 1481 cubic yards

Burial area #2 = (130' l) x (30' w) x (5' d) = 19,500 cubic feet = 722 cubic yards

Burial area #3 = (110' l) x (50' w) x (10' d) = 55,000 cubic feet = 2037 cubic yards

Burial area #4 = (50' l) x (50' w) x (10' d) = 25,000 cubic feet = 926 cubic yards

Total volume = 5,166 cubic yards

Groundwater

Est plume volume = (1200' length) x (700' width) x (20' depth) = 16,800,000 cubic feet

Volume in gallons = (16,800,000 cubic feet) x (7.48 gals/cubic foot) x (0.40 effective porosity) = 50,265,600 gallons

4.0 SITE 7 - ORDNANCE BURN AREA

Soils

Area to be capped = (50' width) x (300' length) = 15,000 square feet

Volume to be excavated = (30' width) x (300' length) x (10' depth) = 90,000 cubic feet = 3,333 cubic yards

Volume for in-situ treatment = (30' width) x (300' length) x (30' depth) = 270,000 cubic feet = 10,000 cubic yards

Groundwater

Est plume volume = (400' length) x (100' width) x (20' depth) = 800,000 cubic feet

Volume in gallons = (800,000 cubic feet) x (7.48 gals/cubic foot) x (0.40 effective porosity) = 2,393,600 gallons

5.0 SITE 8 - ABANDONED CHEMICAL DISPOSAL PIT

Soils/Disposal Pit

Area to be capped = (60' width) x (60' length) = 3,600 square feet

Volume to be excavated = (60' width) x (60' length) x (12' depth) = 43,200 cubic feet = 1,600 cubic yards

Groundwater

Est plume volume = (3.14) x (100' radius)(100') x (20' depth) = 62,832 cubic feet

Volume in gallons = (31,416 cubic feet) x (7.48 gals/cubic foot) x (0.40 effective porosity) = 188,500 gallons

6.0 SITE 9 - INDUSTRIAL WASTEWATER DISPOSAL AREA 300

Soils/Leaching Wells and Field

Volume of leaching wells to be excavated = (10' width) x (10' length) x (10' depth) x (6 wells) = 6,000 cubic feet = 222 cubic yards

Volume of leaching field to be excavated = (50' width) x (75' length) x (6' depth) = 22,500 cubic feet = 833 cubic yards

Total to be excavated = 1,055 cubic yards

Groundwater

Est plume volumes:

Plume #2 = (150' width) x (600' length) x (20' depth) = 1,800,000 cubic feet
Volume in gallons = (1,800,000 cubic feet) x (7.48 gals/cubic foot) x (0.40 effective porosity) = 5,400,000 gallons

Plume #3 = (200' width) x (750' length) x (20' depth) = 3,000,000 cubic feet
Volume in gallons = (3,000,000 cubic feet) x (7.48 gals/cubic foot) x (0.40 effective porosity) = 9,000,000 gallons

Total plume volume = 14,400,000 gallons

7.0 SITE 11 - INDUSTRIAL WASTEWATER DISPOSAL AREA 100

Soils/Leaching Wells

Volume of leaching wells to be excavated = (10' width) x (10' length) x (10' depth) x (13 wells) = 13,000 cubic feet = 481 cubic yards

Groundwater

Est plume volumes:

AIR EMISSIONS CALCULATIONS
THERMAL TREATMENT PROCESS
NSWCWODET SITES

Site	Volume of Soil (CY)	Weight of Soil (Tons)	Weight of Soil (lbs)	Contaminant Concentration (ppm)	Contaminant Weight (lbs)	Emissions After Treatment (99%) (lbs)	Emissions After Condensation (10%) (lbs)	Emissions After Carbon (1%) (lbs)	Emission Rate (lbs/day)		Avg Daily Emission Concentration (ppm)
									After Thermal Treatment	After Air Controls	
2	167	139	278,333	50	13.92	13.78	1.38	0.014	9.900	0.010	0.05
4	5000	4167	8,333,333	100	833.33	825.00	82.50	0.825	19.800	0.020	0.10
7	10000	8333	16,666,667	30	500.00	495.00	49.50	0.495	5.940	0.006	0.03
8	1400	1167	2,333,333	10	23.33	23.10	2.31	0.023	1.980	0.002	0.01
9	1000	833	1,666,667	10	16.67	16.50	1.65	0.017	1.980	0.002	0.01
11	450	375	750,000	10	7.50	7.43	0.74	0.007	1.980	0.002	0.01