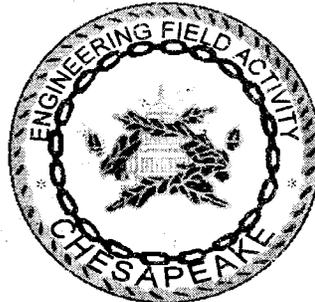


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DRAFT FINAL CORRECTIVE MEASURES STUDY REPORT SITE 7 NSWC WHITE OAK MD  
5/1/2002  
TETRA TECH

**Corrective Measures Study**  
for  
**Site 7**

Former  
Naval Surface Warfare Center  
White Oak  
Silver Spring, Maryland



Engineering Field Activity Chesapeake  
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0839

May 2002



TETRA TECH NUS, INC.

**CORRECTIVE MEASURES STUDY  
FOR  
SITE 7**

**FORMER  
NAVAL SURFACE WARFARE CENTER  
WHITE OAK  
SILVER SPRING, MARYLAND**

**COMPREHENSIVE LONG-TERM  
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT**

**Submitted to:**

**Engineering Field Activity Chesapeake  
Environmental Branch Code 18  
Naval Facilities Engineering Command  
Washington Navy Yard, Building 212  
Washington, D.C. 20374-2121**

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## ACRONYMS

µg/L	microgram per liter
ALC	Adelphi Laboratory Center
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
AWQC	Ambient Water Quality Criteria
B&R	Brown & Root
BCT	BRAC Cleanup Team
BDAT	Best-demonstrated available technology
BERA	Basewide Ecological Risk Assessment
BI	Background Investigation
BRAC	Base Realignment and Closure
CAA	Clean Air Act
CAO	Corrective Action Objective
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CMS	Corrective Measures Study
COD	Chemical Oxygen Demand
COMAR	Code of Maryland Regulations
CS	Confirmation Study
CTO	Contract Task Order
CWA	Clean Water Act
DCA	Dichloroethane
DCB	Dichlorobenzene
DCE	Dichloroethene
DEHP	Di(2-ethylhexyl)phthalate
DNB	Dinitrobenzene
DNT	Dinitrotoluene
DO	Dissolved Oxygen
DOT	Department of Transportation
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
GSA	General Services Administration
HHRA	Human Health Risk Assessment
HI	Hazard Indices
HMX	High Melting Explosive

HSWA	Hazardous and Solid Waste Amendments
IAS	Initial Assessment Study
ILCR	Incremental Lifetime Cancer Risks
IRP	Installation Restoration Program
LDR	Land Disposal Restriction
LUCAP	Land Use Control Plan
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mg/kg	milligrams per kilogram
msl	mean sea level
NB	Nitrobenzene
NCP	National Oil and Hazardous Substances Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NOL	Naval Ordnance Laboratory
NPDES	National Pollution Discharge Elimination System
NPDWS	National Primary Drinking Water Standards
NSPS	New Source Performance Standards
NSWC	Naval Surface Warfare Center
NT	Nitrotoluene
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PCB	Ploychlorinated Biphenyl
PCE	Tetrachloroethene
PCOC	Potential Contaminant of Concern
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goal
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RDX	Royal Demolition Explosive
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI	Remedial Investigation
SDWA	Safe Drinking Water Act
SI	Site Inspection
SMCL	Secondary Maximum Contaminant Level

SSL	USEPA Soil Screening Level
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TBC	To Be Considered
TCE	Trichloroethene
TCL	Target Compound List
TNB	Trinitrobenzene
TNT	Trinitrotoluene
TOC	Total Organic Carbon
TtNUS	Tetra Tech NUS, Inc.
USGS	U.S. Geologic Survey
USNR	United States Naval Reserve
VOC	Volatile Organic Compound

## 1.0 INTRODUCTION

### 1.1 SCOPE AND OBJECTIVES

The Northern Division of the Naval Facilities Engineering Command has issued Contract Task Order (CTO) 0839 to Tetra Tech NUS, Inc. (TtNUS), under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract N62467-94-D-0888, to perform a Resource Conservation and Recovery Act (RCRA) Corrective Measures Study (CMS) for Site 7 – Ordnance Burn Area at the former Naval Surface Warfare Center (NSWC)-White Oak, located in Silver Spring, Maryland. This project is being conducted according to RCRA, as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984.

This work is part of the Navy's Installation Restoration Program (IRP), which is designed to identify contamination of Navy and Marine Corps lands/facilities resulting from past operations and to institute corrective measures, as needed. This CMS is being performed based on the RCRA Facility Investigation (RFI) conducted at Site 7 (TtNUS, 2000). The RFI concluded that elevated risks for soil are a result of exposure to the explosive compounds High Melting Explosive (HMX) and Royal Demolition Explosive (RDX). Further investigation of elevated groundwater risks will be conducted as part of the investigation for Operable Unit 1 (OU1). Therefore, the objectives of this CMS report are as follows:

- Identify Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) criteria for remediation of soils at Site 7.
- Identify risk-based action levels that are protective of human health and the environment.
- Develop Corrective Action Objectives (CAOs), which identify chemicals of concern, receptors, pathways, and preliminary remediation goals (PRGs) for soil at Site 7. PRGs are based on chemical-specific ARARs, TBCs, and risk-based action levels.
- Identify and screen corrective measures technologies appropriate for the contaminants and physical characteristics of Site 7.
- Develop Corrective Measure Alternatives to mitigate the risks of exposure to impacted soil and mitigate the migration of contaminants from soil to groundwater at Site 7.
- Conduct a detailed analysis and comparative analysis of the Corrective Measure Alternatives.

## 1.2 ORGANIZATION OF THE CORRECTIVE MEASURES STUDY

This CMS consists of six sections. Section 1.0 is the introduction section, which, in addition to the scope and objectives of the document, includes a discussion of the facility location, history, and physical characteristics. Section 2.0 provides a description of current site conditions. Section 3.0 identifies ARARs, TBCs, and CAOs. The identification and screening of corrective measure technologies and development of Corrective Measure Alternatives are conducted in Section 4.0. Section 5.0 evaluates the Corrective Measure Alternatives. Section 6.0 presents a comparative analysis of the alternatives and recommends an alternative for implementation at Site 7.

## 1.3 FACILITY DESCRIPTION

NSWC-White Oak was a Navy-owned and -operated laboratory for naval surface warfare research. The facility is located approximately 5 miles north of Washington, D.C., off New Hampshire Avenue in Silver Spring, Maryland (see Figure 1-1). The former NSWC-White Oak covers approximately 712 acres and is located in both Prince George's and Montgomery Counties. Adjacent to the southern corner of the property is the U.S. Army's Adelphi Laboratory Center (ALC) and the United States Naval Reserve (USNR) Training Center. A mixture of residential, park, industrial, and commercial properties border the remainder of the facility. The facility was closed in 1997, and the property was transferred to the General Services Administration (GSA) and the U.S. Army.

Site 7, the Ordnance Burn Area, is located north of Dahlgren Road, approximately 300 yards southeast of Site 4 (the Chemical Burial Area), and north of Buildings 501, 506, and 508. The site consists of a slightly depressed swale approximately 250 feet long and 20 feet wide. Buildings 501 and 506, previously used for the storage of hazardous wastes, are located within a fenced enclosure immediately south of Site 7. The remainder of the area adjacent to the swale is either cleared or covered by woodland or grass. The site is relatively flat with a gentle slope to the east.

Figure 1-2 shows the location of Site 7 in relation to the former Base boundaries, surface water bodies, and other landmarks. The facility boundaries identified on Figures 1-1 and 1-2 are the boundaries that existed prior to the transfer of the property to the GSA and the Army.

## 1.4 FACILITY HISTORY

NSWC-White Oak was originally established in 1944 as the Naval Ordnance Laboratory (NOL), with a mission to carry out research on military guns and explosives. Throughout the years, the mission was expanded to include research involving torpedoes, mines, and projectiles. In September 1974, NOL combined with the Naval Weapons Laboratory, Dahlgren, Virginia, to become the Naval Surface

Weapons Center, which was renamed the Naval Surface Warfare Center, Dahlgren Division, in 1988. After that time, it functioned as the principal Navy research, development, test, and evaluation center for surface warfare weapon systems, ordnance technology, strategic systems, and underwater weapons systems.

NSWC-White Oak was identified as a Base Realignment and Closure (BRAC) facility and was closed in 1997 and the property was transferred to the GSA and to the U.S. Army. GSA is currently investigating plans for the reuse and development of the NSWC-White Oak property. However, land use within the eastern portion of the base, including Site 7, is currently limited and is expected to be limited in the future. The property transferred to the U.S. Army will be used in conjunction with ongoing activities at the adjacent ALC.

Prior to the closure of the former NSWC-White Oak, the Navy investigated environmental sites that were in the IRP under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the remaining sites were investigated under RCRA. Subsequent to its closure, the EPA issued a Unilateral Administrative Order under RCRA 7003 on July 3, 1998 that required the Navy to investigate all of remaining environmental sites at the former NSWC-White Oak under RCRA. The Navy is currently following a hybrid RCRA/CERCLA approach for investigating and documenting activities at environmental sites at the former NSWC-White Oak to facilitate prompt investigation and remediation. Site 7 is included in the sites being studied under the RCRA framework.

## **1.5 PHYSICAL CHARACTERISTICS OF THE FORMER NSWC-WHITE OAK**

The following sections present discussion of the physical characteristics of the former NSWC-White Oak, including topography, the ecological setting, geology and soils, surface water hydrology, hydrogeology, climate and meteorology, and water usage.

### **1.5.1 Topography**

The former NSWC-White Oak lies in gently rolling terrain. The topographic expression of the area represents the result of a deeply incised, dendritic stream channel pattern. Paint Branch and its tributaries dominate local drainage patterns.

The highest elevation on the facility is approximately 398 feet above mean sea level (msl). The lowest elevation is roughly 145 feet above msl. The terrain of the western portion of the facility slopes generally eastward toward Paint Branch, with about a 3.5 percent grade. Similar grades are encountered in the eastern portion of the facility, but slopes are generally more southward or are locally influenced by

proximity to Paint Branch and its tributaries. Near stream channels, ground slopes increase to as much as 65 percent.

### 1.5.2 Ecological Setting

Vegetation communities on the facility have formed as a result of a variety of land uses, soil conditions, and slopes. Former land uses such as gravel mining, building construction, landfilling, and logging have influenced the succession stages and plant species of the facility. This in turn has affected the animal communities on the facility. The physical environment of the facility is typical of the region. Thus, the vegetation communities and wildlife habitats on site are representative of regional patterns.

Developed areas consist primarily of lawns. Trees in developed areas consist of maples, oaks, elms, poplars, and dogwoods. The scrub-shrub community represents a successional stage between an old field and forest community and is diverse because it supports vegetation representative of both communities. Pine forest communities are also successional and indicative of disturbed areas. The majority of the forested regions within the facility can be classified as mixed deciduous, which consist of an abundance of broad-leaved trees and evergreens. In undisturbed areas, a forest community known as Oak-Hickory Forest results. The Oak-Hickory Forest is relatively dry and the soil is often sandy. The trees are generally widely spaced, with low undergrowth of shrubs and vines.

The most conspicuous mammalian species within the facility is the white-tailed deer. At present, no hunting is allowed on the facility. As a result, the deer on site are diurnal, commonly seen foraging in the mid-morning and mid-afternoon.

### 1.5.3 Geology and Soils

The former NSWC-White Oak lies along the boundary between the Piedmont and Coastal Plain physiographic provinces. The boundary, known as the Fall Line, represents the contact between the older Piedmont Plateau rocks to the west and the younger Atlantic Coastal Plain sedimentary units to the east. In the White Oak area, the Fall Line extends from the southwest to the northeast and lies to the west of and roughly parallel to the Montgomery-Prince George's County line. The topography of both provinces in the White Oak area is characterized by rolling hills with steeply eroded stream valleys. The surficial geology of the former NSWC-White Oak is illustrated on Figure 1-3.

Underlying the former NSWC-White Oak, unconsolidated sedimentary units of the Coastal Plain Province overlie fractured metamorphic and igneous rocks of the Piedmont Province. The Coastal Plain sediments include, in ascending order, the Potomac Group, the Upland Sand and Gravel, and undifferentiated Quaternary alluvial deposits. The Potomac Group is of Cretaceous age and consists of a sand, gravel,

and silt unit and a clay unit. The Upland Sand and Gravel is of Tertiary age and consists of sand, gravel, and silt with clay lenses. The Coastal Plain sediments are less than a few tens of feet thick at the facility.

The Piedmont bedrock extending below the Coastal Plain sediments consists of the Wissahickon Formation, diamictite gneiss of late Precambrian age. The upper 50 to 70 feet of the Wissahickon Formation has weathered to an unconsolidated saprolite. The saprolite is a clayey material retaining the parent material structure. The Wissahickon Formation accounts for approximately 50 percent of the surficial geology at NSWC-White Oak. Bedrock outcrops of the Wissahickon gneiss occur along Paint Branch and Westfarm Branch in the central portion of the facility, due to the erosion of overlying sediments.

Except for streambed soils, the facility soils tend to be moderately to excessively well drained and moderately to severely eroded. Soils at the facility tend to be moderately acidic, with pH ranging between 4 and 6 standard units [Brown & Root (B&R) Environmental, 1998]. This may be due to the presence of hydroxyl, humic, and fulvic acids derived from decaying organic matter.

#### **1.5.4 Surface Water Hydrology**

The former NSWC-White Oak lies entirely within the drainage basin of Paint Branch, a 12-mile-long tributary to the northeast branch of the Anacostia River. Like other streams in the region, Paint Branch is a gaining stream, because it is perennially supported by shallow groundwater discharge from small springs and seeps along its length. Another perennial stream, Westfarm Branch, flows through the eastern portion of the property. It originates approximately 1 mile north of the property and joins Paint Branch just south of the facility.

In addition to perennial streams, the facility is traversed by eight intermittent streams, all of which discharge to Paint Branch either on or near the property. Several of these streams are small and are not identified on U.S. Geological Survey (USGS) topographic maps.

#### **1.5.5 Hydrogeology**

Based on the initial work by Malcolm-Pirnie, the groundwater at NSWC-White Oak occurs within both the Coastal Plain units and the Piedmont bedrock (Malcolm-Pirnie, 1992). Within the Coastal Plain units, topography influences groundwater flow, which is from upland areas to lower elevations, discharging to streams or other surface water bodies. Generally, groundwater is unconfined within the Coastal Plain units or, in the northeastern part of the facility, may be perched by clay lenses. Within the Piedmont bedrock, fracturing controls groundwater flow. The saprolite acts as an aquifer or aquitard, depending on the degree of remnant fracturing of the parent material. Groundwater is unconfined in the shallow

bedrock if the saprolite exhibits remnant fracturing and confined if the saprolite does not exhibit remnant fracturing. The Coastal Plain units and the shallow Piedmont bedrock may be hydraulically connected.

#### **1.5.6 Climate and Meteorology**

Summers at the former NSWC-White Oak are warm and humid, and winters are mild. Seasonal temperature variation is approximately 43°F. The warmest weather occurs in July, with daily temperatures ranging from 69°F to 88°F. The coldest weather occurs in late January and early February, with daily temperatures ranging from 28°F to 44°F. The average annual precipitation is approximately 44 inches. Seasonal variation in precipitation is not pronounced, gradually fluctuating between a typical minimum of 3 inches in February to a typical maximum of 5 inches in August. Snowfall accumulations of more than 10 inches are rare; the greatest snowfalls occur in January and February.

The mean annual wind speed varies between 8 miles per hour in August and 11 miles per hour in March. The prevailing wind direction is from the south most of the year, except for northwesterly winds that occur during December, January, and February.

#### **1.5.7 Water Usage**

There is no known use of surface water for potable use at White Oak. Groundwater use is limited to a few residential homes along the southeastern perimeter of the base. In the past, groundwater was used for industrial and possibly potable water supplies at the base. Use of groundwater at NSWC-White Oak was discontinued after the facility was connected to the Washington Suburban Sanitary Commission (municipal water supply).

Figure 1-1 (Color)  
1-1 Site Vicinity Map

Figure 1-1 (Color) (Backside)

1-1 Site Vicinity Map

Figure 1-2 (11 x 17)  
1-2 Site Location Map

Figure 1-2 (11 x 17) (Backside)  
1-2 Site Location Map

Figure 1-3 (8 1/2 x 11)  
1-3 Surficial Geology Map

## 2.0 DESCRIPTION OF CURRENT CONDITIONS

This section presents a summary of the current conditions at Site 7 – Ordnance Burn Area. The discussion is compiled from previous reports and the RFI.

### 2.1 SITE DESCRIPTION AND HISTORY

Site 7 was reportedly used for the thermal destruction of waste ordnance compounds between 1948 and 1968. Site 7 is located north of Dahlgren Road and the fenced area that contains Buildings 501, 506, and 508 and is approximately 300 yards southeast of Site 4 (Chemical Burial Area). Buildings 501 and 506 were previously used for the storage of hazardous wastes. Figure 2-1 depicts Site 7 surface features and topography.

The site consists of a slightly depressed swale approximately 250 feet long and 20 feet wide. The remainder of the area adjacent to the swale is either cleared or covered by woodland or grass. The site is relatively flat with a gentle slope to the east.

The swale is relatively flat and narrow at its westernmost point and widens out downgradient to the east. The swale joins another surface drainage feature and passes under Perimeter Road via a culvert approximately 400 feet east of the origin of the swale near Buildings 501 and 508. As reported in 1999, the culvert was completely plugged with leaves and other debris, inhibiting water flow under the road. The swale is located in a wooded area and water is present only after periods of heavy rainfall. Since the swale is relatively flat and wide in the wooded area and along Perimeter Road, rainfall ponds and infiltrates. The swale was completely dry during a November 1997 site visit (TtNUS, 1999). No aquatic or semi-aquatic community is present in the swale.

Waste disposed at this site included various types of explosives, primarily nitroaromatics and nitroaliphatics. It has been reported that approximately 33,000 pounds of explosives were burned at this site over a period of 20 years.

### 2.2 STUDIES AND INVESTIGATIONS

The following section presents information that pertains to Site 7 studies and investigations. Analytical data, which is discussed in Section 2.4, is presented in Appendix A. Locations of samples and monitoring wells are shown on Figure 2-1.

### **2.2.1 Initial Assessment Study**

The earliest site investigation consisted of the Initial Assessment Study (IAS) by the Naval Energy and Environmental Support Activity (NEESA, 1984). This investigation did not involve any intrusive investigations or field sampling. Completed in November 1984, the IAS identified wastes that were potentially disposed at Site 7 and the period of time during which the site was active. This information was ascertained through a review of the operational history of the site and other relevant documents, plus interviews with facility personnel. The recommendation of the IAS was that Site 7 (and six other sites) required additional study.

### **2.2.2 Confirmation Study, Verification Phase**

A Confirmation Study (CS), Verification Phase was conducted in September 1985 by Malcolm-Pirnie (Malcolm-Pirnie, 1987). The study was conducted to confirm the findings of the IAS and to obtain additional information for characterizing the site and identifying site hazards. The CS involved the installation of one groundwater monitoring well (7GW08) and advancement of 54 soil borings within swale area. The soil sample locations were on transverse sections along the swale - labeled A through Q, with the individual sample locations on each section line numbered 1, 2, etc. Soil samples were collected at the surface and at one-foot intervals to a total depth of five feet at all locations. All surface, 1-foot, and 2-foot deep samples were analyzed, with the analysis of deeper samples performed only when nitroaromatic contamination was identified in the shallower samples.

Monitoring well 7GW08 was sampled on two occasions (events A and B) during this investigation. This study concluded that further study was warranted.

### **2.2.3 RCRA Facility Assessment**

Following the submission of the revised RCRA Part B permit application in 1988, a RCRA Facility Assessment (RFA) was conducted by a contractor for the U.S. Environmental Protection Agency (EPA) in November 1990 (Kearney/Centaur Division, 1990). The RFA identified 97 Solid Waste Management Units (SWMUs) and 19 Areas of Concern (AOCs) at NSWC-White Oak. All 14 of the IRP sites identified in the IAS were also identified as SWMUs or AOCs. In the RFA report, 40 SWMUs were recommended for a RFI, which would assess the presence and migration of potential contaminants of concern (PCOCs). Seven of the IRP sites, including Site 7, were identified for a RFI.

In September 1992, Malcolm-Pirnie completed an RFA review for the Navy, which evaluated the applicability of the general recommendations of the RFA to the individual SWMUs. Generally, for those SWMUs that were being investigated under the IRP, it was concluded that the planned level of effort was

sufficient to address potential impacts from those SWMUs. It was also concluded that some level of sampling would probably be required for most of the SWMUs and AOCs that were recommended for a RFI or verification sampling.

#### **2.2.4 Phase I and II Remedial Investigation**

Phase I and II Remedial Investigation (RI) activities were conducted between January 1989 and March 1992 by Malcolm-Pirnie (Malcolm-Pirnie, 1992). The RI was conducted to further characterize hazards associated with Site 7 as well as other sites. During the Phase I RI, 59 soil samples were collected from 27 locations (7SB01 through 7SB27). The hand auger borings were advanced to a depth of five feet and were used to characterize the nitroaromatic concentrations in the subsurface soil within the swale.

Two groundwater monitoring wells (7GW41 and 7GW43) and one piezometer (7PZ42) were installed during the Phase I investigation. The new and existing wells were sampled during this phase of the investigation.

During the Phase II RI, two soil borings (7SB28 and 7SB29) were advanced to a depth of 15 feet, with samples collected at 5, 10, and 15 feet below the ground surface. The samples were collected to characterize the vertical extent of contamination in the shallow soil within and just beyond the limits of the swale.

The three existing monitoring wells were again sampled during the Phase II investigation. Slug tests were performed at monitoring wells 7GW41 and 7GW43.

#### **2.2.5 Draft Feasibility Study**

A Draft Feasibility Study (FS) was completed in 1993 by Malcolm-Pirnie (Malcolm-Pirnie, 1993). The FS concluded that a significant threat to human health and the environment existed through potential exposure to nitroaromatic and volatile organic contaminants in soil and groundwater. The Draft FS was not finalized and this CMS report supercedes discussions and conclusions presented in the Draft FS.

#### **2.2.6 Wetland/Forest Stand Delineation**

A basewide study was conducted in 1995 (HNUS, 1995) to identify and delineate wetlands and forest stands throughout NSWC. This report concluded that wetlands were not within the Site 7 area. While no forest cover was identified at Site 7, Mixed Deciduous, Virginia Pine, and Successional Hardwood Forest stands are present at the borders of the site.

### **2.2.7 Groundwater and Background Characterization Study**

During June 1997 the three existing groundwater monitoring wells and one existing piezometer were sampled and analyzed at Site 7 for low concentration Volatile Organic Compounds (VOCs) and Semivolatile Organic Compounds (SVOCs) as well as Target Analyte List (TAL) inorganics, cyanide, Target Compound List (TCL) pesticide/polychlorinated biphenyls (PCBs), and explosives. This sampling was performed as part of a facility-wide groundwater investigation. Additional activities were performed in the fall of 1997 to characterize background soil, sediment, groundwater, and surface water. A Background Investigation (BI) report was issued in December 1998 (TtNUS, 1998) for the former NSWC. No additional wells were installed nor were any existing wells sampled in the Site 7 area. The final BI report will be used to evaluate various sites.

### **2.2.8 Site 46 Site Inspection**

In the fall of 1995, contaminated surface water and groundwater was detected on properties adjacent to the former NSWC-White Oak (TTNUS, 2000). A potential source area, known as Site 46, was identified on the former NSWC-White Oak, and a Site Inspection (SI) was undertaken to characterize the site and the nature and extent of contamination. The SI was completed in 1998 and identified several potential source areas within and adjacent to Site 46 associated with surface and groundwater contamination.

Site 7 was one of these potential areas due to the location of Site 7 upstream of Site 46 on Floral Drive Stream. Site 7 was investigated to determine if the area may be the source for the trace levels of explosives at Site 46. The pattern of detections and concentrations did not indicate any significant impacts due to releases of inorganics, as there were no identifiable trends of increasing inorganics concentrations from the upstream to downstream samples, nor were the concentrations above the background levels. Trace levels (<5 µg/L) of two explosives, HMX and RDX, as well as a variety of inorganics were detected in the surface water. No pesticides, PCBs, or explosives were detected in sediment in this stream.

### **2.2.9 RCRA Facility Investigation**

A RFI was performed and completed in September 1999 to gather additional information in preparation for the CMS evaluation (TtNUS, 2000).

Six surface and subsurface soil samples were collected at Site 7 during the RFI field activities (see Figure 2-1). Surface soil samples (0 to 6 inches) and subsurface soil samples (2 to 4 feet) were collected at four locations (7SB102, 7SB103, 7SB104, and 7SB106) within the burn area. Surface and subsurface

soil samples were also collected from two locations in the ephemeral drainage east of the site (7SB101 and 7SB105).

Nine groundwater samples were collected at Site 7 during the first quarter sampling event from the four existing monitoring wells (7GW08, 7GW41, 7GW43, and 7GW101), one existing piezometer (4PZ42), and four newly installed monitoring wells (7GW102, 7GW103, 7GW104, and 7GW105). One existing monitoring well (4GW100) from Site 4 was used to identify contaminant migration onto the site.

No surface water or sediment samples were collected at Site 7 because there are no surface water bodies in the vicinity of the site. The Floral Drive stream is near Site 7, but was not sampled as part of the Site 7 investigation.

In addition to this RFI, a Field Investigation Report was prepared to assess the presence of explosives compounds as a result of past laboratory and field operations at NSWC – White Oak (TtNUS 2000).

Radiation surveys were planned originally for all sites at NSWC-White Oak. Subsequent BRAC Cleanup Team (BCT) discussions determined that further investigation of radiation concerns at the site was not needed. Consequently, the planned surveys were not conducted.

#### **2.2.10 Remedial Investigation of Operable Unit 1**

A RI for Operable Unit (OU) 1 was issued (CH2M HILL, 2002) for the combined areas associated with OU1. Groundwater was sampled during three events (identified in the RI as Rounds 5, 6, and 8) from wells within the Site 7 area. A geophysical survey was also performed to the north of Site 7.

Additional studies have been conducted at NSWC-White Oak to support the investigations at other sites and as facility-wide evaluations. Detailed discussion of previous investigations at the former NSWC-White Oak as well as Site 7 can be found in the references.

### **2.3 SITE CHARACTERISTICS**

#### **2.3.1 Geology**

The Upland Sand and Gravel and the clay and sand facies of the Potomac Group underlie Site 7. The Upland Sand and Gravel extends to depths ranging from approximately 24 to 28 feet below ground surface in the north, to 47 feet in the south. The unit consists of silty sand to sand and gravel. Below the Upland Sand and Gravel unit is the clay facies of the Potomac Group, consisting of clayey sand with

gravel or silt. The clay facies grades into the sand facies of the Potomac Group composed of silty sand to sand with small amounts of clay and gravel.

The depth to the saprolite of the Wissahickon Gneiss or the Wissahickon Gneiss is unknown at Site 7.

### **2.3.2 Site Hydrogeology**

Depth to the water table increases from north to south across Site 7, ranging from approximately 36 feet to 55 feet. Figure 2-1 illustrates the water table surface across Site 7. Groundwater flow in the area is to the southeast and south with an estimated hydraulic gradient of 0.03 to 0.05. The gradient is steepest across the site. Malcom-Pirnie calculated the geometric mean for the hydraulic conductivity of the Potomac Group as  $1.67 \times 10^{-3}$  cm/s (4.73 feet/day) based on slug tests (Malcom-Pirnie, 1992). The four wells tested during the RFI yielded a similar result of  $2.31 \times 10^{-3}$  (6.55 feet/day).

## **2.4 NATURE AND EXTENT OF CONTAMINATION**

This section provides an analysis of the nature and extent of subsurface soil, surface soil and groundwater, contamination at Site 7. This summary of the nature and extent of contamination at Site 7 is based on previous investigations and the discussion presented in the RFI (TtNUS, 2000). The approximate locations where the samples were collected are shown on Figure 2-1. Summary tables of the results from previous investigations are presented in Appendix A. The sources of contamination at Site 7 are believed to be the various types of waste ordnance compounds that were thermally destructed within the site. Potential site-related contaminants included VOCs, SVOCs, Pesticides, PCBs, inorganics, and explosives.

The nature and extent of groundwater impacts is presented in this section. However, conclusions and remedial action recommendations will not be drawn in this report. The impact of any source remedy will be evaluated in the alternative discussions.

Results of surface soil, subsurface soil, and groundwater are discussed in the following sections. Inorganic data from these investigations were compared to facility-wide background concentrations. Background data and statistics are presented in the Background Investigation Report for NSWC-White Oak (TtNUS, 1998).

### **2.4.1 Surface Soil**

Seven surface soil samples were collected and analyzed during the RFI for VOCs, SVOCs, metals, pesticides/PCBs, and miscellaneous parameters. Based on the November 1998 fixed-based laboratory

results, 1 VOC, 13 SVOCs, 18 metals, 6 pesticides, 1 PCB, and 4 explosive compounds were detected in the surface soil samples. Analysis for Chemical Oxygen Demand (COD), pH, and Total Organic Carbon (TOC) were also conducted.

Of the SVOCs, 8 had their maximum detection in sample 7SS1020300. Fluoranthene was detected in 4 of 7 samples at a maximum concentration of 0.95 mg/kg. Hexachloroethane was detected in only one sample (7SS1040100) at a maximum concentration of 0.07 mg/kg. All other SVOCs were detected in 2 or 3 samples.

Eleven of the 18 metals (aluminum, arsenic, calcium, chromium, cobalt, iron, magnesium, manganese, nickel, potassium, and vanadium) had their respective maximum detection in sample 7SS1050100. The maximum detection of copper, lead, mercury, silver, and zinc was in sample 7SS1010100. Antimony and barium were detected at maximum concentration in sample 7SS1060100.

Six pesticides and one PCB (Aroclor-1260) were detected in surface soil samples. Maximum concentrations for the pesticides/PCBs were distributed among several samples. 4,4'-DDT (maximum concentration 0.00049J mg/kg), gamma-chlordane (0.00091J mg/kg), and heptachlor epoxide (0.00082 mg/kg) were detected in only one sample (7SS1030100). Aroclor-1260 had the maximum pesticide/PCB concentration (0.38 mg/kg) and maximum frequency of detection (3 of 7 samples). 4,4'-DDE, Dieldrin and heptachlor epoxide were rejected in data validation (qualified "R") in sample 7SS1010100.

The explosives 2,4,6-Trinitrotoluene (TNT), RDX, and HMX were detected in 2 of the 7 samples collected for the RFI. The maximum concentrations of 2,4,6-TNT, RDX, and HMX were all detected in 7SS1010100 at levels of 7.1 mg/kg, 42 mg/kg, and 860 mg/kg, respectively. Nitrobenzene (NB) was detected in only one sample at 7SS1060100 at a concentration of 0.31 mg/kg.

Previous investigations focused exclusively on explosive compounds. The maximum concentrations of 2,4,6-TNT, RDX, and HMX in surface soil were 15 mg/kg, 8.3 mg/kg, and 160 mg/kg respectively during the Phase I and II RI. Concentrations of 2,4-Dinitrotoluene (DNT), 2,6-DNT, 1,3,5-Trinitrobenzene (TNB), 1,3-DNB, NB, and tetryl were below detection limits during the same RI events. Six explosives were analyzed for during the earlier CS event. 2,4,6-TNT, RDX, HMX, 2,4-DNT, 2,6-DNT, and 1,3,5-TNB were all detected in various locations. Maximum concentrations of 2,020 mg/kg and 2,670 mg/kg for 2,4,6-TNT and RDX, respectively, were determined in the surface sample at location E-3. The maximum concentration of HMX (485 mg/kg) was detected in the surface sample at location L-2.

The approximate locations where the samples were collected are shown on Figure 2-1. Summary tables of the results from previous investigations are presented in Appendix A.

#### **2.4.2 Subsurface Soil**

Six subsurface soil samples were collected and analyzed during the RFI for VOCs, SVOCs, metals, pesticides/PCBs, and explosives. TOC and pH are also reported. Based on the November 1998 fixed-based laboratory results, 2 VOCs, 1 SVOC, 16 metals, 4 pesticides, and 7 explosive compounds were detected in the subsurface soil samples.

Two VOCs (acetone and methylene chloride) were detected. Acetone was found in one sample (7SU1060200) with maximum concentration of 0.02J mg/kg. Methylene chloride was detected in two of six samples with its maximum detection (0.002J mg/kg) in sample 7SU1010200.

The SVOC hexachloroethane was detected in sample 7SU1040200 at a maximum concentration of 0.12J mg/kg. No other SVOCs were detected in any samples.

Sixteen metals were detected in subsurface soil samples, with the maximum concentrations of metals detected distributed among several samples. Selenium was found in one sample (7SU1020200) at a maximum detection of 3.2 mg/kg. The remaining metals were found in five or six samples. A high detection frequency for inorganic metals is common.

Pesticides were detected in only one sample (7SU1010200). Alpha-chlordane, endosulfan 1, gamma-chlordane, and methoxychlor were reported at maximum concentrations of 0.017, 0.0036, 0.018 and 0.0023J mg/kg, respectively.

All seven explosive compounds detected (2,4,6-TNT, 2-amino-4,6-DNT, 2-Nitrotoluene (NT), 4-amino-2,6-DNT, HMX, RDX, and tetryl) had maximum concentrations in the same subsurface soil sample (7SU1010200). The explosive compounds had maximum concentration values ranging from 0.77J mg/kg (tetryl) to 44 mg/kg (HMX). RDX was the only explosive detected in any other sample (7SU1060200).

Previous investigations focused exclusively on explosive compounds. The maximum concentrations of 2,4,6-TNT, RDX, and HMX in subsurface soil were 34 mg/kg, 5.1 mg/kg, and 150 mg/kg respectively during the Phase I and II RI. Concentrations of 2,4-DNT, 2,6-DNT, 1,3,5-TNB, 1,3-Dinitrobenzene (DNB), NB, and tetryl were below detection limits during the same RI events. Six explosives (2,4,6-TNT, RDX, HMX, 2,4-DNT, 2,6-DNT, and 1,3,5-TNB) were analyzed for and all were detected at various subsurface locations during the CS event. Maximum concentrations (1,120 mg/kg, 705 mg/kg, and 401 mg/kg) for

2,4,6-TNT, RDX, and HMX were all detected at one foot below surface at locations E-2, O-3, and K-2 respectively.

### 2.4.3 Groundwater

Nine groundwater samples were collected from eight groundwater monitoring wells and one piezometer for the RFI in January 1999. Unfiltered samples were analyzed during the RFI for VOCs, SVOCs, metals, pesticides/PCBs, and explosives. Additionally, filtered samples were analyzed for metals. Filtered sample results were not used for the risk assessment and were not presented in the RFI summary. However, analytical results for the filtered samples are presented in the Appendix for informational purposes.

Seventeen VOCs were detected in groundwater samples as follows: 1,1,1-trichloroethene (TCE), 1,1,2,2-tetrachloroethene (PCE), 1,1,2-TCE, 1,1-dichloroethane (DCA), 1,1-dichloroethene (DCE), 1,2-DCA, 1,3-dichlorobenzene (DCB), 1,4-DCB, chlorobenzene, chloroform, TCE, PCE, toluene, vinyl chloride, trans-1,2-DCE, xylenes, and cis-1,2-DCE. Eleven VOCs had maximum detections in sample 7GW410001. 1,1,1-TCE, 1,1-DCA, 1,3-DCB, chlorobenzene, toluene, and xylenes were detected in only one sample. Chloroform was detected in 6 of 9 samples at a maximum detection (1.8 µg/L) in sample 7GW1040001. TCE had the maximum detection (370 µg/L) followed by 1,1,2,2-PCE (77 µg/L), and cis-1,2-DCE (44 µg/L). The remaining VOCs had detections less than 2 µg/L.

Of the SVOCs, 2,6-DNT and di-n-butyl phthalate were detected in only one groundwater sample. Di(2-ethylhexyl)phthalate (DEHP) was detected in two of nine samples and had a maximum detection of 1.1 µg/L in sample 7GW1050001.

Seventeen metals were detected in the groundwater samples including: aluminum, arsenic, barium, calcium, chromium, cobalt, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, sodium, thallium, and zinc. Maximum concentrations were distributed among several samples. Barium, calcium, magnesium, manganese, and sodium were detected in every groundwater sample. Lead was detected in only one sample (7GW080001) at maximum concentrations of 3.1 µg/L.

Two pesticides (alpha-chlordane and gamma-BHC) were detected in the groundwater. Alpha-chlordane was detected once in ground well 7GW105 at a maximum concentration of 0.052J µg/L. Gamma-BHC was only detected in ground well 7GW101 with a maximum concentration of 0.058 µg/L.

Six explosive compounds (1,3,5-TNB, 2,4,6-TNT, 2-amino-4,6-DNT, 4-amino-2,6-DNT, HMX, and RDX) were detected in the groundwater. 1,3,5-TNB was only found in sample 7GW1030001 at a maximum concentration of 2.3 µg/L. HMX and RDX were detected in six of nine samples. RDX had a maximum

detected concentration of 510 µg/L (7GW080001), followed by a concentration of 140 µg/L for HMX (7GW1040001). The highest explosive concentration for 2,4,6-TNT (210 µg/L) was detected in sample 7GW080001.

Through the completion of the RI for OU1, 2, 4, 6-TNT, 2-amino-4,6-DNT and 4-amino-4,6-DNT were found to have similar distributions, while HMX and RDX were found to be similarly distributed. During Round 8 of the sampling program, concentrations of 2,4,6-TNT (386 µg/L), 2-amino-4,6-DNT (111 µg/L), and 4-amino-4,6-DNT (124 µg/L) were greatest in monitoring well 07GW104, which is located within Site 7. Concentrations of these compounds decreased significantly at downgradient wells. During Round 8 the maximum concentrations of HMX (357 µg/L) and RDX (801 µg/L) were detected in monitoring well 07GW08, also located within Site 7. As with the TNT and DNT compounds, the HMX and RDX concentrations were significantly reduced in wells downgradient of the source area.

## 2.5 SUMMARY OF BASELINE HUMAN HEALTH RISK ASSESSMENT

This section presents a summary of the baseline Human Health Risk Assessment (HHRA) for Site 7 that was presented in the RFI. Site-specific information on data evaluation, identification of exposure scenarios and exposure point concentrations, characterization of potential human health risks, and specific uncertainties for the site are contained in the RFI.

The human health risk assessment for Site 7 was performed to characterize the potential risks to likely human receptors under current and future land use. The discussion in the RFI evaluated several potential human receptors with respect to exposure to contaminated media at Site 7. These include full time workers, maintenance/utility workers, construction workers, adult recreational users, adolescent trespassers, day care center children, and child and adult residents.

Land use at the site is currently limited and is expected to be limited in the future. Therefore, the elevated risks presented for future residents are not likely to occur, especially in regard to future groundwater use. The residential exposure scenario is conservative and is evaluated for informational purposes. As discussed previously, the conclusions for the OU-1 sites present the remedy for impacted groundwater associated with Site 7.

The RFI developed the following list of PCOCs for Site 7:

- Surface Soil - Carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs), PCBs, HMX and RDX
- Surface/Subsurface Soil - Carcinogenic PAHs, PCBs, 2-amino-4,6-DNT, 4-amino-2,6-DNT, HMX, and RDX

- Groundwater – 1,1,2,2-PCE, 1,1,2-TCE, 1,1-DCE, 1,2-DCA, chloroform, trichloroethene, vinyl chloride, cis-1,2-dichloroethene, gamma-BHC (Lindane), arsenic, mercury, thallium, 2,4,6-TNT, 2-amino-4,6-DNT, 4-amino-2,6-DNT, RDX, ammonium perchlorate

Quantitative estimates of noncarcinogenic and carcinogenic risks associated with these PCOCs were developed for these potential human receptors. Minimal risks (i.e., Hazard Indices [HI] less than unity and Incremental Lifetime Cancer Risks (ILCRs) within the USEPA target risk range) were estimated for full time workers, maintenance/utility workers, adult recreational users, adolescent trespassers, and the child in a day care center. The cumulative HI for construction workers exceeds unity because of dermal exposure to explosive compounds in groundwater.

Cumulative HIs for the child and adult resident exceed unity, and cumulative ILCRs for future residents exceed  $1.0E-4$ , the upper limit of the EPA target risk range. These elevated risks are primarily the result of exposure to PAHs, PCBs, and RDX in surface soil and to 1,1,2,2-PCE, 1,1-DCE, 1,2-DCA, TCE, vinyl chloride, arsenic, mercury, thallium, 2,4,6-TNT, 2-amino-4,6-DNT, 4-amino-2,6-DNT, RDX, and ammonium perchlorate in groundwater. The explosive compounds in soil and groundwater comprise 70 percent of the total cancer risk. VOCs in groundwater are the other major risk factor at Site 7 comprising 25 percent of the total carcinogenic risk.

Potential inhalation exposures from soil at Site 7 were semi-quantitatively evaluated in the risk assessment. Inhalation of volatile emissions from soil and fugitive dust were evaluated by comparing maximum constituent concentrations to EPA Soil Screening Levels (SSLs) for transfers from soil to air. The SSLs are based on residential land use and lifetime exposure scenarios and are, therefore, conservative values for workers, recreational users, trespassers, and day care center children. It should be noted that the majority of the site is vegetated thereby reducing the generation of fugitive dust via wind erosion. Potential risks associated with inhalation exposures via migration from soil to air are minimal.

Based on the risk assessment in the RFI, the media of concern for Site 7 are surface soil and groundwater. Exposure to soil impacted with HMX and RDX present elevated risks (noncarcinogenic and/or carcinogenic). The data indicates that soil is significantly impacted with nitroaromatic compounds to an average depth of 2-feet throughout a large portion of the swale. Smaller isolated areas contain impacted soil above screening levels up to 4 feet. Elevated risks for groundwater are primarily a result of exposure to explosives and chlorinated hydrocarbons. Further groundwater investigation was conducted as part of the investigation for OU1.

## 2.6 SUMMARY OF ECOLOGICAL RISK ASSESSMENT

The risks to ecological receptors were evaluated in the Basewide Screening Level Ecological Risk Assessment (TtNUS, 1999) and are concluded in the Basewide Ecological Risk Assessment (BERA) (TtNUS, 2001). The BERA concludes that there is no current risk to ecological receptors at Site 7. Therefore, CAOs specific to ecological receptors are not necessary. Furthermore, any corrective actions at Site 7 to address risks to human health will mitigate any potential impact that the contaminants at the site will have on ecological receptors in the future.

Figure 2-1 (Pocket Color)  
2-1 Sample and Monitoring Well Locations

Figure 2-1 (Pocket Color) (Backside)  
2-1 Sample and Monitoring Well Locations

### 3.0 CORRECTIVE ACTION OBJECTIVES

The following section describes the development of the proposed CAOs for Site 7 at the former NSWC-White Oak. These CAOs and media clean-up standards are based on promulgated Federal and State of Maryland requirements, risk-derived standards, data and information gathered during the previous investigations, and additional applicable guidance documents.

CAOs are developed for the site as medium- and contaminant-specific objectives that will result in the protection of human health and the environment. The development of CAOs for a site is based on human health and environmental criteria, information gathered during the RFI, EPA guidance, and applicable federal and state regulations. Typically, CAOs are developed based on promulgated standards [e.g., Ambient Water Quality Criteria (AWQC)], background concentrations determined from site-specific investigation, and human health risk-based concentrations (RBCs) developed in accordance with EPA risk assessment guidance. The RFI presents a complete description of the HHRA and contaminant fate and transport. The purpose of this section is to identify ARARs and develop CAOs for remediation of surface and subsurface soil at Site 7.

#### 3.1 ARARS

ARARs are used to develop clean-up criteria for the CAOs and to identify removal action technologies. The term ARAR is defined in the National Oil and Hazardous Substances Contingency Plan (NCP) as follows:

- **Applicable Requirements** means those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that directly and fully address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at the site.
- **Relevant and Appropriate Requirements** means those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law, while not "applicable" address problems or situations sufficiently similar (relevant) to those encountered at the site, that their use is well suited (appropriate) to the particular site.
- **"To Be Considered" (TBC) Criteria** are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing remedial action, or necessary for determining what is protective to

human health and/or the environment. Examples of TBC criteria include the EPA Region III Risk-Based Concentration Table (USEPA, 2000).

Based on the manner in which they are applied during a remedial action, ARARs are classified into the following three categories:

- Chemical-Specific. Chemical-specific ARARs were developed to provide health- or risk-based concentration limits. These limits are specific for an individual chemical or group of chemicals. Often, these ARARs are used to determine the extent of site remediation. Chemical-specific ARARs may be concentration-based cleanup goals or may provide the basis for calculating such levels. In cases where no chemical-specific ARAR exists, chemical advisories may be used to develop removal action objectives.
- Action-Specific. Action-specific ARARs pertain to the implementation of a given remedy. These ARARs control or restrict hazardous substance- or pollutant-related activities. These controls are considered when specific removal activities are planned for a site.
- Location-Specific. Location-specific ARARs are considered in view of natural or man-made site features. These ARARs are intended to limit activities within designated areas.

One of the primary concerns during the development of the corrective measures alternatives for hazardous waste sites under RCRA is the degree of human health and environmental protection afforded by a given remedy. Consideration should be given to corrective measures that attain or exceed ARARs.

In addition to ARARs, other regulations and guidance may be classified as TBC. TBCs are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing CAOs or are necessary for determining what is protective of human health and/or the environment. TBCs are also identified in this section to aid in evaluating the corrective measure alternatives.

### **3.1.1 Chemical-Specific ARARs and TBCs**

This section presents a summary of potential federal and state chemical-specific ARARs and TBCs for Site 7. The chemical-specific ARARs and a brief description of each are outlined on Table 3-1.

Risk-Based Criteria Developed by EPA Region III to be used in selection of chemicals of concern for quantitative risk assessments. The levels listed on the RBC Table (USEPA, 2000) are not regulatory and do not have official status as guidance. Absent of a formal human health risk assessment, RBCs would be TBC for soil at Site 7.

Resource Conservation and Recovery Act (RCRA) 40 Code of Federal Regulations (CFR) 261 presents the regulations that govern the identification and listing of hazardous waste. Potential corrective actions may involve the use or generation of hazardous materials that may be regulated under this act.

Land Disposal Restrictions (LDR) Under RCRA 40 CFR 268, hazardous waste is banned from land disposal unless treated to substantially reduce the toxicity and mobility of the waste. This regulation sets forth standards for wastewater and soil that must be obtained prior to the land disposal of such materials. This regulation may be applicable to options or technologies that would use or may produce hazardous materials.

The Safe Drinking Water Act (SDWA) This act promulgated chemical-specific National Primary Drinking Water Standards (NPDWS) pertaining to drinking water. These regulations are applicable to public water systems that have at least 15 service connections or serve an average of at least 25 people daily for a minimum of 60 days per year.

NPDWS are established in 40 CFR Part 141 and include Maximum Contaminant Levels (MCLs) and MCL Goals (MCLGs). The MCLs are enforceable standards that consider not only health factors but also the economic and technical feasibility of removing a contaminant from a water supply system. MCLGs are strictly health-based standards that disregard cost or feasibility of treatment. MCLs and MCLGs are not legally applicable to remediation of groundwater at the former NSWC-White Oak. They may be viewed, however, as relevant and appropriate in situations where people use private drinking water wells in the area. Both standards may also be relevant and appropriate when the aquifer can potentially be used as a drinking water source, even if it is not currently being used as such.

Secondary MCLs (SMCLs) (40 CFR Part 143) are not enforceable but are intended as guidelines for contaminants that may adversely affect the aesthetic quality of drinking water, such as taste, odor, color, and appearance, and may deter public acceptance of drinking water provided by public water systems. Because they are not legally enforceable, SMCLs are not ARARs but may be TBC criteria.

Maryland Water Quality Standards Code of Maryland Regulations (COMAR) 26.08.02 provides for protection of groundwater and for protection of aquatic life in surface waters define designated uses for various water bodies in the state. The regulation establishes standards for various surface water parameters in light of the use designation, including dissolved oxygen (DO), temperature, pH, turbidity, total residual chlorine, and toxic substances.

Quality of Drinking Water in Maryland COMAR 26.04.01 provides MCLs of contaminants in drinking water. State MCLs are not legally applicable to remediation of groundwater at the former NSWC-White Oak. They may be viewed, however, as relevant and appropriate in situations where people use private drinking water wells in the area and may also be relevant and appropriate when the aquifer can potentially be used as a drinking water source, even if it is not currently being used as such.

Where groundwater discharges to surface water, the more stringent level between the MCL and the state or federal surface water quality standard or criterion for protection of aquatic life will be considered in establishing cleanup levels.

The Clean Water Act (CWA) Sets EPA AWQC, which are non-enforceable guidelines developed for pollutants in surface water pursuant to Section 304(a)(1) of the CWA. Although AWQCs are not legally enforceable, they should be considered as TBC. AWQCs are available for the protection of human health from exposure to contaminants in surface water as well as from ingestion of aquatic biota and for the protection of freshwater and saltwater aquatic life. AWQCs may be considered for actions that involve groundwater treatment and/or discharge to nearby surface water.

The Clean Air Act (CAA) Includes New Source Performance Standards (NSPS), which are established for new sources of air emissions to ensure that the new stationary sources minimize emissions. These standards are for categories of stationary sources that cause or contribute to air pollution that may endanger public health or welfare. Standards are based upon the best-demonstrated available technology (BDAT).

### **3.1.2 Action-Specific ARARs and TBCs**

This section presents a summary of the federal and state action-specific ARARs and TBCs for Site 7. The action-specific ARARs and a brief description of each are outlined on Table 3-2.

Land Use Restrictions at Environmental Remediation Sites This directive (CNBJAXINST 5090.2N4) sets forth requirements to govern land use at remediation sites at Navy installations. These restrictions would be relevant and appropriate to actions that would leave waste on site, including under a containment option.

Department of Transportation (DOT) Rules for Hazardous Materials Transportation 49 CFR 107, 171-179 set forth the requirements for the transportation of hazardous waste. This may be applicable if the option or technology uses or generates hazardous materials.

Transporters of Hazardous Materials Standards that pertain to the transporters of hazardous materials are presented in 40 CFR 263. COMAR 26.13.04 also outlines regulations for the transporters of hazardous wastes. These standards set forth the requirements for the transporters of hazardous waste. This may be applicable if the option or technology uses or generates hazardous materials.

Control of Noise Pollution COMAR 26.02.03 provides limits on the maximum allowable levels of noise at site boundaries during remediation activities. This would be applicable during any excavation or similar activities that use heavy equipment. The operation of any treatment system would also have to conform to this standard.

CWA National Pollution Discharge Elimination System (NPDES) 40 CFR 122 requires permits for the discharge of pollutants from any point source into waters of the United States. These requirements are applicable to corrective measure alternatives that would result in discharge of process water or groundwater to surface water.

Maryland Water Protection Permit Regulations COMAR 26.08.04 defines the general discharge permit program and regulates discharges to surface water of the state, which are applicable to corrective measures at Site 7. Corrective measures that discharge groundwater to adjacent surface water bodies would need to comply with the substantive aspects of this regulation.

Well Construction COMAR 26.04.04 specifies standards and procedures applicable to construction of wells in the state of Maryland. The Board of Well Drillers (COMAR 26.05.01) regulations provide licensing requirements for and ensures that monitoring wells are installed by qualified well drillers. These regulations are applicable to corrective measures that involve installation of groundwater monitoring or extraction wells.

Air Quality COMAR 26.11 regulations may be relevant and appropriate for corrective measures alternatives that generate air emissions.

Stormwater Management and Erosion and Sediment Control COMAR 26.17.02 and 26.17.01, respectively present the standards for the management of stormwater and disturbed land during remediation activities. The primary goal of these regulations is to maintain pre-construction runoff characteristics to the extent practical and to reduce stream channel and surface erosion, sediment pollution, and localized flooding.

Occupational Safety and Health Administration (OSHA) Standards General regulations that would apply to remedial actions and construction activities.

### 3.1.3 Location-Specific ARARs and TBCs

Location-specific ARARs, outlined on Table 3-3, are considered in view of natural or man-made site features and are intended to limit activities within designated areas. Such features include:

- Caves, salt-dome formations, salt-bed formations, and underground mines
- Faults
- Wilderness areas, wildlife refuges, and scenic rivers
- Wetlands and floodplains
- Historic sites and archaeological findings
- Rare, threatened or endangered species

None of these sensitive habitats or conditions exists on or in the vicinity of Site 7. Furthermore, Site 7 does not contain wetlands or other waters of the United States (HNUS, 1995) nor does Site 7 contain areas regulated under Section 404 of the CWA or the Maryland Nontidal Wetlands Protection Act. While a comprehensive survey for endangered animal species has not been conducted at the former NSWC-White Oak, no endangered species are known to exist at the facility (EFACHES, 1997). Therefore, there are no location-specific ARARs or TBCs that would pertain to the implementation of a corrective measure at Site 7.

## 3.2 CORRECTIVE ACTION OBJECTIVES

CAOs generally identify receptors, pathways, and action levels for COCs and are developed in this section to address impacted surface and subsurface soil. The discussion in the RFI and summarized in section 2.5 of this report provides the rationale for screening of PCOCs and selection of COCs for Site 7. Based on this analysis, the RFI identified the explosive compounds HMX and RDX as COCs in soil (TtNUS, 2000). The majority of the risk was from these two contaminants in soil. The Preliminary Remediation Goals (PRGs) that apply for the remediation of the COCs in soil are outlined in Table 3-4.

The CAOs for impacted surface and subsurface soil are as follows.

- Prevent human exposure (through ingestion, inhalation, and dermal contact) to soil having contaminants at concentrations in excess of PRGs.
- Mitigate source areas within Site 7 that may be transported off site to drainage features and sediment.

- Minimize the impact of contaminated soils on groundwater.
- Comply with chemical-, action-, and location-specific ARARs and TBCs.

Elevated risks for groundwater are primarily a result of exposure to explosives and VOCs (specifically chlorinated hydrocarbons), however, the source of VOCs is associated with an upgradient waste management unit (Site 4 - Chemical Burial Area). The CAOs have been formulated to be protective of groundwater for COCs identified in that media. Further groundwater investigation has been conducted as part of the investigation for OU1. Remedies for impacts to groundwater will be outlined in the OU1 CMS.

The CAOs were developed to be protective of groundwater but will not serve to mitigate existing groundwater contamination. Modeling was performed to predict the impact of soil contamination on the underlying groundwater at Site 7, the results of which were used to establish the PRGs for the remedial action. The modeling predicted an RDX concentration of 592 mg/kg in soil to be protective of groundwater at the site. The results of the model are provided in Appendix B. Remedies for impacts to groundwater will be outlined in the OU1 CMS.

### **3.3 VOLUME OF IMPACTED MATERIAL**

Based on the available analytical results presented in Section 2, the volume of impacted soil is estimated to be approximately 1,133 cubic yards. As calculated in Appendix C, this volume is based on the soil within entire swale area being impacted with explosives above the PRGs to an average depth of 1.5 feet. The area is impacted with explosives in a heterogeneous manner, and the data is not conclusive for a detailed delineation. Areas of soil impacted with explosives greater than the PRGs may extend to depths of 3 to 4 feet or deeper, while areas between locations of impacted soil have been sampled and analyzed as having lower degrees of explosives contamination.

For containment or in-situ options, the area of impacted soil is a key design element. The estimated area of swale that is impacted is approximately one-half of an acre (20,400 square feet). Furthermore, in-situ options need a high degree of vertical impact delineation in order to design the remedy. For options that require excavation, pre-remediation delineation as well as post-remediation verification may be performed.

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**TABLE 3-1**  
**SUMMARY OF CHEMICAL-SPECIFIC ARARs AND TBCs**  
**SITE 7 CMS**  
**THE FORMER NSWC-WHITE OAK, SILVER SPRING, MARYLAND**

ARAR or TBC	Rationale for Use at Site 7
Risk-Based Criteria	Soil concentrations that exceed these USEPA Region III TBCs for soil have been used in the human health evaluation. These TBCs may be used for selecting site remediation levels for identified contaminants.
Resource Conservation and Recovery Act	Applicable for options that would generate hazardous materials.
Land Disposal Regulations	Applicable to options that may generate hazardous and banned materials. In general, this is not applicable to the explosives-impacted soils at Site 7 based on the contaminants and concentrations.
The Safe Drinking Water Act	Establishes levels within groundwater for public water systems. Groundwater is not expected to be used and will be addressed in OU1.
Maryland Water Quality Standards	Establishes levels within groundwater for public water systems. Groundwater is not expected to be used and will be addressed in OU1.
Quality of Drinking Water in Maryland	Establishes levels within groundwater for public water systems. Groundwater is not expected to be used and will be addressed in OU1.
Clean Water Act	Guidelines for pollutants in surface water. Would apply for treatment options that discharge to the surface water.
Clean Air Act	Relevant and appropriate requirements to emissions from remedial activities at Site 7.

**TABLE 3-2**  
**SUMMARY OF ACTION-SPECIFIC ARARs AND TBCs**  
**SITE 7 CMS**  
**THE FORMER NSWC-WHITE OAK, SILVER SPRING, MARYLAND**

<b>ARAR or TBC</b>	<b>Rationale for Use at Site 7</b>
Land Use Restrictions at Environmental Remediation Sites	Potentially applicable Navy directive to options that would restrict future use or continued monitoring or maintenance.
DOT Rules for Hazardous Materials Transportation	Potentially applicable to evaluation of removal and disposal alternatives for Site 7. May apply to treatment options that generate or use hazardous materials.
Transporters of Hazardous Materials	Potentially applicable to evaluation of removal and disposal alternatives for Site 7. May apply to treatment options that generate or use hazardous materials.
Control of Noise Pollution	May apply to excavation, remediation, or other actions and on-site treatment systems.
National Pollution Discharge Elimination System	Applicable for options and actions on-site that will require discharge of water to the surface water.
Maryland Water Protection Permit Regulations	Applicable for options and actions on-site that will require discharge of water to the surface water.
Well Construction	Requirements for the construction of new wells. This would apply only if wells were being installed as part of the corrective action.
Air Quality	Applicable for options that generate air emissions.
Stormwater Management and Erosion and Sediment Control	Regulations and guidance are potentially applicable for reducing erosion and sedimentation during land disturbance and restoration activities.
OSHA Standards	TBCs that must be observed during excavation, treatment, loading, and other actions at Site 7.

**TABLE 3-3**  
**SUMMARY OF LOCATION-SPECIFIC ARARs AND TBCs**  
**SITE 7 CMS**  
**THE FORMER NSWC-WHITE OAK, SILVER SPRING, MARYLAND**

<b>ARAR or TBC</b>	<b>Rationale for Use at Site 7</b>
Caves, Slat-Dome Formations, Salt-Bed Formations, and Underground Mines	Not applicable.
Faults	Not applicable.
Wilderness Areas, Wildlife Refuges, and Scenic Rivers	Not applicable.
Wetlands and Floodplains	Not applicable.
Historic Sites and Archaeological Findings	Not applicable.
Rare, Threatened, or Endangered Species	Not applicable.

**TABLE 3-4**  
**PRELIMINARY REMEDIATION GOALS FOR SOIL**  
**SITE 7 CMS**  
**THE FORMER NSWC-WHITE OAK, SILVER SPRING, MARYLAND**

<b>COC</b>	<b>Human Health Residential RBC<sup>1</sup> mg/kg</b>
RDX	5.8
HMX	390

1 EPA Region III Risk Based Concentration,  
10/5/00

## 4.0 IDENTIFICATION, SCREENING, AND DEVELOPMENT OF CORRECTIVE MEASURE ALTERNATIVES

### 4.1 INTRODUCTION

This section presents the identification, screening, and development of the corrective measure alternatives formulated to achieve the CAOs for Site 7. The identification and screening of corrective measure technologies and the development of corrective measure alternatives are based upon the information presented in Section 3 and involve the following activities:

- Identification of applicable general response actions, corrective measures technologies, and process options.
- Screening of potential corrective measure technologies and applicable process options.
- Development of corrective measures alternatives by assembling the remaining technologies into alternatives that have the potential to achieve the defined CAOs.

### 4.2 IDENTIFICATION AND SCREENING OF CORRECTIVE MEASURE TECHNOLOGIES AND PROCESS OPTIONS

This section identifies the corrective measure technologies and process options that may be used to achieve the CAOs. This process was based on the review of current literature (USAEC, 1997), vendor information, and previous experience in developing alternatives for sites with similar media-specific concerns and releases.

#### 4.2.1 Identification and Preliminary Screening of Corrective Measure Technologies and Process Options

Corrective measure technologies and process options can be grouped according to general response actions. Corrective measure alternatives are then formulated by combining general response actions to completely address the CAOs. When implemented, the corrective measure alternative should be capable of achieving the CAOs. The general response actions that could be implemented to achieve the CAOs for Site 7 include:

- No Action
- Institutional Controls
- Containment
- Removal

- In-Situ Treatment
- Ex-Situ Treatment
- Disposal

Each of the general response actions is discussed in more detail below. Corrective measure technologies and process options for each of the general response actions that are applicable to Site 7 are identified and screened in Table 4-1. All technologies and process options that are not eliminated because of effectiveness and implementation concerns are evaluated further in Section 4.2.2.

#### **4.2.1.1 No Action**

No Action is a general response action wherein the status quo is maintained at the site. No Action is normally retained to provide a baseline for comparison with other alternatives. No additional activities would be conducted at the site to address remaining contamination in the soil. There are no implementability concerns, because the contaminated media are considered to be left "as is". Institutional controls, containment, removal, treatment, monitored attenuation or other mitigating actions are not provided to reduce the potential for exposure or contaminant migration.

#### **4.2.1.2 Institutional Controls**

Land use restrictions (e.g., deed restrictions) are institutional control options that may be considered for implementation to reduce or eliminate pathways of exposure to hazardous substances at the site. Physical barriers such as fencing would restrict access to the site and reduce the potential for exposure to contaminated media. Other controls would involve the implementation of soil, sediment, and groundwater use restrictions as well as groundwater and surface water monitoring networks. The application of institutional controls alone does not reduce the volume, mobility, or toxicity of the contaminants.

#### **4.2.1.3 Containment**

Containment involves the application of physical measures to reduce the potential for contaminant migration and/or exposure, and thereby reducing the risk to the public and the environment. The contaminated media must be isolated to prevent future exposure of potential receptors to COCs and to reduce the migration of contaminants via the primary transport mechanisms (i.e., wind, erosion, surface water, and groundwater). Contaminated media are isolated by the installation of surface and/or subsurface barriers that either block or divert any transport media (i.e., groundwater, rainfall, infiltration, surface water runoff, wind, etc.) from the contaminants.

#### 4.2.1.4 Removal

Removal is a general response action that involves activities such as the excavation of soils which is used to move contaminated media from its present location in order to be treated and/or disposed of elsewhere. Other technologies such as a vacuum removal or hydraulic displacement and movement could be implemented when applicable. This option is usually combined with an ex-situ technology such as treatment or disposal to create a complete alternative.

#### 4.2.1.5 In-Situ Treatment

In-situ treatment refers to the treatment of the impacted soil without excavation. The chemical, physical, biological, or thermal technology types offer in place process options for the treatment of soil. Only those process options that are demonstrated for the treatment of explosives in soil will be retained for more detailed evaluation as possible alternatives.

The in-situ chemical/physical process options that are evaluated include soil vapor extraction, solidification/stabilization, soil flushing, fracturing, and electrokinetic separation. The biological options include natural attenuation, land treatment, phytoremediation, bioventing, and enhanced bioremediation/biodegradation. Vitrification and enhanced soil vapor extraction are the thermal options available.

#### 4.2.1.6 Ex-Situ Treatment

Similar to the in-situ general response action in technology types, the ex-situ general response action includes various chemical, physical, biological, or thermal process options. These options are designed to reduce the mobility, toxicity, and/or volume of the contaminants present. The ex-situ treatment options considered appropriate for Site 7 include those that are proven for the treatment of explosives in soil. Treatment residuals, such as extracted materials or process waters are included with the evaluation of these options.

Chemical/physical process options include chemical extraction, separation, solidification/stabilization, chemical reduction/oxidation, dehalogenation, soil washing, soil vapor extraction, and solar detoxification. Biological options include composting, biopiles, landfarming, slurry-phase biological treatment, and fungal bioremediation. Thermal process options include open burn, incineration, thermal desorption, pyrolysis, and hot gas decontamination.

#### 4.2.1.7 Disposal

Disposal technologies include placement of removed or treated materials in an on-site or an off-site permanent disposal facility. Removal options and possibly treatment options can be used with disposal process options to develop alternatives. The toxicity, mobility, or volume of the contaminants is not reduced through the singular application of disposal. This response action would reduce or eliminate exposure pathways related to direct human contact with contaminated material at the site. Disposal technologies may be necessary to complete treatment alternatives that generate residuals or generate products that have associated risk.

The treatment and disposal of material at a facility off site may be considered if applicable.

#### 4.2.2 Final Screening of Corrective Measure Technologies and Process Options

A preliminary screening of corrective measure technologies and process options was completed to eliminate those that are unfeasible to implement, that rely on technologies unlikely to perform satisfactorily or reliably, that do not achieve the CAOs within a reasonable time, and that are incompatible with the presumptive containment remedy. The screening is outlined on Table 4-1. The technologies and process options that passed the preliminary screening are evaluated below.

The criteria used to conduct the final screening of the technologies and process options are described below.

- Effectiveness - This criterion focuses on the potential effectiveness of process options in protecting human health and the environment and in meeting the CAOs. This criterion considers potential impacts to human health and the environment during construction and implementation and how proven and reliable the process is with respect to the contaminants and site conditions.
- Implementability - Implementability is a measure of both the technical and administrative feasibility of implementing a technology. It provides a means of evaluating the ability of a technology to be adapted to site-specific conditions. Technical feasibility includes consideration of construction and operational issues, demonstrated performance, and adaptability to site conditions. Administrative feasibility considerations include the ability to obtain any necessary permits or easements or adherence to applicable laws and concerns of other regulatory agencies. General availability of necessary equipment and resources is also evaluated.
- Cost - Cost evaluations allow a relative comparison between similar technologies and play a limited role in technology screening. The cost analysis is based on engineering judgment and each

technology is evaluated as to whether costs are low, medium, or high relative to the other options in the same technology type. If there is only one process option, costs are compared to other candidate technologies.

#### 4.2.2.1 No Action

The No Action option will be used as a baseline for comparison with other corrective action alternatives. Because no actions are required by definition, this option will be retained as an alternative and will not be evaluated further.

#### 4.2.2.2 Institutional Controls

Institutional controls are non-engineered measures that could be used to control the future use of a site. Such controls may be used to limit uses of the site or to ensure maintenance of a constructed response action. In the case of federally owned property, the implementation strategy for institutional controls is typically described in a Land Use Control Plan (LUCAP).

**Effectiveness** - Access restrictions could be effective in minimizing the direct contact to the contaminated surface soil, depending on the administration of the controls. Contaminant migration to downstream locations through erosion may continue. The impacted soil may continue to be a source of impact to groundwater.

**Implementability** - Institutional controls should be readily available upon execution of a LUCAP or similar plan. Monitoring of environmental media can be easily implemented at Site 7.

**Cost** - Costs of access/use restrictions are low.

**Conclusion** - Retain this option for combining with other options. This option will not be considered as a stand-alone alternative because this option is not effective at meeting the CAOs for Site 7. This option may be combined with other options to create an adequate corrective measures alternative that may achieve the CAOs.

#### 4.2.2.3 Containment

Capping and other containment options would prevent the direct contact and exposure to impacted soil, minimize infiltration to the subsurface soils, and would minimize erosion and migration of contaminants to surface water and sediments. Caps are engineered layers of soil, clay, asphalt, or synthetic materials compacted or placed over the impacted soil area.

Clay, asphalt, concrete, or synthetic materials may be used to construct the cap when contaminant migration to the groundwater via infiltration must be minimized. A multimedia cap typically consists of a composite of natural and synthetic materials. The bottom layer is an infiltration barrier consisting of a low-permeability geomembrane/clay layer typically with a hydraulic conductivity of  $1 \times 10^{-7}$  cm/sec or less. The clay layer may consist of a Geosynthetic Clay Liner (GCL) which is composed of a fabricated layer of bentonite clay sandwiched between two layers of woven geotextile fabric. The geomembrane liner typically consists of thin sheets of flexible thermoplastic or thermoset polymeric materials. Above the infiltration barrier, a drainage layer is provided. A layer of fill is provided above the drainage layer as a zone of root penetration for the overlying vegetative layer and also as a buffer zone for frost protection of the underlying drainage layer. Over the fill is a layer of top soil with vegetation. Because no gas generation is present at Site 7, a gas collection layer consisting of either sand or a geonet that would typically be used beneath the geomembrane layer to allow gases, if any, emitted by decomposition of wastes, to be collected, treated, and discharged is not necessary. Geotextile layers may be used to separate layers as needed.

Asphalt or concrete pavement on a properly prepared subgrade would also provide an adequate containment barrier.

**Effectiveness** – Any type of cap would be effective in eliminating the direct exposure pathway to Site 7 impacted soils. A cap of compacted soil that includes a topsoil layer, vegetative cover, and the appropriate surface water controls would be an effective barrier to minimize direct exposure and prevent migration due to erosional transport mechanisms. However, this type of cap would not be effective because the migration of contaminants to groundwater contaminant would continue. Alternately, an asphalt or similar impervious multimedia cap, as defined above, would be required not only to minimize direct exposure but also to minimize rainfall infiltration through the waste and subsequent contaminant migration to the groundwater. This type of cap would also provide an effective barrier to minimize direct exposure and prevent migration due to erosional transport mechanisms. A consideration for the cap system at Site 7 may be that this area is currently a drainage feature and may need to be designed to convey surface water across the cap and through the site.

**Implementability** – Caps are readily implementable and resources, equipment, and materials are readily available to perform this work. The technology is well proven and established in the construction/remediation industry. However, a concern with the implementation of caps and erosion controls is the maintenance of the integrity of the cap under the influence of natural and human interferences. Site 7 is expected to remain under GSA control, therefore human interferences can be minimized.

**Cost** – The costs of caps are moderate, and are dependent on the type, material and labor involved with site preparation and placement. Operation and maintenance (O&M) costs can be moderate.

**Conclusion** – Retain the use of soil and geosynthetic cap. This option would meet the CAOs due to the minimization of rainfall infiltration through the waste and subsequent contaminant migration to the groundwater as well as the reduction to direct contact and erosion of impacted soil.

#### 4.2.2.4 Removal

The technology being considered under removal is excavation of impacted soil at Site 7. Excavation can be performed by a variety of equipment, such as hydraulic excavators, front-end loaders, dozers, and backhoes. The type of equipment selected must take into account several factors, such as type of material being excavated, load-supporting ability of the soil, rate of excavation required, depth of excavation, etc. Usually excavators or backhoes are used for deep excavations and/or when high rates of excavation production are required.

The logistics of excavation must take into account the available space for operating equipment, loading/unloading to transport the removed material, location of the site, etc. The depth of excavation will dictate whether bracing, shoring, etc. will be required. The excavated area is either restored to new contours or is backfilled to pre-excavation conditions with either treated or clean fill material.

**Effectiveness** – Excavation/regrading would be an effective method for combining with an ex-situ treatment option or for off site disposal. Confirmatory sampling and analysis would be necessary to determine the limits of the excavations at Site 7. Potential exposure to contaminated soil, sediment, and waste material can be controlled to acceptable levels during construction by the use of personal protective equipment (PPE), and the safe work practices following OSHA guidelines. Total excavation of all contaminated soil and waste material contained in Site 7 would also be effective in meeting the CAOs. However, it alone is not a corrective measures alternative and must be combined with an ex-situ treatment or disposal option.

**Implementability** – Excavation is easily implementable and excavation equipment and services are readily available. The technology is well proven and established in the construction/remediation industry.

**Cost** – Excavation costs are directly proportional to the volume of material excavated, the depth of the material, and the characteristics of the material. Surface soil excavation costs are low to moderate compared to deeper soil excavation.

**Conclusion** – Retain limited removal/excavation for further consideration in the development of alternatives.

#### 4.2.2.5 In-Situ Treatment

Four in-situ treatment options were retained from the initial screening. Three options are biological treatment options (land treatment, phytoremediation, and enhanced bioremediation/biodegradation) that have been demonstrated on various levels and scales to be effective for the COCs at Site 7. The fourth option, solidification/stabilization, is a chemical/physical process which has potential applicability to explosives impacted soil but no demonstrated results.

**Effectiveness** – Land treatment and phytoremediation are applicable to impacted soil in the surface and shallow subsurface (12 to 18-inch) zone. Soil at Site 7 has been delineated above the PRGs at depths greater than the effective treatment depths.

Enhanced bioremediation/biodegradation, which is applicable to surface and subsurface soils, usually requires the use of injected water to create the required conditions and may increase the short-term impact to groundwater. Furthermore, enhanced bioremediation has been used for remediating low level residual contamination in conjunction with source removal. This option is not demonstrated for source remediation with full-scale results. This option may be able to achieve the CAOs for Site 7, but lengthy research and treatability data would be required.

Solidification/stabilization has been used for explosives - impacted soil. However, in-situ application of this option is not demonstrated.

**Implementability** – All four options would require lengthy treatability studies to formulate the remedy and the effectiveness of the option implemented. After a feasible design is complete, the options are moderate to implement, and typically require materials and equipment that are available.

**Cost** – The cost associated with the options is highly variable, and depends on the treatability results and degree of implementation required. The cost of the options is in the moderate range.

**Conclusion** – All in-situ options are eliminated from further consideration. Land treatment and phytoremediation are not applicable to the estimated depth of impacted soil found at Site 7. Enhanced bioremediation/biodegradation as well as solidification/stabilization, although potentially effective for the COCs at Site 7, are not demonstrated for full scale remediation.

#### 4.2.2.6 Ex-Situ Treatment

Four Chemical/Physical treatment options (chemical extraction, solidification/stabilization, soil washing, and solar detoxification) were retained for further evaluation in the initial screening. Chemical extraction and soil washing cleanse the impacted soil by extracting the contaminant from the soil. This effectively would concentrate the contaminant in a smaller volume with a higher concentration. The treated soil would be returned to the excavation upon sampling and approved results. The extract would require proper disposal. Solidification/stabilization has been demonstrated in the remediation of metals and explosives - impacted soil. The addition of activated carbon effectively stabilized RDX (HTRW, 1999). Solar detoxification provides for complete destruction of the contaminant.

All five biological options were retained. These options (composting, biopiles, landfarming, slurry-phase biological treatment, and fungal bioremediation) all have varying degrees of demonstrated effectiveness and implementability with the COCs found at Site 7.

Four of the five thermal options are applicable to the COCs at Site 7. These options are open burn, incineration, thermal desorption, and hot gas decontamination.

**Effectiveness** – Chemical extraction and soil washing may be effective at the removal of the COCs from the soil, but would produce an extract that would require disposal. Solidification/stabilization may be effective in binding the COCs within the soil but would not destroy the contaminants. The permanence of this option may not be effective. Solar detoxification, demonstrated as effective for explosives-impacted groundwater, has not been applied to explosives-impacted soils on a full scale.

All biological options have some effectiveness on the COCs at Site 7. These options have varying degrees of effectiveness and of demonstration.

Thermal options are the most proven of the treatment technology types. The retained treatment options would be effective in reducing the concentrations of the COCs in soil to the PRGs. These options, most notably incineration, would be the most effective in the destruction of the COCs at Site 7.

The initial concentration as related to the PRG has a great effect on the option effectiveness of any process option. The relatively low concentrations of the COCs in soil at Site 7 make the overall effectiveness of many of the options difficult to evaluate.

**Implementability** – The chemical/physical options would require treatability studies and collection of site specific data prior to implementation. All of the options have been used in remediation projects at varying degrees. Some of the options require specialized process equipment and/or materials.

All biological options have the same basic pretreatment requirements as outlined for the chemical/physical options and are moderate to implement.

Thermal options are most likely the most difficult to implement. Equipment for some (i.e. thermal desorption) is available from vendors and transportable to the site. The total volume of soil to be treated makes these technologies costly to implement. Furthermore, permitting requirements for incineration technologies would be extensive.

**Cost** – The chemical/physical options are moderate cost options, with high costs for treatment areas and extract disposal.

Biological options have the lowest relative costs. The costs can vary widely due to the limited demonstration information. Actual costs for the treatment facility and treatment materials (e.g. amendments) may significantly increase during design and implementation.

Thermal options are most likely the most expensive options to implement. Furthermore, permitting requirements for incineration technologies would be extensive. The volume and initial concentrations of the COCs in soil at Site 7 make the thermal treatment options cost prohibitive.

**Conclusion** – Chemical/physical options are eliminated from further consideration. These options either provide for non-destructive options (transfer risk to other media) or are not demonstrated to a high confidence level.

Composting is retained as the representative biological treatment option. This option has the most demonstrated application for the COCs in soil at Site 7.

All thermal options are eliminated from further consideration due to the low volume of material to be treated, the low initial concentration of the COCs in soil, and the high initial cost for the technologies.

#### 4.2.2.5 Disposal

The technology option being considered under disposal is offsite disposal. This option would include the proper characterization and analysis, loading, transportation, and final disposal at an appropriate offsite treatment/disposal facility.

**Effectiveness** – Offsite treatment and disposal would be effective for the COCs in soil at Site 7. The individual and total concentrations of COCs as well as any potential hazardous constituents are either not

present or are at levels acceptable for off site disposal at a non-hazardous facility. This option reduces the on-site risk, but does not reduce the volume of material at the disposal facility.

**Implementability** – Federal and state regulations regarding handling, treatment, and disposal of the impacted soil would need to be followed.

**Cost** – Costs associated with off site disposal would be moderate – assuming that non-hazardous disposal is acceptable.

**Conclusion** – Retain offsite disposal option for consideration during development of remedial alternatives.

#### 4.3 IDENTIFICATION OF CORRECTIVE MEASURE ALTERNATIVES

This section describes the development of the corrective measure alternatives for Site 7 considering the information provided in the previous sections. The following technologies and process options were retained for use at Site 7.

- No Action
- Containment (Soil and geosynthetic cap)
- Removal (Excavation)
- Ex-Situ Treatment (Composting)
- Disposal (Offsite – Non-hazardous disposal facility)

The above options were developed into corrective measure alternatives for further consideration and evaluation.

##### 4.3.1 Alternative 1 – No Action

No action is required for this alternative. This alternative is required by the NCP as a baseline comparison to other alternatives.

##### 4.3.2 Alternative 2 – Containment

This alternative would involve the installation of an impervious cap system within the swale of Site 7. The cap will limit precipitation and runoff from entering the impacted soil and will significantly reduce the amount of infiltration that could leach contaminants from the material. The design for the cap system may present the necessity of slight contour adjustments to the subgrade for the overall performance of the cap

system, although the movement of impacted soil would be kept to a minimum and would result in no net change in soil volume.

The limits of the cap and the final cap components will be determined during the design of the corrective measure for Site 7. Field test kits may be used for the general screening of the limits of the cap system. The total area of the cap will be approximately one acre. The additional cover material that would be required to blend the cap system into the existing sides of the swale is accounted for in the increased site area. The cap components from the bottom to the top will tentatively include the following:

- Subgrade layer of clean fill that would vary in thickness above the existing or regraded surface.
- Geosynthetic cap layers consisting of a GCL and a geomembrane.
- Drainage layer using a geocomposite net.
- Cover soil consisting of a minimum thickness of 18-inch fill material.
- Vegetative support layer consisting of 6 inches of topsoil or soil amended and capable of sustaining vegetation.

The extent and conceptual section of the proposed cap is shown on Figure 4-1. Areas surrounding the cap system will be blended into cap to protect the remedy from erosion. The cap may be designed to promote drainage through the swale system, to allow a uniform sheet flow of the surface water over the cap, or to incorporate perimeter drainage features to channel runoff as well as runoff. Permanent erosion control measures will be installed where surface water will be concentrated and where the cap discharges into the existing drainage features. Temporary surface water controls will be installed during the installation of the cap system.

After the restoration and vegetation of the areas surrounding the cap system, institutional controls would be implemented at Site 7. These controls may include land use and future site disturbance restrictions. Land use restrictions on the capped area preventing the disturbance of the cap system would be included in the LUCAP or similar plan. Long-term maintenance would be performed on the cap system to ensure the effectiveness of the remedy. Maintenance may include repairing soil erosion, repairing vegetation, and clearing of drainage features.

Groundwater, surface water, and downstream sediment monitoring would be completed after installation of the cap system. A detailed monitoring plan would be developed and followed during the effort. The results of the monitoring would be used to evaluate the effectiveness of the corrective action and to determine if additional actions are necessary. The screening criteria that would be used to evaluate the effectiveness of the action would be defined in the monitoring plan. The corrective action will be reviewed every 5 years.

#### 4.3.3 Alternative 3 – Composting

This alternate (Figure 4-2) would require complete excavation and on-site treatment of soil above the PRGs. Impacted soil would be delineated using field test kits for explosives. Excavation would proceed after the construction of the treatment area described below. Excavated soil would be transported to a treatment area adjacent to the excavation area. Excavation areas would be sampled and analysis performed to verify that soil impacted with COCs above the PRGs have been removed. The option used in this CMS includes the treatment of soil using the biological option known as a windrow composting process. This process would require the mixing of impacted soil with a blend of amendments.

The treatment area, conceptually 150 feet by 150 feet and constructed of an asphalt treatment pad to contain the soil and amendments, would be properly constructed for the handling, treatment, and containment of the impacted soil and any treatment residuals or runoff. The treatment area would also require a temporary structure or multiple structures erected over the windrows during the treatment of the soil. This structure would be necessary to reduce dust and wind blown particles, to eliminate storm water from the treatment process, and to control the operating parameters of the composting process.

The treated soil will have a significant increase in volume due to the addition of amendments. The total volume of treated soil would be returned to the excavation, placed, and compacted as necessary for site restoration. Due to the increase in volume of soil with the composting process, the post-remedial contours would be different from the pre-remediation topography. The design would need to provide for this additional material in the swale area. The area would be restored with vegetative materials and would not require any long term maintenance or monitoring.

#### 4.3.4 Alternative 4 – Off Site Disposal

Similar to the treatment alternative, this option would require the delineation of the impacted soil above the PRGs and the complete excavation of the identified material. All soil above the PRGs would be excavated and sent to an appropriate off-site facility for disposal as shown on Figure 4-3. Based on previous sampling and analytical results, the soil is not characterized as hazardous waste and can be transported and disposed of as non-hazardous material.

A temporary handling and loadout area would need to be constructed for this alternative. This area would consist of a stabilized construction entrance, tire wash/truck decontamination station, and material loadout and covering area.

This option, similar to the treatment option, would not require any long-term monitoring due to the complete removal of impacted material.

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General Action	Technology	Process Option	Description	General Screening/Decision
No Action	No Action	No Action	No activities conducted at site to address contamination.	No action is retained to provide a baseline for comparison with other alternatives. R
Institutional Controls	Institutional Controls	Access Controls/ Deed Restrictions	Administrative action used to restrict future site activities.	Use restrictions are viable, in combination with other technologies, especially alternatives that would leave contaminated soil in place. R
Containment	Capping	Capping	Use of impermeable or semi-permeable materials (e.g., soil, clay, synthetic membrane, or asphalt) to prevent exposure to contamination and/or reduce the vertical migration of contaminants to groundwater.	Capping would prevent direct contact with contaminated soils and would reduce infiltration of storm water into impacted soil. R
Removal	Excavation	Excavation	Excavation of contaminated soil and combination with other general action, such as ex-situ treatment options.	Excavation would be combined with any ex-situ process option as well as any disposal option. R
In-Situ Treatment	Chemical/ Physical	Soil Vapor Extraction	Soil vapor extraction (SVE) is a remediation technology applicable in unsaturated (vadose) zone soil. A vacuum is applied to the soil to induce the controlled flow of air and remove volatile and some semivolatile contaminants from the soil. Treatment of the gas leaving the soil may be performed to recover or destroy the contaminants, depending on local and state air discharge regulations.	SVE is applicable in certain cases with soil impacted with VOCs and some fuels. SVE will not remove heavy oils, metals, PCBs, or dioxins. However, SVE often promotes the in-situ biodegradation of low-volatility organic compounds that may be present because the process involves the continuous flow of air through the soil. E
		Solidification/ Stabilization	Solidification/stabilization (S/S) reduces the mobility of hazardous substances and contaminants in the environment through both physical and chemical means. S/S immobilizes contaminants within their medium. Leachability testing is typically performed to measure the immobilization of contaminants.	The target contaminant group for S/S is generally inorganics. Treatability studies for S/S of explosives involve addition of granular activated carbon with slurry. R
		Soil Flushing	Separation of contaminants from a solution by contact with an immiscible liquid with a higher affinity for the contaminants of concern.	Technology used primarily for inorganics. Used in certain cases for VOCs and SVOCs -- but will increase mobility and requires containment and recovery of groundwater. E

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General Acton	Technology	Process Option	Description	General Screening/Decision	
		Fracturing	Fracturing is an enhancement technology designed to increase the efficiency of other in-situ technologies in difficult soil conditions. The fracturing extends and enlarges existing fissures and introduces new fractures, making the formation more conducive to vapor extraction. Technologies commonly used in soil fracturing include pneumatic fracturing (PF), blast-enhanced fracturing and Lasagna™ process.	Fracturing is applicable to compliment a range of in-situ technologies that require engineered modifications to the formation. This technology does not target any particular contaminant group. The technology is used primarily to fracture silts, clays, shale, and bedrock.	E
		Electrokinetic Separation	Electrokinetic remediation is the application of a low-intensity direct current through the soil between ceramic electrodes that are divided into a cathode array and an anode array. This mobilizes charged species, causing ions and water to move toward the electrodes. Metal ions, ammonium ions, and positively charged organic compounds move toward the cathode. Anions such as chloride, cyanide, fluoride, nitrate, and negatively charged organic compounds move toward the anode. The current creates an acid front at the anode and a base front at the cathode. This generation of acidic condition in-situ may help to mobilize sorbed metal contaminants for transport to the collection system at the cathode.	Electrokinetic remediation is targeted for heavy metals, anions, and polar organics in soil, mud, sledge, and marine dredging. Electrokinetics is most applicable in low permeability soils. Such soils are typically saturated and partially saturated clays and silt-clay mixtures, and are not readily drained.	E
	Biological	Natural Attenuation	Natural attenuation (NA) is the use (and monitoring) of natural biotransformation processes such as dilution, dispersion, volatilization, biodegradation, adsorption, and chemical reactions with soil materials. NA processes can reduce contaminant concentrations to acceptable levels. Natural attenuation may be considered for remediation of contaminants in soils if site-specific factors are understood and support its use.	Target contaminants for natural attenuation are VOCs and SVOCs and fuel hydrocarbons. Fuel and halogenated VOCs (chlorinated solvents) are so far the most commonly evaluated for natural attenuation. Pesticides also can be allowed to naturally attenuate, but the process may be less effective and may be applicable to only some compounds within the group.	E

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General Acton	Technology	Process Option	Description	General Screening/Decision	
		Land Treatment	Land Treatment is a bioremediation technology in which contaminated soils are turned over or mixed and allowed to interact with the soil and climate at the site. The waste, soil type, climate, and biological activity interact dynamically as a system to degrade, transform, and immobilize waste constitutes.	Contaminants that have been successfully treated include diesel fuel, No. 2 and No. 6 fuel oils, JP-5, oily sludge, wood-preserving wastes (PCP, PAHs, and creosote), coke wastes, and certain pesticides.  This option is effective to maximum depths of approximately 18 inches below grade.	R
		Phytoremediation	Phytoremediation is a process that uses plants to remove, transfer, stabilize, and destroy contaminants in soil and sediment. The mechanisms of phytoremediation include enhanced rhizosphere biodegradation, phyto-extraction (also called phyto-accumulation), phyto-degradation, and phyto-stabilization.	Phytoremediation may be applicable for the remediation of metals, pesticides, solvents, explosives, crude oil, PAHs, and landfill leachates. This option is limited by the depth of the plant root system and is generally effective to maximum depths of approximately 18 inches below grade.	R
		Bioventing	Bioventing stimulates the natural in-situ biodegradation of any aerobically degradable compounds in soil by providing oxygen to existing soil microorganisms. In contrast to soil vapor vacuum extraction, bioventing uses low air flow rates to provide only enough oxygen to sustain microbial activity.	Bioventing has been used to remediate soils contaminated by petroleum hydrocarbons, nonchlorinated solvents, some pesticides, wood preservatives, and other organic chemicals. Remediation of inorganics is experimental, however, data indicates that bioventing may be used to change the valence state of inorganics and cause adsorption, uptake, accumulation, and concentration of inorganics in micro or macroorganisms, but will not aid in direct degradation. In addition to degradation of adsorbed fuel residuals, volatile compounds are biodegraded as vapors move slowly through biologically active soil.	E

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General Acton	Technology	Process Option	Description	General Screening/Decision
		Enhanced Bioremediation/ Biodegradation	Enhancement of natural aerobic and/or anaerobic processes by injecting nutrients and appropriate chemicals into the saturated zone.	Bioremediation has been used to remediate soils contaminated with petroleum hydrocarbons, solvents, pesticides, wood preservatives, and other organic chemicals. Bench- and pilot-scale studies have demonstrated the effectiveness of anaerobic microbial degradation of nitrotoluenes in soils contaminated with munitions wastes. Bioremediation is especially effective for remediating low level residual contamination in conjunction with source removal.
	Thermal	Vitrification	In-situ vitrification (ISV) is version of a S/S process which uses an electric current to melt soil at extremely high temperatures and thereby immobilize most inorganics and destroy organic pollutants by pyrolysis. Inorganic pollutants are incorporated within the vitrified glass and crystalline mass. The vitrification product is a chemically stable, leach-resistant, glass and crystalline material. Combustion products are captured in a hood which draws the contaminants into an off-gas treatment system that removes particulates and other pollutants from the gas.	The ISV process can destroy or remove organics and immobilize most inorganics in contaminated soils, sludge, or other earthen materials. The process has been tested on a broad range of VOCs and SVOCs, other organics including dioxins and PCBs, and on most priority pollutant metals and radionuclides. This technology is not proven for explosives.
		Enhanced Soil Vapor Extraction	Thermally enhanced SVE is a technology that uses electrical resistance, electromagnetic, fiber optic, radio frequency heating, or hot-air/steam injection to increase the volatilization rate of semi-volatiles and facilitate extraction. The process is otherwise similar to standard SVE, but requires heat resistant extraction wells.	The system is designed to treat SVOCs but will consequently treat VOCs. Thermally enhanced SVE technologies also are effective in treating some pesticides and fuels, depending on the temperatures achieved by the system. This technology is not proven for explosives.

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General Acton	Technology	Process Option	Description	General Screening/Decision	
Ex-situ Treatment	Chemical/ Physical	Chemical Extraction	<p>Chemical extraction is a means of separating hazardous contaminants from soils, thereby reducing the volume of the hazardous waste that must be treated. The technology uses an extracting chemical and differs from soil washing, which generally uses water or water with wash-improving additives.</p> <p>Physical separation steps are often used before chemical extraction to grade the soil into coarse and fine fractions, with the assumption that the fines contain most of the contamination.</p>	<p>Chemical extraction using solvents has been shown to be effective in treating soils containing primarily organic contaminants such as PCBs, VOCs, halogenated solvents, and petroleum wastes. The process has been shown to be applicable for the separation of the organic contaminants in paint wastes, synthetic rubber process wastes, coal tar wastes, drilling muds, wood-treating wastes, separation sludges, pesticide/insecticide wastes, and petroleum refinery oily wastes. Chemical extraction using acids is suitable to treat soils contaminated by heavy metals.</p> <p>This technology has been demonstrated with soil impacted with explosives.</p>	R
		Separation	<p>Separation can be performed by many processes, including gravity, magnetic, and sieving/physical separation. Physical separation often precedes chemical extraction treatment based on the assumption that most of the contamination is tied to the finer soil fraction, which alone may need to be treated. Separation is also useful when heavy metal contaminants occur as particulates.</p>	<p>The target contaminant groups for separation processes are SVOCs, fuels, and inorganics; including radionuclides. The technologies can be used on selected VOCs and pesticides. Magnetic separation, which is a newer technology, is specifically used on heavy metals, radionuclides, and magnetic radioactive particles, such as uranium and plutonium compounds. This technology is not demonstrated for explosives impacted soil.</p>	E

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General Acton	Technology	Process Option	Description	General Screening/Decision
		Solidification/ Stabilization	<p>Similar to in-situ solidification/stabilization, ex situ S/S physically binds or encloses contaminants within a stabilized mass (solidification), or induces chemical reactions between the stabilizing agent and contaminants to reduce their mobility (stabilization). Ex situ S/S, however, typically requires disposal of the resultant materials.</p> <p>There are many innovations in the stabilization and solidification technology. Most of the innovations are modifications of proven processes and are directed to encapsulation or immobilizing the harmful constituents and involve processing of the waste or contaminated soil. Nine distinct innovative processes or groups of processes include: (1) bituminization, (2) emulsified asphalt, (3) modified sulfur cement, (4) polyethylene extrusion, (5) pozzolan/Portland cement, (6) radioactive waste solidification, (7) sludge stabilization, (8) soluble phosphates, and (9) vitrification/molten glass.</p>	<p>The target contaminant group for ex situ S/S is inorganics, including radionuclides. Most S/S technologies have limited effectiveness against organics and pesticides, except vitrification which destroys most organic contaminants.</p> <p>S/S of soils impacted with explosives has been performed with the addition of carbon into the process.</p>
		Chemical Reduction/ Oxidation	<p>Reduction/oxidation (Redox) reactions chemically convert hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert. Redox reactions involve the transfer of electrons from one compound to another. Specifically, one reactant is oxidized (loses electrons) and one is reduced (gains electrons). The oxidizing agents most commonly used for treatment of hazardous contaminants are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide.</p>	<p>Chemical redox is a full-scale, well-established technology used for disinfection of drinking water and wastewater, and it is a common treatment for cyanide wastes. Enhanced systems are now being used more frequently to treat contaminants in soils.</p> <p>The target contaminant group for chemical redox is inorganics. The technology can be used but may be less effective against nonhalogenated VOCs and SVOCs, fuel hydrocarbons, and pesticides.</p> <p>This technology is not applicable to the remediation of explosives-impacted soil and is eliminated from further consideration.</p>

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General Acton	Technology	Process Option	Description	General Screening/Decision	
		Dehalogenation	Contaminated soil is screened, processed with a crusher and pug mill, and mixed with reagents. The mixture is heated in a reactor. The dehalogenation process is achieved by either the replacement of the halogen molecules or the decomposition and partial volatilization of the contaminants.	The target contaminant groups for dehalogenation treatment are halogenated SVOCs and pesticides. APEG dehalogenation is one of the few processes available other than incineration that has been successfully field tested in treating PCBs. The technology can be used but may be less effective against selected halogenated VOCs. The technology is amenable to small-scale applications. The BCD can be also used to treat halogenated VOCs but will generally be more expensive than other alternative technologies.	E
		Soil Washing	Soil washing is a water-based process for scrubbing soils to remove contaminants. The process removes contaminants from soils by either dissolving or suspending them in the wash solution or by concentrating them into a smaller volume of soil through particle size separation, gravity separation, and attrition.	The target contaminant groups for soil washing are SVOCs, fuels, and heavy metals. The technology can be used on selected VOCs and pesticides. The technology offers the ability for recovery of metals and can clean a wide range of organic and inorganic contaminants from coarse-grained soils.	R
		Soil Vapor Extraction	Ex-situ soil vapor extraction (SVE) is a full-scale technology in which soil is excavated and placed over a network of aboveground piping to which a vacuum is applied to encourage volatilization of organics. Soil piles are generally covered to prevent volatile emissions and to prevent the soil from becoming saturated by precipitation. The process includes a system for handling off-gases.	Advantages of ex-situ SVE over its in situ counterpart include that the excavation process forms an increased number of passageways, shallow ground water no longer limits the process, leachate collection is possible, and treatment is more uniform and easily monitored. The major disadvantage over in situ SVE is the increased excavation costs. Although more advantageous than in-site SVE, this technology is not applicable for explosives-impacted soil.	E

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General Acton	Technology	Process Option	Description	General Screening/Decision
		Solar Detoxification	<p>In this process, vacuum extraction is used to remove contaminants from soils. After condensation, contaminants are mixed with a semiconductor catalyst and fed through a reactor which is illuminated by sunlight. Ultraviolet light activates the catalyst, which results in the formation of reactive chemicals known as "radicals". These radicals are powerful oxidizers that break down the contaminants into non-toxic by-products such as carbon dioxide and water.</p> <p>An advantage of solar detoxification over conventional treatment processes such as those using granular activated carbon or air stripping is that it completely destroys the toxic compounds in the water instead of simply removing or displacing them. The solar process also has no atmospheric emissions.</p>	<p>The target contaminant group for solar detoxification is VOCs, SVOCs, solvents, pesticides, and dyes. The process may also remove some heavy metals from water.</p> <p>R</p>
	Biological	Composting	<p>Composting is a controlled biological process by which organic contaminants are converted by microorganisms to innocuous, stabilized byproducts. Typically, thermophilic conditions must be maintained to properly compost soil contaminated with hazardous organic contaminants. The increased temperatures result from heat produced by microorganisms during the degradation of the organic material in the waste. Soils are excavated and mixed with bulking agents and organic amendments, such as wood chips, animal, and vegetative wastes, to enhance the porosity of the mixture to be decomposed. Maximum degradation efficiency is achieved through maintaining oxygenation (e.g., daily windrow turning), irrigation as necessary, and closely monitoring moisture content, and temperature.</p>	<p>The composting process may be applied to soils and lagoon sediments contaminated with biodegradable organic compounds. Pilot and full-scale projects have demonstrated that aerobic, thermophilic composting is able to reduce the concentration of explosives (TNT, RDX, and HMX), ammonium picrate (or yellow-D), and associated toxicity to acceptable levels. Aerobic, thermophilic composting is also applicable to PAH-contaminated soil. All materials and equipment used for composting are commercially available.</p> <p>R</p>

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General Acton	Technology	Process Option	Description	General Screening/Decision	
		Biopiles	<p>Biopile treatment is a full-scale technology in which excavated soils are mixed with soil amendments and placed on a treatment area that includes leachate collection systems and some form of aeration. Soil piles and cells commonly have an air distribution system buried under the soil to pass air through the soil either by vacuum or by positive pressure. The soil piles in this case can be up to 20 feet high. Soil piles may be covered with plastic to control runoff, evaporation, and volatilization and to promote solar heating. Moisture, heat, nutrients, oxygen, and pH can be controlled to enhance biodegradation.</p> <p>The treatment area is generally covered or contained with an impermeable liner to minimize the risk of contaminants leaching into an uncontaminated soil.</p> <p>If there are VOCs in the soil that will volatilize into the air stream, the air leaving the soil may be treated to remove or destroy the VOCs before they are discharged to the atmosphere.</p>	<p>Biopile treatment has been applied to treatment of nonhalogenated VOCs and fuel hydrocarbons. Halogenated VOCs, SVOCs, and pesticides also can be treated, but the process effectiveness will vary and may be applicable only to some compounds within these contaminant groups.</p>	R
		Landfarming	<p>Landfarming is a bioremediation technology which requires excavation and placement of contaminated soils into lined beds or uncontaminated areas and periodically turned over or tilled to aerate the waste. Soil conditions are often controlled to optimize the rate of contaminant degradation.</p> <p>Contaminated media is usually treated in lifts that are up to 18 inches thick. When the desired level of treatment is achieved, the lift is removed and a new lift is constructed.</p>	<p>Landfarming has been proven most successful in treating petroleum hydrocarbons. As a rule of thumb, the higher the molecular weight, the slower the degradation rate. Also, the more chlorinated or nitrated the compound, the more difficult it is to degrade.</p> <p>Contaminants that have been successfully treated using landfarming include diesel fuel, No. 2 and No. 6 fuel oils, JP-5, oily sludge, wood-preserving wastes (PCP and creosote), coke wastes, and certain pesticides.</p>	R

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General Acton	Technology	Process Option	Description	General Screening/Decision	
		Slurry-Phase Biological Treatment	<p>Slurry phase biological treatment involves the controlled treatment of excavated soil in a bioreactor. The excavated soil is first processed to physically separate stones and rubble. The soil is then mixed with water to a predetermined concentration dependent upon the concentration of the contaminants, the rate of biodegradation, and the physical nature of the soils. Some processes pre-wash the soil to concentrate the contaminants. Clean sand may then be discharged, leaving only contaminated fines and washwater to biotreat. Typically, a slurry contains from 10 to 30% solids by weight.</p> <p>The solids are maintained in suspension in a reactor vessel and mixed with nutrients and oxygen. If necessary, an acid or alkali may be added to control pH. Microorganisms also may be added if a suitable population is not present. When biodegradation is complete, the soil slurry is dewatered. Dewatering devices that may be used include clarifiers, pressure filters, vacuum filters, sand drying beds, or centrifuges.</p>	<p>Bioremediation techniques have been successfully used to remediate soils, sludges, and sediments contaminated by explosives, petroleum hydrocarbons, petrochemicals, solvents, pesticides, wood preservatives, and other organic chemicals.</p> <p>Bioreactors are favored over in-situ biological techniques for heterogenous soils, low permeability soils, areas where underlying ground water would be difficult to capture, or when faster treatment times are required.</p> <p>Sequential anaerobic/aerobic slurry-phase bioreactors are used to treat PCBs, halogenated SVOCs, pesticides, and ordnance compounds found in excavated soils or dredged sediments.</p>	R
		Fungal Biodegradation	<p>The utilization of fungal biodegradation involves the controlled usage of these specially cultivated fungi (i.e. White rot fungus) to treat contaminants. White rot fungus has been reported to degrade a wide variety of organopollutants because of its lignin-degrading or wood-rotting enzymes. An aerobic system using moisturized air on wood chips is used in a reactor for biodegradation. The open system is similar to composting, with wood chips on a liner or hard contained surface that is covered. Temperature is not controlled in this type of system. The optimum temperature for biodegradation with lignin-degrading fungus ranges from 86 to 100° F. The heat of the biodegradation reaction will help to maintain the</p>	<p>White rot fungus has the ability to degrade and mineralize a number of organopollutants including the predominant conventional explosives TNT, RDX, and HMX. In addition, white rot fungus has the potential to degrade and mineralize other recalcitrant materials, such as DDT, PAH, PCB, and PCP.</p> <p>Although white rot fungus degradation of TNT has been reported in laboratory-scale settings using pure cultures, several factors increase the difficulty of using this technology for full-scale remediation.</p>	R

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General Acton	Technology	Process Option	Description	General Screening/Decision
			temperature of the process near the optimum.	
	Thermal	Open Burn	<p>Open burn (OB) and open detonation (OD) operations are conducted to destroy excess, obsolete, or unserviceable munitions and energetic materials. In OB operations, energetics or munitions are destroyed by self-sustained combustion, which is ignited by an external source, such as flame, heat, or a detonation wave. In this case, an auxilliary fuel may be added to initiate and sustain the combustion of materials. In OD operations, detonatable explosives and munitions are destroyed by a detonation, which is generally initiated by the detonation of an energetic charge.</p> <p>In the past, OB/OD generally ocured in the surface of the land or in pits. Recently, burn trays and blast boxes are being used in an attempt to control and contain the destruction of energetics and resulting contaminants/emissions. In detonation processes the blast box may be below grade and covered with soil to further minimize the release of emissions.</p> <p>OB and OD can be initiated either by electric, burning, or energetic charge ignition systems. In general, electric systems are preferable because they provide better control over the timing of the initiation. In an electric system, electric current heats a bridge wire, which ignites a primary explosive or pyrotechnic, which, in turn, ignites or detonates the material slated to be burned or detonated. If necessary, safety fuses, which consists of propellants wrapped in plastic weather stripping, are used to initiate the burn or detonation. In some cases, scrap energetics or dried activated carbon from pink/red water treatment may be used as the initiation charge.</p>	<p>OB/OD can be used to destroy excess, obsolete, or unserviceable munitions, components, energetic materials, as well as, media contaminated with energetics.</p>

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General Acton	Technology	Process Option	Description	General Screening/Decision	
		Incineration	<p>High temperatures, 1,400 to 2,200 °F, are used to volatilize and combust (in the presence of oxygen) halogenated and other refractory organics in hazardous wastes. Often auxiliary fuels are employed to initiate and sustain combustion. The destruction and removal efficiency (DRE) for properly operated incinerators exceeds the 99.99% requirement for hazardous waste and can be operated to meet the 99.9999% requirement for PCBs and dioxins. Off gases and combustion residuals generally require treatment.</p>	<p>Incineration is used to remediate soils contaminated with explosives and hazardous wastes, particularly chlorinated hydrocarbons, PCBs, and dioxins.</p>	R
		Thermal Desorption	<p>Thermal desorption is a physical separation process and is not designed to destroy organics. Wastes are heated to volatilize water and organic contaminants. A carrier gas or vacuum system transports volatilized water and organics to the gas treatment system. The bed temperatures and residence times designed into these systems will volatilize selected contaminants but will typically not oxidize them.</p> <p>All thermal desorption systems require treatment of the off-gas to remove particulates and contaminants. Particulates are removed by conventional particulate removal equipment, such as wet scrubbers or fabric filters. Contaminants are removed through condensation followed by carbon adsorption, or they are destroyed in a secondary combustion chamber or a catalytic oxidizer. Most of these units are transportable.</p>	<p>Thermal desorption systems have varying degrees of effectiveness against the full spectrum of organic contaminants.</p> <p>The target contaminant groups for LTTD systems are nonhalogenated VOCs and fuels. The technology can be used to treat SVOCs at reduced effectiveness.</p> <p>The target contaminants for HTTD are SVOCs, PAHs, PCBs, and pesticides; however, VOCs and fuels also may be treated, but treatment may be less cost-effective. Volatile metals may be removed by HTTD systems. The presence of chlorine can affect the volatilization of some metals, such as lead. The process is applicable for the separation of organics from refinery wastes, coal tar wastes, wood-treating wastes, creosote-contaminated soils, hydrocarbon-contaminated soils, mixed (radioactive and hazardous) wastes, synthetic rubber processing waste, pesticides and paint wastes.</p>	R

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TABLE 4-1

**PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL  
SITE 7 CMS  
THE FORMER NSWC-WHITE OAK, SILVER SPRING, MARYLAND  
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General Action	Technology	Process Option	Description	General Screening/Decision	
		Pyrolysis	<p>Pyrolysis is formally defined as chemical decomposition induced in organic materials by heat in the absence of oxygen. Because some oxygen will be present in any pyrolytic system, nominal oxidation will occur. If volatile or semivolatile materials are present in the waste, thermal desorption will also occur.</p> <p>Pyrolysis transforms hazardous organic materials into gaseous components, small quantities of liquid, and a solid residue (coke) containing fixed carbon and ash. Pyrolysis of organic materials produces combustible gases, including carbon monoxide, hydrogen and methane, and other hydrocarbons. If the off-gases are cooled, liquids condense producing an oil/tar residue and contaminated water. Pyrolysis typically occurs under pressure and at operating temperatures above 800 °F. The pyrolysis off-gases may be treated in a secondary combustion chamber, flared, and partially condensed. Particulate removal equipment such as fabric filters or wet scrubbers are also required.</p>	<p>The target contaminant groups for pyrolysis are SVOCs and pesticides. The process is applicable for the separation of organics from refinery wastes, coal tar wastes, wood-treating wastes, creosote-contaminated soils, hydrocarbon-contaminated soils, mixed (radioactive and hazardous) wastes, synthetic rubber processing wastes, and paint waste.</p> <p>Pyrolysis systems may be applicable to a number of organic materials that "crack" or undergo a chemical decomposition in the presence of heat. Pyrolysis has shown promise in treating organic contaminants in soils and oily sludges. Chemical contaminants for which treatment data exist include PCBs, dioxins, PAHs, and many other organics. Pyrolysis is not effective in either destroying or physically separating inorganics from the contaminated medium. Volatile metals may be removed as a result of the higher temperatures associated with the process but are similarly not destroyed.</p>	E
		Hot Gas Decontamination	<p>The process involves raising the temperature of the contaminated equipment or material to 500 °F for a specified period of time. The gas effluent from the material is treated in an afterburner system to destroy all volatilized contaminants.</p> <p>Hot gas decontamination can also be used for decontamination of explosives-contaminated masonry or metallic structures. The method involves sealing and insulating the structures, heating with hot gas stream to 500 °F for a prescribed period of time, volatilizing the explosive contaminants, and destroying them in an afterburner. Operating conditions are site-specific. Contaminants are completely destroyed.</p>	<p>The method is applicable for process equipment requiring decontamination for reuse. It is also applicable for explosive items, such as mines and shells, being demilitarized (after removal of explosives) or scrap material contaminated with explosives. The method can also be used for buildings or structures associated with ammunition plants, arsenals, and depots involved in the manufacture, processing, loading, and storage of pyrotechnics, explosives, and propellants.</p>	R

TABLE 4-1

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL  
 SITE 7 CMS  
 THE FORMER NSWC-WHITE OAK, SILVER SPRING, MARYLAND  
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General Acton	Technology	Process Option	Description	General Screening/Decision	
Disposal	Disposal	Off-site Disposal Facility	Disposal of hazardous or nonhazardous materials at permitted off-site facilities.	Off-site disposal is feasible considering the relatively small volume of contaminated soil. Contaminant concentrations would not prohibit the transportation or proper disposal of the impacted soil.	R
		Off-site Treatment Facility	Treatment and subsequent disposal of hazardous or nonhazardous materials at permitted off-site facilities.	Off-site treatment is not cost effective considering the relatively small volume of contaminated soil. Contaminant concentrations would not prohibit the transportation or proper disposal of the impacted soil.	E

- R Potentially applicable as a primary or secondary technology. An example of a secondary technology would be the handling of treatment residuals resulting from a primary technology technology.
- E Eliminated as a primary or secondary technology. Technology will not be retained for further screening.

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Figure 4-1 (11 x 17)  
4-1 Alternative 2 - Containment

Figure 4-1 (Backside)  
4-1 Alternative 2 - Containment

Figure 4-2 (11 x 17)  
4-2 Alternative 3 - Compositing

Figure 4-2 (Backside)  
4-2 Alternative 3 - Compositing

Figure 4-3 (11 x 17)  
4-3 Alternative 2 - Off Site Disposal

Figure 4-3 (Backside)  
4-3 Alternative 2 - Off Site Disposal

## 5.0 EVALUATION OF THE CORRECTIVE MEASURES ALTERNATIVES

This section evaluates the corrective measure alternatives that were developed in Section 4. The alternatives are evaluated using criteria set forth in Office of Solid Waste and Emergency Response (OSWER) Guidance Document 9902.3-2A, RCRA Corrective Action Plan (EPA, 1994).

### 5.1 EVALUATION CRITERIA

The following criteria outline the major technical components of remedies including cleanup of releases, source control and management of wastes that are generated by remedial activities. The evaluation criteria, outlined in the OSWER guidance are as follows:

- Protect human health and the environment
- Attain media cleanup standards set by the implementing agency
- Control release sources so as to reduce or eliminate, to the extent practical, further releases that may pose a threat to human health and the environment
- Comply with any applicable standards for management of wastes
- Other factors
  - Long-term reliability and effectiveness
  - Reduction in toxicity, mobility, or volume of wastes
  - Short-term effectiveness
  - Implementability
  - Cost

Decision information pertaining to the above criteria are summarized in the following sections.

#### 5.1.1 Protect Human Health and the Environment

Corrective action remedies must be protective of human health and the environment. Remedies may include options and measures that are needed to be protective, but are not directly related to media cleanup, source control, or management of wastes. The discussion of any short-term remedies that may be appropriate should be included in this criterion.

#### 5.1.2 Media Cleanup Standards

Remedies will be required to attain media cleanup standards set by the implementing agency which may be derived from existing state or federal regulations, or from other standards as determined appropriate. The media cleanup standards for a remedy will often play a large role in determining the extent of and

technical approaches to the remedy. In some cases, certain technical aspects of the remedy, such as the practical capabilities of remedial technologies, may influence to some degree the media cleanup standards that are established. The evaluation should address whether the potential remedy will achieve the CAO and meet the ARARs outlined for the site. An approximate estimate of the time frame necessary for each alternative to meet these standards should be included with this evaluation.

For this CMS, the media cleanup standards are the PRGs for soil presented on Table 3-4.

### **5.1.3 Source Control**

A critical objective of any remedy must be to stop further environmental degradation by controlling or eliminating further releases that may pose a threat to human health and the environment. Unless source control measures are taken, efforts to clean up releases may be ineffective or, at best, will essentially involve a perpetual cleanup. Therefore, an effective source control program is essential to ensure the long-term effectiveness and protectiveness of the corrective action program. The source control standard is not intended to mandate a specific remedy or class of remedies. Instead, this criteria encourages the development and evaluation of a wide range of options. Other protective remedies that may be developed to control the source, such as capping and in-situ treatment should be equally considered with total excavation or treatment. The guidance notes that when evaluating potential alternatives, further releases from sources of contamination are to be controlled to the extent practicable. This qualifier is intended to account for the technical limitations that may in some cases be encountered in achieving effective source control. The evaluation should address the issue of whether source control measures are necessary, and if so, the type of actions that would be appropriate.

### **5.1.4 Waste Management Standards**

This criteria includes a discussion of how the specific waste management activities will be conducted in compliance with all ARARs. This would pertain to options that have components such as closure requirements and LDRs.

### **5.1.5 Other Factors**

There are five general factors that are considered as appropriate in selecting and approving a remedy that meets the first four standards listed above. These factors represent a combination of technical measures and management controls for addressing the environmental problems at the facility. The five general decision factors include:

- Long-term reliability and effectiveness;
- Reduction in the toxicity, mobility or volume of wastes;
- Short-term effectiveness;
- Implementability; and
- Cost.

### **Long-Term Reliability and Effectiveness**

Demonstrated and expected reliability of an option or technology is a way of assessing the risk and effect of failure. Consideration as to whether the technology or a combination of technologies have been used effectively under analogous site conditions, whether failure of any one technology in the alternative would have an immediate impact on receptors, and whether the alternative would have the flexibility to deal with uncontrollable changes at the site (e.g., heavy rain storms, earthquakes, etc.) must be given to each alternative. Most corrective measure technologies, with the exception of destruction, deteriorate and may become less effective with time. Often, deterioration can be slowed through proper system operation and maintenance, but the technology eventually may require replacement. Each corrective measure alternative should be evaluated in terms of the projected useful life of the overall alternative and of its component technologies. Useful life is defined as the length of time the level of effectiveness can be maintained.

### **Reduction in Toxicity, Mobility, and Volume**

Remedies that employ techniques that are capable of eliminating or substantially reducing the inherent potential of the impacted material to cause future environmental releases or other risks to human health and the environment are preferred. There may be some situations where achieving substantial reductions in toxicity, mobility or volume may not be practical or even desirable. Estimates of how much the corrective measure alternatives will reduce the toxicity, volume, and/or mobility of a contaminant should be one criterion considered.

### **Short-Term Effectiveness**

Short-term effectiveness may be particularly relevant when remedial activities will be conducted in densely populated areas, or where contaminant or site characteristics are such that risks to workers or to the environment are high and special protective measures are needed. Possible factors to consider include fire, explosion, exposure to hazardous substances and potential threats associated with treatment, excavation, transportation, and redisposal or containment of impacted material.

## **Implementability**

Implementability will often be a determining variable in shaping and selecting remedies. Some technologies will require state or local approvals prior to construction, which may increase the time necessary to implement the remedy. In some cases, state or local restrictions or concerns may necessitate eliminating or deferring certain technologies or remedial approaches from consideration in remedy selection. The evaluation of the implementability of an alternative includes the administrative activities needed to implement the corrective measure alternative (e.g., permits, rights of way, off-site approvals, etc.); the duration of the planning and remedial phases of the alternative; the constructibility, time for implementation, and time for complete and/or beneficial results of the alternative; the availability of adequate off-site treatment, storage capacity, disposal services, needed technical services and materials; and the availability of prospective technologies for each corrective measure alternative.

## **Cost**

The estimated cost of a alternative is an appropriate and important consideration, especially in those situations where several different technical alternatives to remediation will offer equivalent protection of human health and the environment, but may vary widely in cost. However, in those situations where only one remedy is being proposed, the issue of cost would not need to be considered. Cost estimates should consider all direct and indirect capital costs, including costs for engineering, site preparation, construction, materials, labor, sampling/analysis, waste management/disposal, permitting, health and safety measures, training, operation and maintenance, etc. Costs for long-term monitoring and maintenance should be included in any cost estimates and evaluations.

## **5.2 ALTERNATIVE 1: NO ACTION**

### **5.2.1 Protect Human Health and the Environment**

Alternative 1 is considered primarily for comparison to the other corrective measure alternatives. This alternative is not protective of human health. Contaminants would remain in the surface and subsurface soil, which would continue to present a risk to exposure and for potential migration to the groundwater. Concentrations of explosives may slowly biodegrade and attenuate, although these effects are not monitored or analyzed in this alternative. Groundwater within the Site 7 area is not currently being used, therefore no current environmental risks to human health are present from this pathway. Furthermore, exposure to contaminated groundwater is also unlikely in the future. However, if the site were ever developed for residential use or the aquifer were used as a drinking water source, Alternative 1 would not be protective of human health. The report for OU1 will address the remedial actions for the groundwater associated with Site 7.

Existing concentrations and exposure pathways are not expected to pose a significant potential risk to ecological receptors. Although the current risk appears to be low for ecological receptors, site conditions would not change appreciably under this alternative.

#### **5.2.2 Media Cleanup Standards**

Alternative 1 would not comply with soil PRGs developed for Site 7.

#### **5.2.3 Source Control**

Alternative 1 involves no additional source control because no action would be performed at Site 7.

#### **5.2.4 Waste Management Standards**

There are no actions to be implemented for Alternative 1 and, therefore, no waste would be generated.

#### **5.2.5 Other Factors**

##### **Long-Term Reliability and Effectiveness**

The future potential threat to human health would remain since there would be no access controls, removal of impacted soil, or removal of the potential source for continued direct contact or impact to groundwater. Except for any decrease through natural attenuation, explosive related soil contamination would remain at Site 7 at levels greater than the PRGs and may migrate off site. Since monitoring is not a component of this alternative, the reliability and effectiveness of this alternative over the long run would not be known.

This alternative would not achieve CAOs because exposure would not be restricted or prevented, the potential impact to groundwater quality would remain, and the alternative does not comply with ARARs.

##### **Reduction in Toxicity, Mobility, and Volume**

Alternative 1 involves no reduction in toxicity, mobility, or volume of the contaminants at Site 7 other than that which would result from natural degradation or other attenuating factors. There are no treatment processes employed, and therefore no materials are treated or destroyed.

##### **Short-Term Effectiveness**

Alternative 1 involves no action and would not pose any risks to workers, the public, or to the environment.

### **Implementability**

Since no actions would occur, this alternative is readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable.

### **Cost**

There are no costs associated with the No Action alternative.

## **5.3 ALTERNATIVE 2 - CONTAINMENT**

### **5.3.1 Protect Human Health and the Environment**

Containment of impacted soil under a cap system would be protective to human health and the environment. It would prevent direct exposure to the contaminated soil. Furthermore, the cap would minimize the amount of potential contaminant migration from the impacted soil to surface water and/or sediment. Further impacts to groundwater be reduced because the cap would minimize further contaminant migration via infiltration. In addition, the current concentrations of contaminants in groundwater may decrease due to natural attenuation processes.

Implementation of institutional controls including access controls along with the cap would provide added assurance of protection of human health and the environment. Land use restrictions would prohibit the use and disturbance of the cap system and underlying soil. Groundwater, surface water, and sediment monitoring would verify that unacceptable levels of contaminants are not migrating downgradient and impacting downgradient receptors.

### **5.3.2 Media Cleanup Standards**

Although this alternative would minimize direct exposure to the impacted soil and would reduce infiltration and potential leaching of contaminants to the groundwater, the concentration of contaminants would not be reduced to the PRGs. However, the risk to exposure or contact to impacted soil will be minimized to acceptable levels with the cap system. After the design is completed, it is anticipated that the cap system and related construction activities could be completed within 4 to 6 months.

### **5.3.3 Source Control**

Alternative 2 would control and minimize surface water that can infiltrate into the impacted soil. This reduction of infiltrated water would prevent the leaching of contaminants from the soil and transport to the

groundwater. This option would provide adequate source control over the long term with proper site inspections and maintenance of the cap system.

#### **5.3.4 Waste Management Standards**

Alternative 2 does not treat or remove contaminated soil, and therefore no waste is generated. Long-term monitoring of groundwater, surface water, and sediment may generate a small amount of water or solid material. These materials may require sampling, analysis, appropriate handling, and final disposal at a proper facility. The volume of material that would be generated is small and waste management regulations would be easily met.

#### **5.3.5 Other Factors**

##### **Long-Term Reliability and Effectiveness**

Installation and maintenance of a cap system over the consolidated waste material along with monitoring and institutional controls will be an effective long-term corrective action. Caps are designed with life spans of 30 years, but are expected to be effective much longer. The cap will provide an effective barrier to the impacted soil, eliminating any direct exposure or contaminant migration pathways due to erosion to surface water or sediment. The cap will also minimize the amount of infiltration that passes through the impacted soil and may leach contaminants to the groundwater. Site inspections, cap maintenance, and long-term groundwater, surface water, and sediment monitoring will verify the effectiveness of the corrective action. Implementation of land use restrictions would enhance the long-term reliability of the corrective action.

##### **Reduction in Toxicity, Mobility, and Volume**

The toxicity and volume of impacted soil will not be reduced with this alternative. The mobility of the contaminants will be reduced with the construction and long-term maintenance of the cap system.

##### **Short-Term Effectiveness**

The containment alternative may pose short-term exposure to impacted soil during minor regrading and initial cap soil layer placement. Upper layers of the cap system would not expose workers to impacted materials. The proper use of PPE, monitoring equipment, and observance of OSHA guidelines will reduce, if not eliminate these short-term risks. Public and off site short-term risks include items such as an increase in dust, erosion, noise, and construction vehicles during the implementation of this alternative. Dust control measures would have to be employed during construction activities to minimize the emission of particulate contaminants. Erosion and sediment control measures would be placed prior

to construction activities to minimize the impact to the swale. Noise would be monitored and the site activities planned and controlled as appropriate. Truck deliveries of soil and other cap components would be scheduled at times to reduce risk to the public.

### **Implementability**

Alternative 2 is expected to be readily implementable since Site 7 is located within a government-operated facility. Capping components as well as qualified contractors are typically available. Restrictions for future property use would involve legal assistance and regulatory approval. Site inspections, maintenance, and sampling and analysis activities can also be readily implemented.

### **Cost**

Alternative 2 is estimated to have capital costs totaling \$682,000 and 30-year operation and maintenance costs of \$180,000. The total cost for Alternative 2 is \$862,000. Detailed cost estimates are included in Appendix B.

## **5.3 ALTERNATIVE 3: COMPOSTING**

### **5.3.1 Protect Human Health and the Environment**

Alternative 3 would provide the only treatment option for impacted soil at Site 7. The biological treatment option of composting would provide a method that can achieve the PRGs for the explosives impacted soil. The on-site treatment of the soil and backfilling of the swale with the treated soil would be protective of human health and the environment. Further impacts to groundwater would be reduced due to the remediation of the source of explosives contaminated groundwater. In addition, the current concentrations of contaminants in groundwater may decrease due to natural attenuation processes.

### **5.3.2 Media Cleanup Standards**

The process option of composting has been demonstrated at other facilities for the effective remediation of the COCs identified at Site 7. Based on case study performance, this alternative should be able to achieve the PRGs for impacted soil. It is estimated that this option could be performed within one construction season. However, this option is dependent on the optimization of the excavation, treatment cycles, confirmation and approval sampling and analysis, and site restoration activities. The actual treatment duration for each batch of impacted soil may be approximately 15 to 21 days.

### 5.3.3 Source Control

This option would provide source control for future impacts to groundwater at the site. Impacted soil at levels below the PRGs would remain under the treated soil, but would have a significantly reduced future impact to groundwater than the current conditions at Site 7.

### 5.3.4 Waste Management Standards

This option would treat all soil at a composting facility constructed adjacent to Site 7. All treated soil, including the increased volume due to the addition and blending with amendments, would be returned to the excavation and the site restored. No waste should be generated from the treatment system. The covered treatment piles will be protected from erosion of the impacted soil and from stormwater, which would require collection and management. The treatment would require process water, but due to the characteristics of the composting process will not generate leachate.

### 5.3.5 Other Factors

#### **Long-Term Reliability and Effectiveness**

The destruction of the contaminants in the soil during composting provides for effective long-term reliability of the alternative. Unlike many treatment options that may bind the contaminants in the soil or may extract the contaminants and generate a concentrated waste, composting breaks the contaminants into less toxic and eventually non-toxic byproducts. The analytical program that will guide the acceptance of the treated soil is crucial for the alternative. The COCs and related byproducts must be thoroughly studied and understood prior to implementation and during the treatment of the soil.

#### **Reduction in Toxicity, Mobility, and Volume**

The composting option provides for reduction in toxicity, mobility, and volume. The treatment option has been demonstrated at other facilities to reduce the concentration of RDX and HMX by 99.8% and 96.8%, respectively (Roy F. Weston, 1993). These reductions were based on initial maximum concentrations of RDX and HMX in soil of 731 mg/kg and 485 mg/kg, respectively. The analyses for key intermediate products (primarily from the degradation of 2,4,6-TNT) were also effectively reduced to below 5 mg/kg.

The volume of impacted soil will decrease with treatment although the total volume of soil after treatment will increase significantly due to the composting treatment technology. The treated soil volume may be in the range of 200% to 250% greater than the impacted soil prior to treatment, depending on the blend and ratio of amendments used for project. Typical composting projects have used a ratio of approximately 30% impacted soil to 70% amendments.

### **Short-Term Effectiveness**

The short-term risks include the handling of impacted soil during excavation, transportation, and on-site treatment of the soil. The typical excavation equipment and methods present risks that can be managed in the contractor plans. The operation of the treatment system will present short-term risks to workers, both from the impacted soil and from the equipment required to treat the soil. In addition the construction vehicles, the windrow turner and other composting equipment have safety precautions that must be observed. The treatment does not pose an increased risk to the community because there are not emissions or toxic materials being generated. The process would be performed under a temporary structure, which will minimize dust, noise, odor, and other objectionable components of a composting operation.

### **Implementability**

This alternative would require a site-specific treatability study during the design phase. This study would determine the optimum blend of amendments as well as the treatment time required for each batch of composted soil. The materials and equipment needed for this alternative and can be procured with adequate lead time. The treatment area would require preparation with typical construction methods and materials. The consistent availability of amendments would need to be secured in order to maintain an aggressive schedule.

### **Cost**

Alternative 3 is estimated to have capital costs totaling \$1,677,000. There is no long-term maintenance or monitoring required for this alternative, therefore there are no operation and maintenance costs. Detailed cost estimates are included in Appendix B.

## **5.3 ALTERNATIVE 4: OFF SITE DISPOSAL**

### **5.3.1 Protect Human Health and the Environment**

All soil impacted above the PRG is removed and disposed of at an appropriate off-site facility. This would provide for an alternative that is protective of human health and the environment as well as meet the ARARs. This option would also provide for source removal for future impacts to groundwater. The remedy for OU1 would address the monitoring of the groundwater to assess the effect of the Site 7 soil removal. Impacted soil at levels below the PRGs would remain, but would have a significantly reduced future impact to groundwater than the current soils at Site 7.

### 5.3.2 Media Cleanup Standards

This alternative would meet all PRGs and ARARs.

### 5.3.3 Source Control

The complete removal and disposal of impacted material at an off site facility would reduce the future impact of Site 7 to the underlying groundwater. This option would not remove soil that is impacted with explosives less than the PRG. However, the low residual concentrations of explosives in deeper subsurface soil left after restoration would be significantly less than the current concentrations, which in turn should significantly reduce further impact to groundwater. The groundwater under and surrounding Site 7 will be addressed in the measures prescribed in the future OU1 report.

### 5.3.4 Waste Management Standards

This alternative includes the direct excavation, transportation, and disposal of all impacted soil. The impacted soil is characterized as non-hazardous waste and can be managed as such. All ARARs related to the handling, transportation, and disposal of the material will be followed.

### 5.3.5 Other Factors

#### **Long-Term Reliability and Effectiveness**

This alternative would provide for a reliable long-term action at Site 7. Excavation and off site disposal has been implemented as an effective solution for many projects.

#### **Reduction in Toxicity, Mobility, and Volume**

The toxicity, mobility, and volume will be reduced at Site 7. The reduction of these three items at Site 7 is partially offset by the transfer of risk to a facility that is designed to contain the impacted material. The containment controls at the off site facility will reduce the migration potential of the contaminants as well as direct exposure to the impacted soil.

#### **Short-Term Effectiveness**

The existing data indicates that the concentration of explosives in the excavated soil is relatively low. This would render the excavated soil in vehicles leaving the site as relatively low risk to the public during the implementation of the corrective action. Workers would be exposed to risks during excavation and loading of trucks for off site disposal. The risks to workers can be adequately addressed by adhering to the contractors health and safety plan for the site which would include proper levels of PPE.

### **Implementability**

The excavation and disposal alternative is implementable and would present few technical challenges. A proper disposal facility would need to be procured and additional characterization sampling and analysis may be required.

### **Cost**

Alternative 4 is estimated to have capital costs totaling \$435,000. There is no long-term maintenance or monitoring required for this alternative, therefore there are no operation and maintenance costs. Detailed cost estimates are included in Appendix B.

## 6.0 RECOMMENDATION OF THE FINAL CORRECTIVE MEASURE

### 6.1 INTRODUCTION

This section presents a comparative analysis of the corrective measure alternatives in Section 5 for each of the evaluation standards. The standards for comparison are identical to those presented and described for the detailed analysis of the individual alternatives.

The following corrective measure alternatives are being compared in this section.

- Alternative 1 – No Action
- Alternative 2 – Containment
- Alternative 3 – Composting
- Alternative 4 – Off Site Disposal

### 6.2 COMPARATIVE ANALYSIS OF ALTERNATIVES

#### 6.2.1 Protection of Human Health and the Environment

Alternative 1 would not be protective of human health or the environment. The contaminants remaining in the soil would pose risks to human receptors. The contaminants would also be a continuing source of contamination to the groundwater underlying Site 7. Under Alternative 2, a cap will be constructed over impacted soil that will be protective of human health and the environment. It will prevent direct exposure to the contaminated soil, sediment, and waste and it will minimize the amount of contaminant migration to the groundwater and surface water from the material. Implementation of institutional controls under Alternative 2 along with the cap will provide added assurance of protection of human health and the environment. Land use restrictions limit future access to the site and prevent disturbance of the cap system. Groundwater, surface water, and sediment monitoring will be used to verify that the corrective action is effective. Alternatives 3 and 4 provide options that would permanently remove the risk to contaminants, and are the most protective of human health and the environment.

#### 6.2.2 Media Cleanup Standards

The PRGs would not be met with the implementation of Alternative 1. Alternative 2 would prevent exposure to impacted material. The limitation to exposure pathways will reduce the risk to human receptors and therefore would meet the PRGs for direct contact. Alternatives 3 and 4 would either treat or remove material above the PRGs. These options would permanently meet the media cleanup

standards at Site 7. Excavation under Alternatives 3 and 4 would continue until confirmatory sampling indicates that the remaining soil has concentrations of COCs below the selected soil PRGs.

### **6.2.3 Source Control**

Alternative 1 involves no action and would result in no source control. The capping of the swale in Alternative 2 would constitute a significant degree of source control for both surface erosion and migration as well as future impact to groundwater. This alternative will also prevent direct exposure pathways. Alternative 3 would provide the complete excavation and on-site treatment of impacted soil. The backfilling with treated soil and site restoration would provide for the elimination of potential surface migration and will remove the major source of future impact to groundwater. Alternative 4 would have the same level of source control as Alternative 3. Under Alternatives 3 and 4, subsurface soil impacted with concentrations of explosives below the PRGs would remain. These concentrations would be significantly less than the current surface and subsurface soil concentrations and are expected to have a limited future impact on groundwater. Although the groundwater at Site 7 will be addressed in the OU1 report, Alternative 2 would require long-term monitoring to gauge the effectiveness of the cap system. Alternatives 3 and 4 would not include any long-term monitoring. The future impact to groundwater from the subsurface soil remaining at concentrations below the PRGs would be monitored under the alternative for OU1, though it is expected to be minimal.

### **6.2.4 Waste Management Standards**

There are no actions to be implemented for Alternative 1 and, therefore, no waste would be generated. Site 7 does not contain any known hazardous wastes and does not have any UXO reported within the surface or subsurface soil. The cap system in Alternative 2 would meet and exceed the ARARs for soil covers due to the installation of geosynthetic liner and drainage zone materials. Alternative 3 would treat impacted soil on site and would not generate any waste products. The treated soil, combined with the amendments used in the treatment of the soil, would be placed within the excavation areas. Because excavation and off-site disposal would not treat any material on site, this option would involve the handling of the greatest volume of impacted soil. Alternative 4 would meet the appropriate federal and state waste regulations during the handling, transportation, and disposal of the impacted soil.

### **6.2.5 Long-Term Reliability and Effectiveness**

Under Alternative 1 the current threat to human health and the environment would remain since there would be no removal or treatment of the contaminants. There are no long-term management controls for Site 7 under this alternative. Alternative 1 would not implement any long-term monitoring programs to assess the migration of contaminants from the site. Alternative 2 provides an effective long-term corrective

action for Site 7. Cap systems are designed with life spans of 30 years and are generally expected to perform beyond this time frame. However, this alternative may require significant repairs, total replacement, or the implementation of another corrective measure after the life span of the cap is expired. Alternatives 3 and 4 both provide for permanent removal of impacted material from the site and are more effective in the long term than the capping option.

#### **6.2.6 Reduction in Toxicity, Mobility, or Volume**

Alternative 1 involves no reduction in toxicity, mobility, or volume of the contaminants at Site 7 other than that which would result from natural dispersion, dilution, or other attenuating factors. Alternative 3 and 4 would both reduce the toxicity, mobility, and volume of impacted material. The actual volume of treated soil would increase with Alternative 3 due to the addition of composting amendments. Alternative 4 would remove the toxicity, mobility, and volume from the site, although the impacted soil is being moved and disposed of in an appropriate facility and not destroyed as in Alternative 3. Alternative 2 would reduce the toxicity at the site through the elimination of the direct exposure and contact pathways. Alternative 2 would also reduce the mobility of the contaminants at the site by limiting infiltrated water from leaching contaminants from impacted soil to the groundwater.

#### **6.2.7 Short-Term Effectiveness**

Alternative 1 involves no action and therefore, would not pose any risks to on-site workers during implementation. Furthermore, no environmental impacts, noise, dust, increased vehicle traffic, or other construction related disturbances would be generated. Exposure to impacted soil at Site 7 during capping activities would be a short-term risk under Alternative 2. The complete excavation and handling of impacted soil under Alternatives 3 and 4 would pose more short-term risk than Alternative 2. The use of the proper PPE, monitoring equipment, and observance of OSHA guidelines will address these concerns in Alternatives 2, 3, and 4. Dust, stormwater and erosion, noise abatement, and other construction related issues would be addressed and control measures implemented during construction activities. Alternative 3, which is the only on-site treatment option, may create significant odor during the composting operation and placement of the treated material back in the excavations.

#### **6.2.8 Implementability**

No actions will occur under Alternative 1 therefore it is the most implementable. Alternative 2 is readily implementable. Resources, equipment, and materials for the cap construction are readily available. Services for construction and maintenance of the cap are also readily available. Groundwater, surface water, and sediment monitoring would be easily implemented at the site after construction of the cap. Site grading and cap design would be needed prior to implementation. Alternative 3 would be the most

difficult to implement. This option would require a treatability study during the design to optimize the treatment system. Alternative 3 would also require the most site preparation activities. The treatment option would require a large treatment area as well as temporary structures. The specialized equipment for the treatment is available and could be obtained within the time frame of the planning phase. Alternative 4 would be expected to be easier to implement than Alternatives 2 and 3. Except for procurement of the appropriate disposal facility and arrangement for transportation, this option would not require an extended planning phase or design. Limits of excavation and site restoration would need to be designed.

The administrative implementability of the long term monitoring of Alternative 2 would be relatively easy as long as GSA retains ownership of the site. In the event that the federal government would sell the property, continued site security and maintenance and monitoring of the cap would be required. In addition, any transfer of property must be accompanied by land use restrictions, which would involve legal procedures. Alternatives 3 and 4 would not require any long term maintenance or monitoring.

#### **6.2.9 Cost**

The costs associated with the alternatives are summarized below. The cost estimates are summarized on Table 6-1 and the details for each alternative provided in Appendix B.

### **6.3 RECOMMENDED CORRECTIVE MEASURE ALTERNATIVE**

The recommended alternative for Site 7 is Alternative 4 because it meets the CAOs, can be implemented at the lowest cost, and the site will be remediated to a level that would not require long-term commitments such as maintenance or monitoring. Under Alternative 4, Site 7 soil will be excavated, loaded and transported to an appropriate off-site facility for disposal.

TABLE 6-1

SUMMARY OF CAPITAL, O&M, AND MONITORING COSTS  
SITE 7 CMS  
THE FORMER NSWC-WHITE OAK, SILVER SPRING, MARYLAND

Alternative	Capital Cost	Total 30-Year O & M Cost	Total Present Worth Cost for Alternative
1 – No Action	\$0	\$0	\$0
2 – Containment with soil and geosynthetic cap system	\$681,916	\$179,656	\$861,572
3 – Excavation and on-site treatment using the biological process of windrow composting	\$1,676,619	\$0	\$1,676,619
4 – Excavation and off-site disposal of all impacted soil	\$434,853	\$0	\$434,853

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**APPENDIX A**

**SUMMARY OF HISTORICAL DATA**

**APPENDIX B**

**SOIL TO GROUNDWATER MODELING**

**MODELING CONTAMINANT MIGRATION FROM SOIL TO GROUNDWATER  
SITE 7, ORDNANCE BURN AREA  
NSWC WHITE OAK  
SILVER SPRING, MARYLAND**

**Introduction**

This appendix documents groundwater modeling that was performed in support of the Corrective Measures Study (CMS) developed for the Ordnance Burn Area (Site 7), NSWC White Oak. Energetic compounds have been detected at relatively elevated concentrations in surface and subsurface soil samples collected from soil boring 07SB101 and in groundwater samples collected from four monitoring wells during the RCRA Facility Investigation (RFI) that was performed by Tetra Tech NUS, Inc. (TtNUS, 2000). Four of these compounds were detected in soils and groundwater at concentrations that caused them to be listed as potential contaminants of concern (PCOCs) in both media (i.e., soils and groundwater). These four PCOCs include:

- RDX
- 2,4,6-trinitrotoluene (TNT)
- 2-amino-4,6-dinitrotoluene (2ADNT)
- 4-amino-2,6-dinitrotoluene (4ADNT)

Soil-to-groundwater modeling was performed to determine at what cleanup concentration in the soil would be sufficiently protective, such that the risk-based concentrations of these four compounds will not be exceeded in the groundwater beneath or downgradient of Site 7. These groundwater-protective soil concentrations were then compared against soil concentrations detected at Site 7 to ensure that adequate volumes of soil are removed or treated as a part of the corrective measures that are evaluated in the CMS.

**Potential Contaminants of Concern**

Table 7-7 of the RFI (TtNUS, 2000) lists 15 different organic and inorganic compounds that were detected in groundwater samples from Site 7 at concentrations above risk-based screening levels. These PCOCs include eight chlorinated volatile organic compounds (VOCs), one pesticide (gamma-BHC), one metal (thallium), ammonium perchlorate, and four energetic compounds. None of the VOCs, gamma-BHC, thallium, or ammonium perchlorate were detected in the surface or subsurface soil samples collected at Site 7 in 1998 (RFI Tables 7-1 and 7-2). Therefore, these compounds have not been included in this soil-to-groundwater pathway analysis, nor have any soil concentrations protective of groundwater been developed for these compounds because they were not detected in any soil sample. The absence of these compounds in Site 7 soils means that the contaminants migrated laterally into groundwater beneath Site 7 from a different upgradient source. As an example, the trichloroethene detected in Site 7 groundwater may have originated from Site 4 (upgradient of Site 7).

The four energetic compounds detected in Site 7 groundwater that are PCOCs are RDX, TNT, 2ADNT, and 4ADNT. The RDX and TNT are primary explosives; whereas, the 2ADNT and 4ADNT are considered to be biodegradation products of TNT (discussed below). The levels of these four compounds detected at Site 7 (based on 1998 and

1999 samples) are listed in Table B-1. The risk-based screening levels for groundwater are also listed in Table B-1.

### **Modeling Software**

A one-dimensional, unsaturated flow, leaching and contaminant transport spreadsheet-type model (ECTran) developed by TtNUS was used to perform this analysis. The ECTran model is capable of simulating vertical contaminant transport in variably-saturated vadose zone soils and lateral transport in a water-table aquifer, with advection, dispersion, dilution, adsorption/desorption, and degradation as factors that cause the contaminant to attenuate as it migrates. The model code is based in part on the vadose zone transport model SESOIL, the analytical groundwater transport equation developed by Domenico (1987), and the analytical groundwater transport model AT123D. The overall structure of the model, the mathematical equations used in the model, the modeling assumptions and simplifications, and the input data requirements are presented by Halliburton NUS (now TtNUS, 1993), Chiou et al. (1993), and Brown and Root Environmental (now TtNUS, 1996). This model has been used for evaluating hazardous waste sites in U.S. EPA Regions III, V, VI, and X to determine soil cleanup goals, cleanup time estimates, and to support baseline risk assessments. It has been verified against other analytical and numerical models (ODAST, SWIFT) during model validation for the U.S. Department of Energy (Halliburton NUS, 1993).

### **Site Geology and Hydrogeology**

Data collected during the RFI (TtNUS, 2000) were used to develop the following generalizations about soil in the vadose zone and groundwater beneath Site 7:

- The average depth to the water table is 45 below ground surface (ft bgs).
- Total porosity in the vadose zone and saturated aquifer is 0.43.
- The water-filled porosity in the vadose zone is 0.30.
- The percent saturation in the vadose zone is 0.70 (i.e., 0.30/0.43).
- The rate of surface water infiltration (and groundwater recharge) is 12 inches per year (1.0 foot/year).
- The vertical rate of water movement in the vadose zone is 3.33 ft/year (1.0/0.30).
- The dry bulk density of the vadose zone and aquifer material is 1.7 g/cm<sup>3</sup>.
- The saturated thickness of the water table aquifer is 20 feet.
- The horizontal conductivity of the aquifer material is 6.55 ft/day, based on the average value of slug tests for Site 7.
- Groundwater is flowing to the southeast and south near soil boring 7SB101 (where the most contaminated soil was located) and well 07GW08 (the most contaminated groundwater); the local horizontal hydraulic gradient is about 0.025 ft/ft.
- The approximate linear velocity of groundwater is 0.38 ft/day (6.55\*0.025/0.43) or 139 ft/year.

These values for site characteristics were used as input for model calculations.

### **Spatial Extent of Contamination**

Almost all of the positive detections in soil for the four energetic compounds evaluated in this paper were found in a single soil boring (7SB101). These compounds were

completely absent in all of the other soil borings, except TNT and RDX which were found at very low concentrations in 7SB106 (Table B-1). The overall area of contamination in swale was estimated to be 60 feet wide (parallel to groundwater flow direction) and 340 feet long (perpendicular to groundwater flow). Because the maximum concentrations of energetic compounds were found in a single boring, the total area of 20,400 ft<sup>2</sup> for soils contaminated with energetic compounds is probably an overestimation. However, this value was used to perform the modeling in order to be conservative.

RDX and TNT were at much higher concentrations in the shallow soil sample (0 - 0.5 ft bgs) and decreased significantly in the deeper soil sample (2 - 4 ft bgs). This rapid decrease of concentrations with depth indicates that the contamination is primarily located near the ground surface. In the deeper soil sample (2-4 ft bgs), the presence of 2ADNT and 4ADNT indicates that TNT is already degrading in the upper soil materials (discussed in greater detail below). For modeling purposes, the average thickness of contaminated soil over the entire 20,400 ft<sup>2</sup> swale area was estimated to 1.5 feet. In reality, the contaminated soil layer may be thicker in some portions of the 20,400 ft<sup>2</sup> area and may be absent in other portions. A thickness of 1.5 feet is conservative in that maximum RDX and TNT values were detected in the top 6 inches of soil in 07SB101.

The four energetic compounds were detected in four to six of the nine wells sampled at Site 7. However, the highest concentrations of these four compounds were all found in a single well, 07GW08. The second greatest concentrations of RDX and TNT were detected in 07GW104, which is located a short distance (about 70 feet) southwest of 07GW08 (see RFI Figure 7-4). Wells 07GW103 and 07GW105 are located about 150 feet downgradient of the two wells above. In the downgradient wells, RDX and TNT are about 10 to 20% of the concentrations detected immediately upgradient (RFI Figure 7-4). In other words, the concentrations of these two compounds are sharply reduced in the downgradient direction. The same holds true for 2ADNT and 4ADNT. Dilution, dispersion, and/or biodegradation are causing the rapid reduction of contaminant concentrations in the direction of groundwater flow.

### **Mobility of Energetic Compounds**

As they migrate through soil and rock materials, contaminants partially sorb to the materials. If the contaminant sorbs strongly to the solid matrix, then its mobility is limited and it migrates very slowly. If a contaminant does not bind significantly to a solid matrix, then its mobility is relatively great and it can travel in the groundwater system at nearly the same velocity as groundwater. The conceptual model generally used for binding of organic compounds on soils and rock matrix materials is that binding is a linear isotherm, is reversible, and is instantaneous (i.e., not constrained by kinetic processes). The soil-water partition coefficient ( $K_d$ ) is used to represent the degree of adsorption that occurs. Like most organic compounds, the  $K_d$  values of the energetic compounds are related to the fraction of organic carbon present in the geologic matrix ( $f_{oc}$ ) and the organic carbon-water partition coefficient ( $K_{oc}$ ). However, the results of many soil investigations have shown that the  $K_d$  values are also related to the amount of clay in a soil and perhaps the amount of amorphous iron oxyhydroxides in the soil (i.e., inorganic binding sites). Thus, the ability of a soil to sorb these energetic compounds has not proven to be easily estimated. Table B-2 lists  $K_d$  values of the energetic compounds that are reported for individual studies and field investigations. Little information is available for the TNT degradation products, 2ADNT and 4ADNT; a greater amount of measured  $K_d$  values appear in the literature for RDX and TNT. Approximate average  $K_d$  values for the four

compounds are listed in Table B-2; these were used for transport modeling in both the vadose zone and the water-table aquifer for the base runs. Lower and higher values of  $K_d$  are listed in the following columns and they were used to perform sensitivity runs for each compound.

As shown in Table B-2, TNT is the most strongly sorbed to soil materials followed by the TNT degradation products and RDX. RDX is clearly the most mobile of the four compounds.

### **Biodegradation of Energetic Compounds**

Many studies have shown that RDX, TNT, 2ADNT, and 4ADNT can degrade in soils and groundwater (Pennington et al., 1999; Talmage et al., 1999). In some cases the degradation can occur relatively quickly. TNT can degrade biotically and abiotically in soils. Transformation of TNT generally results from reduction of one of the three nitro groups to an amine radical (Li et al., 1997; Daun et al., 1998). The resulting products are 2-amino-4,6-dinitrotoluene and 4-amino-2,6-dinitrotoluene. The transformation products (2ADNT and 4ADNT) are often observed in TNT-contaminated soils and groundwater, which indicates that TNT degradation is a common process at contaminated sites (Pennington et al., 1999; May et al., 2002). The rates of TNT degradation observed in laboratory and field studies are listed in Table B-2. The half-lives determined for TNT range from relatively short (0.88 year) to 10 years or more; however, most referenced values are less than 5 years. For modeling purposes, a half-life of 10 years was used in the base run (Table B-2).

Very little information was found related to the half-lives of TNT daughter products (2ADNT and 4ADNT). One laboratory study by Funk (1993) indicated that 2ADNT half-life was 18 days or less. Most researchers believe the half-lives of these two compounds are shorter than the parent compound, TNT. For modeling purposes, a half-life of 0.5 year was used for both compounds (Table B-2).

In general, RDX has been found to be more resistant to biodegradation. Half-lives cited in scientific literature and site investigation reports indicate that the half-life may range somewhere between 0.88 and 36 years (Table B-2). For modeling purposes, a conservative half-life of 20 years was selected to perform the base run for RDX.

### **Modeling Approach**

A base run was performed for each of the four compounds. Each of these model simulations included the best estimates available for each of the geological, hydrological, and biochemical input parameters. The contaminated soil layer was assigned the highest concentration of energetic compound that was detected during the RFI (a very conservative assumption). Based on these input parameters, the model predicted the concentration of contaminant in the leachate emanating from the surface soil over time, the contaminant concentration as it exits each soil layer over time, the concentration over time in groundwater beneath the site when it is fully mixed, and the maximum concentration at a given location downgradient of the site. To be conservative, the concentrations predicted in groundwater directly beneath the site were evaluated and compared against the risk-based concentrations acceptable for groundwater.

Because there is uncertainty in most of the input parameters used in this model, a sensitivity analysis was performed for each of the four compounds. The base run was used as the starting point in the sensitivity analyses. In each sensitivity run, only one parameter was varied. For sensitivity run 1 (SR-1) for TNT, the  $K_d$  value was decreased by a factor of three. For SR-2, the  $K_d$  value was increased by a factor of three. In SR-3, the half-life of TNT was decreased by 50%. In SR-4, the half-life of TNT was increased by 50%. In SR-5, the surface infiltration rate and velocity of water movement through the vadose zone was decreased by 50%. In SR-6, the surface infiltration rate and velocity of water movement through the vadose zone was increased by 50%. These sensitivity runs show how the model is sensitive to three critical variables in the model that presumably have the greatest uncertainty attached to the values that were used in the model simulations; these were  $K_d$  value which affects mobility of the contaminants, the biodegradation rate, and the rate of water movement through the vadose zone.

The predicted maximum concentration of contaminants in groundwater beneath Site 7 for each simulation are presented in Table B-3. These concentrations are compared against the risk-based concentration allowable in the water-table aquifer. If the criteria was exceeded, then the appropriate soil concentration that should be protective of groundwater quality was then listed.

### **Results of Base Simulations**

Using the maximum-detected concentration of RDX in the surface soil, the base run for RDX predicted that a maximum concentration of RDX in groundwater beneath the site would be 1.17 ug/L, which is about 19% of the risk-based ( $10^{-5}$  cancer risk) concentration of 6.1 ug/L. For the other compounds, the base simulations showed that concentrations of the contaminants should be orders of magnitude lower than the criteria, and would not be detectable. RDX appears in groundwater at levels that approach it's criterion because it sorbs the least to the geologic media and it has the lowest potential for biodegradation. However, even the predicted RDX concentration did not exceed the risk-based criterion of 6.1 ug/L. A summary of the input parameter values and the model predictions are included in Attachment B-1.

### **Sensitivity and Uncertainty in Modeling Results**

A summary of the input parameter values and the model predictions for all sensitivity runs are included in Attachment B-1. The sensitivity runs showed that the predicted groundwater concentrations for each compound increased as the  $K_d$  values were lowered and increased as the degradation rates were decreased. The change in infiltration rates through the contaminated soil had a lesser affect on the maximum predicted concentrations. None of the sensitivity runs produced a predicted maximum concentration above the risk-based criteria, except RDX SR-1. In this simulation, the decrease in the  $K_d$  value from 1.5 to 0.5 L/kg caused the maximum predicted concentration of RDX in groundwater to be 21.2 ug/L, which is above the allowable 6.1 ug/L. However, the areal size of the contaminated soil, the thickness of contaminated soil, and the maximum concentration assigned to the contaminated soil layer, in addition to the lower  $K_d$  value, makes this RDX simulation very conservative. The likelihood that all of these site factors would actually occur at Site 7 at the conservative levels utilized in SR-1 is relatively small. Thus, the contaminant concentrations that were detected in soils during the RFI do not appear to pose a concern in terms of the soil-to-groundwater pathway.

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**TABLE B-1**

**MAXIMUM CONCENTRATIONS OF PCOCs DETECTED IN SOIL AND GROUNDWATER**

Matrix	Compound	Frequency of Detection	Concentration Detected (mg/kg)	Location	Soil Depth (ft bgs)
Soil	RDX	4/13	42	7SB101	0 - 0.5
			9.9	7SB101	2 - 4
			0.83	7SB106	0 - 0.5
			0.17	7SB106	2 - 4
	TNT	3/13	14	7SB101	2 - 4
			7.1	7SB101	0 - 0.5
			0.039	7SB106	0 - 0.5
	2ADNT	1/13	2.3	7SB101	2 - 4
	4ADNT	1/13	6.3	7SB101	2 - 4

Matrix	Compound	Overall Frequency of Detection	Maximum Concentrations Detected in the Main Plume Area (ug/L)	Location	Risk-Based Concentration Limit for Groundwater (1) (ug/L)
Groundwater	RDX	6/9	510	7GW08	6.1
			270	7GW104	
			44	7GW103	
			20	7GW105	
	TNT	4/9	210	7GW08	22.0
			110	7GW104	
			34	7GW103	
	2ADNT	4/9	62	7GW08	2.2 (2)
			38	7GW104	
			6.6	7GW103	
			1.4	7GW105	
	4ADNT	5/9	110	7GW08	2.2 (2)
			66	7GW104	
14			7GW103		
1.4			7GW105		

(1) Concentration limits based on  $10^{-5}$  incremental cancer risk for carcinogens (RDX, TNT) or 1.0 hazard quotient for noncarcinogens (2ADNT, 4ADNT)

(2) Sum of 2ADNT and 4ADNT should not exceed 2.2 ug/L

TABLE B-2

## ADSORPTION AND BIODEGRADATION CHARACTERISTICS OF ENERGETIC COMPOUNDS

COMPOUND	$K_d$ (1) (L/kg)	Reference	$K_d$ Value Used, Base Run (L/kg)	$K_d$ Value Used in SR-1 (2) (L/kg)	$K_d$ Value Used in SR-2 (3) (L/kg)
RDX	0.21 - 0.33 (0.30) 0.80 - 4.15 (2.67) 1.4, 4.2 (2.8) 0.2 - 7.8 (4.05) (2.17) 0.101, 0.284 (0.19) 1.57, 1.59 (1.58) 0.12 - 2.37 (0.89) 0.95, 0.97 (0.96) 0.2 - 7.8 6.38 0.29 0.42	Pennington et al., 1999 Sikka et al., 1980 Spanggord et al., 1980b Hale et al., 1979 Layton et al., 1987 AMEC, 2001 Xue, Iskandar, and Selim, 1995 Ainsworth et al., 1993 Singh et al., 1998 Townsend and Meyers, 1996 Sheremata et al., 2001 Price et al., 2000 May et al., 2002	1.5	0.5	4.5
TNT	2.0 - 11.0 (4.0) 5.5 - 22.2 (14.6) 5.5 - 19.3 1.1, 2.5 (1.8) 0.08 - 0.33 (0.23) 2.58	Pennington and Patrick, 1990 Sikka et al., 1980 Spanggord et al., 1980a AMEC, 2001 Pennington et al., 1999 May et al., 2002	6.0	2.0	18.0
2ADNT	3.7, 4.9 (4.3) 2.42	Pennington and Patrick, 1990 May et al., 2002	3.6	1.2	10.8
4ADNT	2.42	May et al., 2002	3.6	1.2	10.8

COMPOUND	Half-life (1) (years)	Reference	Half-life ( $t_{1/2}$ ) value used, base run (years)	Half-life ( $t_{1/2}$ ) value used in SR-3 (4) (years)	Half-life ( $t_{1/2}$ ) value used in SR-4 (5) (years)
RDX	36 0.88 - 10.7+ (10.6)	DuBois and Baytos, 1991 Pennington et al., 1999	20	10	30
TNT	1.0 0.1 0.88 - 10.7+ (4.1) 1.11	DuBois and Baytos, 1991 Cataldo et al., 1989 Pennington et al., 1999 May et al., 2002	5.0	2.5	10.0
2ADNT	< 0.05 < 0.05	Funk et al., 1993 Alvarez et al., 1995	0.5	0.25	1.0
4ADNT	-	-	0.5	0.25	1.0

- (1) Individual values or range of values listed in column; average value shown in parentheses.
- (2) Sensitivity run 1 (SR-1) was performed for each compound using the base run and the smaller  $K_d$  value listed below
- (3) Sensitivity run 2 (SR-2) was performed for each compound using the base run and the larger  $K_d$  value listed below
- (4) Sensitivity run 3 (SR-3) was performed for each compound using the base run and the smaller half-life value listed below
- (5) Sensitivity run 4 (SR-4) was performed for each compound using the base run and the larger half-life value listed below

**TABLE B-3**

**SUMMARY OF MODELING RUN RESULTS**

Compound	Model Run	Predicted Concentration in Groundwater Below Site (ug/L)	Risk-Based Concentration Limit (ug/L)	Is Concentration Limit Exceeded (yes/no)	Appropriate Soil Cleanup Level (mg/kg)
RDX	Base Run	1.17	6.1	no	12.1
	SR-1	21.2	6.1	YES	
	SR-2	0.00142	6.1	no	
	SR-3	0.041	6.1	no	
	SR-4	3.62	6.1	no	
	SR-5	0.023	6.1	no	
	SR-6	4.11	6.1	no	
TNT	Base Run	9.92E-13	22.0	no	
	SR-1	3.41E-06	22.0	no	
	SR-2	2.39E-21	22.0	no	
	SR-3	8.55E-18	22.0	no	
	SR-4	2.05E-08	22.0	no	
	SR-5	6.90E-18	22.0	no	
	SR-6	4.59E-10	22.0	no	
2ADNT	Base Run	3.15E-28	2.2 (1)	no	
	SR-1	7.84E-19	2.2 (1)	no	
	SR-2	4.44E-38	2.2 (1)	no	
	SR-3	7.57E-34	2.2 (1)	no	
	SR-4	8.69E-22	2.2 (1)	no	
	SR-5	2.65E-34	2.2 (1)	no	
	SR-6	8.95E-25	2.2 (1)	no	
4ADNT	Base Run	3.08E-27	2.2 (1)	no	
	SR-1	2.15E-18	2.2 (1)	no	
	SR-2	3.30E-37	2.2 (1)	no	
	SR-3	2.07E-33	2.2 (1)	no	
	SR-4	2.38E-21	2.2 (1)	no	
	SR-5	2.48E-33	2.2 (1)	no	
	SR-6	9.14E-24	2.2 (1)	no	

(1) 2.2 ug/L is the allowable sum of the 2ADNT and 4ADNT concentrations based on a hazard quotient = 1.0.

**ATTACHMENT B-1**

**SUMMARY SHEETS FOR MODEL SIMULATIONS, INCLUDING  
MODEL INPUT DATA AND GROUNDWATER CONCENTRATION  
PREDICTIONS**

# RDX Base Run

ECTran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/9/2002
<b>CHEMICAL CHARACTERISTICS</b>		<b>ITERATIVE DECISION-MAKING BOX</b>	
CONTAMINANT: RDX	EXPOSURE POINT: (UNDERS, FL) UNDERS	LEACHATE CONCENTRATION (YES,NO) ?	no
HALF-LIFE (YRS): 2.00E+01	UNDERS: Under source, FL: Fenceline	INPUT SOLID-PHASE CONCENTRATION (MG/KG)	4.200E+01
SPECIFIC ACTIVITY (Ci/g): 0.00E+00	WATER CRITERIA (UG/L): 6.10E+00	CONSTANT CONCENTRATION (YES,NO)?	no
	TIME FRAME (YRS): - 120	TRY NEW GOAL:	2.20E+02
		ACCEPTABLE!	INCREASE
<b>SOURCE-TERM INFORMATION</b>		<b>ENGINEERING CONTROL INFORMATION</b>	
Ke:	1.00	INFILT(FYR):	1.00E+00
Kl (L/KG):	1.50E+00	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG): 4.20E+01		THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT): 1.5		TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE: 0.7		SATURATION RATE:	0.7
POROSITY: 0.43		POROSITY:	0.43
BULK DENSITY (G/CM^3): 1.7		BULK DENSITY (G/CM^3):	1.7
		Kd (L/KG):	1.50E+00
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT): 2.20E+01		TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE: 0.7		SATURATION RATE:	0.7
POROSITY: 0.43		POROSITY:	0.43
BULK DENSITY (G/CM^3): 1.7		BULK DENSITY (G/CM^3):	1.7
Kd (L/KG): 1.50E+00		Kd (L/KG):	1.50E+00
INITIAL SOIL CONC. (MG/KG): 0		INITIAL SOIL CONC. (MG/KG):	0
<b>SATURATED LAYER</b>			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>z0</sub> (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADE AREA INFILTRATION RATE, q (FT/YR)	1
Kd (L/KG): 1.50E+00		SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY: 0.43		MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, A <sub>z</sub> (FT): 0.25		TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT): 25.0		AGE (YRS):	0
LATERAL DISPERSIVITY, A <sub>y</sub> (FT): 2.5		CONC. IN UPGRADIENT GROUNDWATER, CU <sub>2</sub> (UG/L)	0
INITIAL CONC. (ug/L): 0		DISTANCE TO F.L.:	500
<b>PREDICTED IMPACTS:</b>		<b>TIME OF MAXIMUM (YR)</b>	
SATURATED LAYER CONCENTRATION:	1.17E+00 (UG/L)		81.6
FENCE LINE CONCENTRATION:	4.31E-02 (UG/L)		100.8

# RDX SR-1

ECTran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7 CTO 839		INVESTIGATOR: JPS	DATE: 5/9/2002
<b>CHEMICAL CHARACTERISTICS</b>		<b>ITERATIVE DECISION-MAKING BOX</b>	
CONTAMINANT: RDX SR-1	EXPOSURE POINT: (UNDERS, FL.) UNDERS	LEACHATE CONCENTRATION (YES,NO) ?	no
HALF-LIFE (YRS): 2.00E+01	UNDERS: Under source, FL: Fenceline	INPUT SOLID-PHASE CONCENTRATION (MG/KG)	4.200E+01
SPECIFIC ACTIVITY (Ci/g): 0.00E+00	WATER CRITERIA (UG/L): 6.10E+00	CONSTANT CONCENTRATION (YES,NO)?	no
	TIME FRAME (YRS): - 120	TRY NEW GOAL:	1.21E+01
		ACCEPTABLE!	DECREASE
<b>SOURCE-TERM INFORMATION</b>		<b>ENGINEERING CONTROL INFORMATION</b>	
Kc:	1.00	INFILT(FY/YR):	1.00E+00
KI (L/KG):	5.00E-01	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG): 4.20E+01		THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT): 1.5		TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE: 0.7		SATURATION RATE:	0.7
POROSITY: 0.43		POROSITY:	0.43
BULK DENSITY (G/CM^3): 1.7		BULK DENSITY (G/CM^3):	1.7
		Kd (L/KG):	5.00E-01
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT): 2.20E+01		TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE: 0.7		SATURATION RATE:	0.7
POROSITY: 0.43		POROSITY:	0.43
BULK DENSITY (G/CM^3): 1.7		BULK DENSITY (G/CM^3):	1.7
Kd (L/KG): 5.00E-01		Kd (L/KG):	5.00E-01
INITIAL SOIL CONC. (MG/KG): 0		INITIAL SOIL CONC. (MG/KG):	0
<b>SATURATED LAYER</b>			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>z0</sub> (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	1
Kd (L/KG): 5.00E-01		SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY: 0.43		MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, Az (FT): 0.25		TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, Ax (FT): 25.0		AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT): 2.5		CONC. IN UPGRADIENT GROUNDWATER, CU2 (UG/L)	0
INITIAL CONC. (ug/L): 0		DISTANCE TO F.L.:	500
<b>PREDICTED IMPACTS:</b>			<b>TIME OF MAXIMUM (YR)</b>
SATURATED LAYER CONCENTRATION:	2.12E+01 (UG/L)		26.4
FENCE LINE CONCENTRATION:	4.22E+00 (UG/L)		38.4

# RDX SR-2

ECTran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7 CTO 839		INVESTIGATOR: JPS	DATE: 5/9/2002
<b>CHEMICAL CHARACTERISTICS</b>		<b>ITERATIVE DECISION-MAKING BOX</b>	
CONTAMINANT: RDX SR-2	EXPOSURE POINT: (UNDERS, FL) UNDERS	LEACHATE CONCENTRATION (YES,NO) ?	no
HALF-LIFE (YRS): 2.00E+01	UNDERS: Under source, FL. Fence line	INPUT SOLID-PHASE CONCENTRATION (MG/KG)	4.200E+01
SPECIFIC ACTIVITY (Ci/g): 0.00E+00	WATER CRITERIA (UG/L): 6.10E+00	CONSTANT CONCENTRATION (YES,NO)?	no
	TIME FRAME (YRS): - 300	TRY NEW GOAL:	1.80E+05
		ACCEPTABLE!	INCREASE
<b>SOURCE-TERM INFORMATION</b>		<b>ENGINEERING CONTROL INFORMATION</b>	
Ke:	1.00	INFILT(FY/YR):	1.00E+00
Ki (L/KG):	4.50E+00	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG): 4.20E+01		THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT): 1.5		TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE: 0.7		SATURATION RATE:	0.7
POROSITY: 0.43		POROSITY:	0.43
BULK DENSITY (G/CM <sup>3</sup> ): 1.7		BULK DENSITY (G/CM <sup>3</sup> ):	1.7
		Kd (L/KG):	4.50E+00
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM <sup>3</sup> ):	1.7	BULK DENSITY (G/CM <sup>3</sup> ):	1.7
Kd (L/KG):	4.50E+00	Kd (L/KG):	4.50E+00
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
<b>SATURATED LAYER</b>			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>20</sub> (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	1
Kd (L/KG):	4.50E+00	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, A <sub>z</sub> (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, A <sub>y</sub> (FT):	2.5	CONC. IN UPGRADIENT GROUNDWATER, CU <sub>2</sub> (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
<b>PREDICTED IMPACTS:</b>		<b>TIME OF MAXIMUM (YR)</b>	
SATURATED LAYER CONCENTRATION:	1.42E-03 (UG/L)		168
FENCE LINE CONCENTRATION:	8.21E-07 (UG/L)		210

# RDX SR-3

ECTran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7 CTO 839		INVESTIGATOR: JPS	DATE: 5/9/2002
CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX	
CONTAMINANT: RDX SR-3	EXPOSURE POINT: (UNDERS, FL) UNDERS	LEACHATE CONCENTRATION (YES,NO) ?	no
HALF-LIFE (YRS): 1.00E+01	UNDERS: Under source, FL: Fenceline	INPUT SOLID-PHASE CONCENTRATION (MG/KG)	4.200E+01
SPECIFIC ACTIVITY (Ci/g): 0.00E+00	WATER CRITERIA (UG/L): 6.10E+00	CONSTANT CONCENTRATION (YES,NO)?	no
	TIME FRAME (YRS): - 120	TRY NEW GOAL:	6.24E+03
		ACCEPTABLE!	INCREASE
SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FT/YR):	1.00E+00
Ki (L/KG):	1.50E+00	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	4.20E+01	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	1.5	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3):	1.7	BULK DENSITY (G/CM^3):	1.7
		Kd (L/KG):	1.50E+00
		Kd (L/KG):	1.50E+00
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3):	1.7	BULK DENSITY (G/CM^3):	1.7
Kd (L/KG):	1.50E+00	Kd (L/KG):	1.50E+00
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>z0</sub> (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRAIDENT AREA INFILTRATION RATE, q (FT/YR)	1
Kd (L/KG):	1.50E+00	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, A <sub>z</sub> (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, A <sub>y</sub> (FT):	2.5	CONC. IN UPGRADIENT GROUNDWATER, CU2 (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
PREDICTED IMPACTS:			TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	4.10E-02 (UG/L)		67.2
FENCE LINE CONCENTRATION:	7.95E-04 (UG/L)		86.4

# RDX SR-4

ECtran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7 CTO 839		INVESTIGATOR: JPS	DATE: 5/9/2002
<b>CHEMICAL CHARACTERISTICS</b>		<b>ITERATIVE DECISION-MAKING BOX</b>	
CONTAMINANT: RDX SR-4	EXPOSURE POINT: (UNDERS, FL) UNDERS UNDERS: Under source, FL: Fenceline WATER CRITERIA (UG/L): 6.10E+00	LEACHATE CONCENTRATION (YES,NO)?	no
HALF-LIFE (YRS): 3.00E+01		INPUT SOLID-PHASE CONCENTRATION (MG/KG)	4.200E+01
SPECIFIC ACTIVITY (Ci/g): 0.00E+00	TIME FRAME (YRS): - 160	CONSTANT CONCENTRATION (YES,NO)?	no
		TRY NEW GOAL:	7.07E+01
		ACCEPTABLE!	INCREASE
<b>SOURCE-TERM INFORMATION</b>		<b>ENGINEERING CONTROL INFORMATION</b>	
Ke:	1.00	INFILT(FT/YR):	1.00E+00
Ki (L/KG):	1.50E+00	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG): 4.20E+01		THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT): 1.5		TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE: 0.7		SATURATION RATE:	0.7
POROSITY: 0.43		POROSITY:	0.43
BULK DENSITY (G/CM^3): 1.7		BULK DENSITY (G/CM^3):	1.7
		Kd (L/KG):	1.50E+00
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT): 2.20E+01		TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE: 0.7		SATURATION RATE:	0.7
POROSITY: 0.43		POROSITY:	0.43
BULK DENSITY (G/CM^3): 1.7		BULK DENSITY (G/CM^3):	1.7
Kd (L/KG): 1.50E+00		Kd (L/KG):	1.50E+00
INITIAL SOIL CONC. (MG/KG): 0		INITIAL SOIL CONC. (MG/KG):	0
<b>SATURATED LAYER</b>			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, Vzo (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR):	1
Kd (L/KG): 1.50E+00		SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY: 0.43		MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, Az (FT): 0.25		TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, Ax (FT): 25.0		AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT): 2.5		CONC. IN UPGRADIENT GROUNDWATER, CU2 (UG/L)	0
INITIAL CONC. (ug/L): 0		DISTANCE TO F.L.:	500
<b>PREDICTED IMPACTS:</b>		<b>TIME OF MAXIMUM (YR)</b>	
SATURATED LAYER CONCENTRATION:	3.62E+00 (UG/L)		80
FENCE LINE CONCENTRATION:	1.72E-01 (UG/L)		102.4

# RDX SR-5

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX	
ECTran Version 2.0 for Excel 4.0 & 5.0 Copyright 1997		<b>TETRA TECH NUS, INC.</b>	
SITE: White Oak-Site 7 CTO 839		INVESTIGATOR: JPS	
		DATE: 5/9/2002	
CONTAMINANT: RDX SR-5 HALF-LIFE (YRS): 2.00E+01 SPECIFIC ACTIVITY (Ci/g): 0.00E+00	EXPOSURE POINT: (UNDERS, FL) UNDERS UNDERS: Under source. FL: Fenceline WATER CRITERIA (UG/L): 6.10E+00 TIME FRAME (YRS): - 240	LEACHATE CONCENTRATION (YES,NO)? no INPUT SOLID-PHASE CONCENTRATION (MG/KG) 4.200E+01 CONSTANT CONCENTRATION (YES,NO)? no TRY NEW GOAL: 1.11E+04 ACCEPTABLE! INCREASE	
SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke: 1.00 Kf (L/KG): 1.50E+00  DEPLETING SOURCE: WASTE CHARACTERISTICS: INITIAL SOLID-PHASE CONCENTRATION (MG/KG): 4.20E+01 INPUT FOLLOWING PARAMETERS: THICKNESS (FT): 1.5 SATURATION RATE: 0.7 POROSITY: 0.43 BULK DENSITY (G/CM^3): 1.7		INFILT(FT/YR): 5.00E-01  LENGTH (FT): 60  WIDTH (FT): 340  IS THERE A CLAY LINER LAYER (YES,NO)? NO  THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION HOW MANY SUBLAYERS (1 - 10)? 3 TOTAL THICKNESS (UP TO 30 FT) (FT): 10 SATURATION RATE: 0.7 POROSITY: 0.43 BULK DENSITY (G/CM^3): 1.7 Kd (L/KG): 1.50E+00	
IS THERE A TYPE 1 LAYER (YES,NO)? yes		IS THERE A TYPE 2 LAYER (YES,NO)? yes	
HOW MANY SUBLAYERS (1 - 10)? 10 TOTAL THICKNESS (UP TO 30 FT) (FT): 2.20E+01 SATURATION RATE: 0.7 POROSITY: 0.43 BULK DENSITY (G/CM^3): 1.7 Kd (L/KG): 1.50E+00 INITIAL SOIL CONC. (MG/KG): 0		HOW MANY SUBLAYERS (1 - 10)? 10 TOTAL THICKNESS (UP TO 30 FT) (FT): 21.5 SATURATION RATE: 0.7 POROSITY: 0.43 BULK DENSITY (G/CM^3): 1.7 Kd (L/KG): 1.50E+00 INITIAL SOIL CONC. (MG/KG): 0	
SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT): 20 HORIZONTAL SEEPAGE VELOCITY, V (FT/YR): 139 Kd (L/KG): 1.50E+00 POROSITY: 0.43 VERTICAL DISPERSIVITY, Az (FT): 0.25 LONGITUDINAL DISPERSIVITY, Ax (FT): 25.0 LATERAL DISPERSIVITY, Ay (FT): 2.5 INITIAL CONC. (ug/L): 0		VERTICAL SEEPAGE VELOCITY, Vzo (FT/YR): 0 DOWNGRADE AREA INFILTRATION RATE, q (FT/YR): 0.5 SPECIFY MIXING DEPTH (Computed from formula if input NO) 20 MIXING DEPTH, H (FT): 20.0 TIME OF PUMPING STOP, P&T (YEARS): 0 AGE (YRS): 0 CONC. IN UPGRADIENT GROUNDWATER, CU2 (UG/L): 0 DISTANCE TO F.L.: 500	
<b>PREDICTED IMPACTS:</b>			<b>TIME OF MAXIMUM (YR)</b>
SATURATED LAYER CONCENTRATION: 2.30E-02 (UG/L)		129.6	
FENCE LINE CONCENTRATION: 2.73E-03 (UG/L)		153.6	

# RDX SR-6

ECTran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7 CTO 839	INVESTIGATOR:	JPS	DATE: 5/9/2002
<b>CHEMICAL CHARACTERISTICS</b>		<b>ITERATIVE DECISION-MAKING BOX</b>	
CONTAMINANT:	RDX SR-6	EXPOSURE POINT: (UNDERS, FL) UNDERS	LEACHATE CONCENTRATION (YES,NO) ? no
HALF-LIFE (YRS):	2.00E+01	UNDERS: Under source, FL: Fenceline WATER CRITERIA (UG/L): 6.10E+00	INPUT SOLID-PHASE CONCENTRATION (MG/KG) 4.200E+01
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	TIME FRAME (YRS): - 160	CONSTANT CONCENTRATION (YES,NO)? no
			TRY NEW GOAL: 6.24E+01
			ACCEPTABLE! INCREASE
<b>SOURCE-TERM INFORMATION</b>		<b>ENGINEERING CONTROL INFORMATION</b>	
Ke:	1.00	INFILT(FT/YR):	1.50E+00
Ki (L/KG):	1.50E+00	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	4.20E+01	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	1.5	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3)	1.7	BULK DENSITY (G/CM^3):	1.7
		Kd (L/KG):	1.50E+00
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3)	1.7	BULK DENSITY (G/CM^3)	1.7
Kd (L/KG):	1.50E+00	Kd (L/KG):	1.50E+00
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
<b>SATURATED LAYER</b>			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>z0</sub> (FT/YR):	0
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	1.5
Kd (L/KG):	1.50E+00	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, A <sub>z</sub> (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, A <sub>y</sub> (FT):	2.5	CONC. IN UPGRADE GROUNDWATER, CU2 (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
<b>PREDICTED IMPACTS:</b>			<b>TIME OF MAXIMUM (YR)</b>
SATURATED LAYER CONCENTRATION:	4.11E+00 (UG/L)		48
FENCE LINE CONCENTRATION:	5.37E-02 (UG/L)		67.2

# TNT Base Run

ECTran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/9/2002
<b>CHEMICAL CHARACTERISTICS</b>		<b>ITERATIVE DECISION-MAKING BOX</b>	
CONTAMINANT: TNT - BASE RUN	EXPOSURE POINT: (UNDERS, FL) UNDERS	LEACHATE CONCENTRATION (YES,NO) ?	no
HALF-LIFE (YRS): 5.00E+00	UNDERS: Under source, FL: Fenceline	INPUT SOLID-PHASE CONCENTRATION (MG/KG)	1.400E+01
SPECIFIC ACTIVITY (Ci/g): 0.00E+00	WATER CRITERIA (UG/L): 2.20E+01	CONSTANT CONCENTRATION (YES,NO)?	no
	TIME FRAME (YRS): - 200	TRY NEW GOAL:	3.10E+14
		ACCEPTABLE!	INCREASE
<b>SOURCE-TERM INFORMATION</b>		<b>ENGINEERING CONTROL INFORMATION</b>	
Ke:	1.00	INFILT(FT/YR):	1.00E+00
Kf (L/KG):	6.00E+00	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG): 1.40E+01		THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT): 1.5		TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE: 0.7		SATURATION RATE:	0.7
POROSITY: 0.43		POROSITY:	0.43
BULK DENSITY (G/CM^3): 1.7		BULK DENSITY (G/CM^3):	1.7
		Kd (L/KG):	6.00E+00
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT): 2.20E+01		TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE: 0.7		SATURATION RATE:	0.7
POROSITY: 0.43		POROSITY:	0.43
BULK DENSITY (G/CM^3): 1.7		BULK DENSITY (G/CM^3):	1.7
Kd (L/KG): 6.00E+00		Kd (L/KG):	6.00E+00
INITIAL SOIL CONC. (MG/KG): 0		INITIAL SOIL CONC. (MG/KG):	0
<b>SATURATED LAYER</b>			
TOTAL SATURATED ZONE THICKNESS, B (FT): 20		VERTICAL SEEPAGE VELOCITY, V <sub>z0</sub> (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR): 139		DOWNGRAIDENT AREA INFILTRATION RATE, q (FT/YR):	1
Kd (L/KG): 6.00E+00		SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY: 0.43		MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, Az (FT): 0.25		TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, Ax (FT): 25.0		AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT): 2.5		CONC. IN UPGRADIENT GROUNDWATER, CU2 (UG/L)	0
INITIAL CONC. (ug/L): 0		DISTANCE TO F.L.:	500
<b>PREDICTED IMPACTS:</b>		<b>TIME OF MAXIMUM (YR)</b>	
SATURATED LAYER CONCENTRATION:	9.92E-13 (UG/L)		80
FENCE LINE CONCENTRATION:	1.26E-18 (UG/L)		120

# TNT SR-1

ECTran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7	CTO 239	INVESTIGATOR: JPS	DATE: 5/9/2002
<b>CHEMICAL CHARACTERISTICS</b>		<b>ITERATIVE DECISION-MAKING BOX</b>	
CONTAMINANT: TNT SR-1 HALF-LIFE (YRS): 5.00E+00 SPECIFIC ACTIVITY (Ci/g): 0.00E+00	EXPOSURE POINT: (UNDERS, FL) UNDERS UNDERS: Under source, FL: Fenceline WATER CRITERIA (UG/L): 2.20E+01 TIME FRAME (YRS): - 120	LEACHATE CONCENTRATION (YES,NO) ? no INPUT SOLID-PHASE CONCENTRATION (MG/KG) 1.400E+01 CONSTANT CONCENTRATION (YES,NO)? no TRY NEW GOAL: 9.03E+07 ACCEPTABLE! INCREASE	
<b>SOURCE-TERM INFORMATION</b>		<b>ENGINEERING CONTROL INFORMATION</b>	
Ke: 1.00 Kf (L/KG): 2.00E+00  DEPLETING SOURCE:  WASTE CHARACTERISTICS: INITIAL SOLID-PHASE CONCENTRATION (MG/KG): 1.40E+01 INPUT FOLLOWING PARAMETERS: THICKNESS (FT): 1.5 SATURATION RATE: 0.7 POROSITY: 0.43 BULK DENSITY (G/CM^3): 1.7	INFILT(FT/YR): 1.00E+00  LENGTH (FT): 60  WIDTH (FT): 340  IS THERE A CLAY LINER LAYER (YES,NO)? NO  THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION HOW MANY SUBLAYERS (1 - 10)? 3 TOTAL THICKNESS (UP TO 30 FT) (FT): 10 SATURATION RATE: 0.7 POROSITY: 0.43 BULK DENSITY (G/CM^3): 1.7 Kd (L/KG): 2.00E+00		
IS THERE A TYPE 1 LAYER (YES,NO)? yes		IS THERE A TYPE 2 LAYER (YES,NO)? yes	
HOW MANY SUBLAYERS (1 - 10)? 10 TOTAL THICKNESS (UP TO 30 FT) (FT): 2.20E+01 SATURATION RATE: 0.7 POROSITY: 0.43 BULK DENSITY (G/CM^3): 1.7 Kd (L/KG): 2.00E+00 INITIAL SOIL CONC. (MG/KG): 0	HOW MANY SUBLAYERS (1 - 10)? 10 TOTAL THICKNESS (UP TO 30 FT) (FT): 21.5 SATURATION RATE: 0.7 POROSITY: 0.43 BULK DENSITY (G/CM^3): 1.7 Kd (L/KG): 2.00E+00 INITIAL SOIL CONC. (MG/KG): 0		
<b>SATURATED LAYER</b>			
TOTAL SATURATED ZONE THICKNESS, B (FT): 20 HORIZONTAL SEEPAGE VELOCITY, V (FT/YR): 139 Kd (L/KG): 2.00E+00 POROSITY: 0.43 VERTICAL DISPERSIVITY, Az (FT): 0.25 LONGITUDINAL DISPERSIVITY, Ax (FT): 25.0 LATERAL DISPERSIVITY, Ay (FT): 2.5 INITIAL CONC. (ug/L): 0	VERTICAL SEEPAGE VELOCITY, Vzo (FT/YR): 1 DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR): 1 SPECIFY MIXING DEPTH (Computed from formula if input NO): 20 MIXING DEPTH, H (FT): 20.0 TIME OF PUMPING STOP, P&T (YEARS): 0 AGE (YRS): 0 CONC. IN UPGRADIENT GROUNDWATER, CU2 (UG/L): 0 DISTANCE TO F.L.: 500		
<b>PREDICTED IMPACTS:</b>			<b>TIME OF MAXIMUM (YR)</b>
SATURATED LAYER CONCENTRATION:		3.41E-06 (UG/L)	57.6
FENCE LINE CONCENTRATION:		6.18E-09 (UG/L)	79.2

# TNT SR-2

ECTran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/9/2002
CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX	
CONTAMINANT: TNT SR-2	EXPOSURE POINT: (UNDERS, FL) UNDERS	LEACHATE CONCENTRATION (YES,NO) ?	no
HALF-LIFE (YRS): 5.00E+00	UNDERS: Under source, FL: Fenceline	INPUT SOLID-PHASE CONCENTRATION (MG/KG)	1.400E+01
SPECIFIC ACTIVITY (Ci/g): 0.00E+00	WATER CRITERIA (UG/L): 2.20E+01	CONSTANT CONCENTRATION (YES,NO)?	no
	TIME FRAME (YRS): - 200	TRY NEW GOAL:	1.29E+23
		ACCEPTABLE!	INCREASE
SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FT/YR):	1.00E+00
Ki (L/KG):	1.80E+01	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	1.40E+01	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	1.5	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM <sup>3</sup> ):	1.7	BULK DENSITY (G/CM <sup>3</sup> ):	1.7
		Kd (L/KG):	1.80E+01
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM <sup>3</sup> ):	1.7	BULK DENSITY (G/CM <sup>3</sup> ):	1.7
Kd (L/KG):	1.80E+01	Kd (L/KG):	1.80E+01
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>z0</sub> (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	1
Kd (L/KG):	1.80E+01	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, A <sub>z</sub> (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, A <sub>y</sub> (FT):	2.5	CONC. IN UPGRADE GROUNDWATER, CU <sub>2</sub> (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)	
SATURATED LAYER CONCENTRATION:	2.39E-21 (UG/L)		100
FENCE LINE CONCENTRATION:	2.02E-33 (UG/L)		172

# TNT SR-3

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX	
ECTran Version 2.0 for Excel 4.0 & 5.0 Copyright 1997		TETRA TECH NUS, INC.	
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/9/2002
CONTAMINANT: TNT SR-3	EXPOSURE POINT: (UNDERS, FL) UNDERS	LEACHATE CONCENTRATION (YES,NO) ?	no
HALF-LIFE (YRS): 2.50E+00	UNDERS: Under source, FL: Fenceline	INPUT SOLID-PHASE CONCENTRATION (MG/KG)	1.400E+01
SPECIFIC ACTIVITY (Ci/g): 0.00E+00	WATER CRITERIA (UG/L): 2.20E+01	CONSTANT CONCENTRATION (YES,NO)?	no
	TIME FRAME (YRS): 100	TRY NEW GOAL:	3.60E+19
		ACCEPTABLE!	INCREASE
SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FY/YR):	1.00E+00
Kf (L/KG):	6.00E+00	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	1.40E+01	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	1.5	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3)	1.7	BULK DENSITY (G/CM^3):	1.7
Kd (L/KG):	6.00E+00	Kd (L/KG):	6.00E+00
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3)	1.7	BULK DENSITY (G/CM^3)	1.7
Kd (L/KG):	6.00E+00	Kd (L/KG):	6.00E+00
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>z0</sub> (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	1
Kd (L/KG):	6.00E+00	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, A <sub>z</sub> (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, A <sub>y</sub> (FT):	2.5	CONC. IN UPGRADIENT GROUNDWATER, CU <sub>2</sub> (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
<b>PREDICTED IMPACTS:</b>		<b>TIME OF MAXIMUM (YR)</b>	
SATURATED LAYER CONCENTRATION:	8.55E-18 (UG/L)		48
FENCE LINE CONCENTRATION:	9.00E-26 (UG/L)		80

# TNT SR-4

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX	
ECTran Version 2.0 for Excel 4.0 & 5.0 Copyright 1997		TETRA TECH NUS, INC.	
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/9/2002
CONTAMINANT:	TNT SR-4	EXPOSURE POINT: (UNDERS, FL)	UNDERS
HALF-LIFE (YRS):	1.00E+01	UNDERS: Under source, FL: Fence/line	
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	WATER CRITERIA (UG/L):	2.20E+01
		TIME FRAME (YRS):	240
		LEACHATE CONCENTRATION (YES,NO) ?	no
		INPUT SOLID-PHASE CONCENTRATION (MG/KG)	1.400E+01
		CONSTANT CONCENTRATION (YES,NO)?	no
		TRY NEW GOAL:	1.50E+10
		ACCEPTABLE!	INCREASE
SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Kc:	1.00	INFILT(FT/YR):	1.00E+00
Kd (L/KG):	6.00E+00	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	1.40E+01	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	1.5	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3)	1.7	BULK DENSITY (G/CM^3):	1.7
		Kd (L/KG):	6.00E+00
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3)	1.7	BULK DENSITY (G/CM^3)	1.7
Kd (L/KG):	6.00E+00	Kd (L/KG):	6.00E+00
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>z0</sub> (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	1
Kd (L/KG):	6.00E+00	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, A <sub>z</sub> (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, A <sub>y</sub> (FT):	2.5	CONC. IN UPGRADIENT GROUNDWATER, CU2 (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)	
SATURATED LAYER CONCENTRATION:	2.05E-08 (UG/L)		139.2
FENCE LINE CONCENTRATION:	4.17E-13 (UG/L)		187.2

# TNT SR-5

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX	
ECTran Version 2.0 for Excel 4.0 & 5.0 Copyright 1997		<b>TETRA TECH NUS, INC.</b>	
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	
		DATE: 5/9/2002	
CONTAMINANT: TNT SR-5 HALF-LIFE (YRS): 5.00E+00 SPECIFIC ACTIVITY (Ci/g): 0.00E+00	EXPOSURE POINT: (UNDERS, FL) UNDERS UNDERS: Under source, FL: Fenceline WATER CRITERIA (UG/L): 2.20E+01 TIME FRAME (YRS): - 200	LEACHATE CONCENTRATION (YES,NO)? no INPUT SOLID-PHASE CONCENTRATION (MG/KG) 1.400E+01 CONSTANT CONCENTRATION (YES,NO)? no TRY NEW GOAL: 4.47E+19 ACCEPTABLE! INCREASE	
SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
K <sub>e</sub> : 1.00 K <sub>d</sub> (L/KG): 6.00E+00  DEPLETING SOURCE:  WASTE CHARACTERISTICS: INITIAL SOLID-PHASE CONCENTRATION (MG/KG): 1.40E+01 INPUT FOLLOWING PARAMETERS: THICKNESS (FT): 1.5 SATURATION RATE: 0.7 POROSITY: 0.43 BULK DENSITY (G/CM <sup>3</sup> ): 1.7	INFILT(FY/yr): 5.00E-01  LENGTH (FT): 60  WIDTH (FT): 340  IS THERE A CLAY LINER LAYER (YES,NO)? NO  THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION HOW MANY SUBLAYERS (1 - 10)? 3 TOTAL THICKNESS (UP TO 30 FT) (FT): 10 SATURATION RATE: 0.7 POROSITY: 0.43 BULK DENSITY (G/CM <sup>3</sup> ): 1.7 K <sub>d</sub> (L/KG): 6.00E+00		
IS THERE A TYPE 1 LAYER (YES,NO)? yes	IS THERE A TYPE 2 LAYER (YES,NO)? yes		
HOW MANY SUBLAYERS (1 - 10)? 10 TOTAL THICKNESS (UP TO 30 FT) (FT): 2.20E+01 SATURATION RATE: 0.7 POROSITY: 0.43 BULK DENSITY (G/CM <sup>3</sup> ): 1.7 K <sub>d</sub> (L/KG): 6.00E+00 INITIAL SOIL CONC. (MG/KG): 0	HOW MANY SUBLAYERS (1 - 10)? 10 TOTAL THICKNESS (UP TO 30 FT) (FT): 21.5 SATURATION RATE: 0.7 POROSITY: 0.43 BULK DENSITY (G/CM <sup>3</sup> ): 1.7 K <sub>d</sub> (L/KG): 6.00E+00 INITIAL SOIL CONC. (MG/KG): 0		
SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT): 20 HORIZONTAL SEEPAGE VELOCITY, V (FT/YR): 139 K <sub>d</sub> (L/KG): 6.00E+00 POROSITY: 0.43 VERTICAL DISPERSIVITY, A <sub>z</sub> (FT): 0.25 LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT): 25.0 LATERAL DISPERSIVITY, A <sub>y</sub> (FT): 2.5 INITIAL CONC. (ug/L): 0	VERTICAL SEEPAGE VELOCITY, V <sub>z0</sub> (FT/YR): 0.5 DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR) 0.5 SPECIFY MIXING DEPTH (Computed from formula if input NO) 20 MIXING DEPTH, H (FT): 20.0 TIME OF PUMPING STOP, P&T (YEARS): 0 AGE (YRS): 0 CONC. IN UPGRADIENT GROUNDWATER, CU2 (UG/L) 0 DISTANCE TO F.L.: 500		
<b>PREDICTED IMPACTS:</b>			<b>TIME OF MAXIMUM (YR)</b>
SATURATED LAYER CONCENTRATION: 6.90E-18 (UG/L)		92	
FENCE LINE CONCENTRATION: 8.80E-23 (UG/L)		140	

# TNT SR-6

ECTran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/9/2002
CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX	
CONTAMINANT:	TNT SR-6	EXPOSURE POINT: (UNDERS, FL)	UNDERS
HALF-LIFE (YRS):	5.00E+00	UNDERS: Under source, FL: Fenceline	
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	WATER CRITERIA (UG/L):	2.20E+01
		TIME FRAME (YRS):	200
		LEACHATE CONCENTRATION (YES,NO) ?	no
		INPUT SOLID-PHASE CONCENTRATION (MG/KG)	1.400E+01
		CONSTANT CONCENTRATION (YES,NO)?	no
		TRY NEW GOAL:	6.71E+11
		ACCEPTABLE!	INCREASE
SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Kc:	1.00	INFILT(FY/YR):	1.50E+00
Ki (L/KG):	6.00E+00	LENGTH (FT):	60
		WIDTH (FT):	340
DEPLETING SOURCE		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
WASTE CHARACTERISTICS:		THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	1.40E+01	HOW MANY SUBLAYERS (1 - 10)?	3
INPUT FOLLOWING PARAMETERS:		TOTAL THICKNESS (UP TO 30 FT) (FT):	10
THICKNESS (FT):	1.5	SATURATION RATE:	0.7
SATURATION RATE:	0.7	POROSITY:	0.43
POROSITY:	0.43	BULK DENSITY (G/CM^3):	1.7
BULK DENSITY (G/CM^3)	1.7	Kd (L/KG):	6.00E+00
		INITIAL SOIL CONC. (MG/KG):	0
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT)	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3)	1.7	BULK DENSITY (G/CM^3)	1.7
Kd (L/KG):	6.00E+00	Kd (L/KG):	6.00E+00
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>z0</sub> (FT/YR):	1.5
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	1.5
Kd (L/KG):	6.00E+00	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, A <sub>z</sub> (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, A <sub>y</sub> (FT):	2.5	CONC. IN UPGRADIENT GROUNDWATER, CU <sub>2</sub> (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
<b>PREDICTED IMPACTS:</b>		<b>TIME OF MAXIMUM (YR)</b>	
SATURATED LAYER CONCENTRATION:	4.59E-10 (UG/L)		68
FENCE LINE CONCENTRATION:	7.11E-17 (UG/L)		104

# 2ADNT Base Run

ECTran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/10/2002
CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX	
CONTAMINANT: 2ADNT BASE RUN	EXPOSURE POINT: (UNDERS, FL) UNDERS: Under source, FL: Fence/line WATER CRITERIA (UG/L):	UNDERS 1.10E+00	LEACHATE CONCENTRATION (YES.NO) ? INPUT SOLID-PHASE CONCENTRATION (MG/KG) CONSTANT CONCENTRATION (YES.NO)? TRY NEW GOAL: ACCEPTABLE! INCREASE
HALF-LIFE (YRS): 5.00E-01			2.300E+00 no no 8.04E+27
SPECIFIC ACTIVITY (Ci/g): 0.00E+00	TIME FRAME (YRS): -	120	
SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke: 1.00	Ki (L/KG): 3.60E+00	INFILT(FI/YR): 1.00E+00	LENGTH (FT): 60
DEPLETING SOURCE		WIDTH (FT): 340	IS THERE A CLAY LINER LAYER (YES,NO)? NO
WASTE CHARACTERISTICS: INITIAL SOLID-PHASE CONCENTRATION (MG/KG): 2.30E+00	INPUT FOLLOWING PARAMETERS: THICKNESS (FT): 1.5 SATURATION RATE: 0.7 POROSITY: 0.43 BULK DENSITY (G/CM^3): 1.7	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION HOW MANY SUBLAYERS (1 - 10)? 3 TOTAL THICKNESS (UP TO 30 FT) (FT): 10 SATURATION RATE: 0.7 POROSITY: 0.43 BULK DENSITY (G/CM^3): 1.7 Kd (L/KG): 3.60E+00	
IS THERE A TYPE 1 LAYER (YES,NO)? yes		IS THERE A TYPE 2 LAYER (YES,NO)? yes	
HOW MANY SUBLAYERS (1 - 10)? 10	TOTAL THICKNESS (UP TO 30 FT) (FT): 2.20E+01	HOW MANY SUBLAYERS (1 - 10)? 10	TOTAL THICKNESS (UP TO 30 FT) (FT): 21.5
SATURATION RATE: 0.7	POROSITY: 0.43	SATURATION RATE: 0.7	POROSITY: 0.43
BULK DENSITY (G/CM^3): 1.7	Kd (L/KG): 3.60E+00	BULK DENSITY (G/CM^3): 1.7	Kd (L/KG): 3.60E+00
INITIAL SOIL CONC. (MG/KG): 0		INITIAL SOIL CONC. (MG/KG): 0	
SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT): 20	HORIZONTAL SEEPAGE VELOCITY, V (FT/YR): 139	VERTICAL SEEPAGE VELOCITY, V20 (FT/YR): 1	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR): 1
Kd (L/KG): 3.60E+00	POROSITY: 0.43	SPECIFY MIXING DEPTH (Computed from formula if input NO): 20	
VERTICAL DISPERSIVITY, Az (FT): 0.25	LONGITUDINAL DISPERSIVITY, Ax (FT): 25.0	MIXING DEPTH, H (FT): 20.0	
LATERAL DISPERSIVITY, Ay (FT): 2.5	INITIAL CONC. (ug/L): 0	TIME OF PUMPING STOP, P&T (YEARS): 0	
		AGE (YRS): 0	
		CONC. IN UPGRADIENT GROUNDWATER, CU2 (UG/L): 0	
		DISTANCE TO F.L.: 500	
PREDICTED IMPACTS:			TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:		3.15E-28 (UG/L)	2.4
FENCE LINE CONCENTRATION:		3.02E-42 (UG/L)	16.8

# 2ADNT SR-1

ECTran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/10/2002
<b>CHEMICAL CHARACTERISTICS</b>		<b>ITERATIVE DECISION-MAKING BOX</b>	
CONTAMINANT: 2ADNT SR-1	EXPOSURE POINT: (UNDERS, FL) UNDERS	LEACHATE CONCENTRATION (YES,NO) ?	no
HALF-LIFE (YRS): 5.00E-01	UNDERS: Under source, FL: Fenceline	INPUT SOLID-PHASE CONCENTRATION (MG/KG)	2.300E+00
SPECIFIC ACTIVITY (Ci/g): 0.00E+00	WATER CRITERIA (UG/L): 1.10E+00	CONSTANT CONCENTRATION (YES,NO)?	no
	TIME FRAME (YRS): - 32	TRY NEW GOAL:	3.23E+18
		ACCEPTABLE!	INCREASE
<b>SOURCE-TERM INFORMATION</b>		<b>ENGINEERING CONTROL INFORMATION</b>	
Ke:	1.00	INFILT(FY/YR):	1.00E+00
Ki (L/KG):	1.20E+00	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	2.30E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	1.5	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3):	1.7	BULK DENSITY (G/CM^3):	1.7
		Kd (L/KG):	1.20E+00
		INITIAL SOIL CONC. (MG/KG):	0
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3):	1.7	BULK DENSITY (G/CM^3):	1.7
Kd (L/KG):	1.20E+00	Kd (L/KG):	1.20E+00
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
<b>SATURATED LAYER</b>			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>z0</sub> (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	1
Kd (L/KG):	1.20E+00	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, A <sub>z</sub> (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, A <sub>y</sub> (FT):	2.5	CONC. IN UPGRADIENT GROUNDWATER, CU2 (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
<b>PREDICTED IMPACTS:</b>		<b>TIME OF MAXIMUM (YR)</b>	
SATURATED LAYER CONCENTRATION:	7.84E-19 (UG/L)		7.68
FENCE LINE CONCENTRATION:	3.23E-26 (UG/L)		16

# 2ADNT SR-2

ECTran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/10/2002
CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX	
CONTAMINANT: 2ADNT SR-2	EXPOSURE POINT: (UNDERS, FL) UNDERS	LEACHATE CONCENTRATION (YES,NO) ?	no
HALF-LIFE (YRS): 5.00E-01	UNDERS: Under source, FL: Fenceline	INPUT SOLID-PHASE CONCENTRATION (MG/KG)	2.300E+00
SPECIFIC ACTIVITY (C/g): 0.00E+00	WATER CRITERIA (UG/L): 1.10E+00	CONSTANT CONCENTRATION (YES,NO)?	no
	TIME FRAME (YRS): - 120	TRY NEW GOAL:	5.70E+37
		ACCEPTABLE!	INCREASE
SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FI/YR):	1.00E+00
Ki (L/KG):	1.08E+01	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	2.30E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	1.5	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3):	1.7	BULK DENSITY (G/CM^3):	1.7
		Kd (L/KG):	1.08E+01
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3):	1.7	BULK DENSITY (G/CM^3):	1.7
Kd (L/KG):	1.08E+01	Kd (L/KG):	1.08E+01
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V20 (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRAIDENT AREA INFILTRATION RATE, q (FT/YR)	1
Kd (L/KG):	1.08E+01	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, Az (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, Ax (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	2.5	CONC. IN UPGRAIDENT GROUNDWATER, CU2 (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)	
SATURATED LAYER CONCENTRATION:	4.44E-38 (UG/L)		2.4
FENCE LINE CONCENTRATION:	3.74E-64 (UG/L)		26.4

# 2ADNT SR-3

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX	
ECTran Version 2.0 for Excel 4.0 & 5.0 Copyright 1997		TETRA TECH NUS, INC.	
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/10/2002
CONTAMINANT: 2ADNT SR-3	EXPOSURE POINT: (UNDERS, FL) UNDERS	LEACHATE CONCENTRATION (YES,NO) ?	no
HALF-LIFE (YRS): 2.50E-01	UNDERS: Under source, FL: Fence/line	INPUT SOLID-PHASE CONCENTRATION (MG/KG)	2.300E+00
SPECIFIC ACTIVITY (Ci/g): 0.00E+00	WATER CRITERIA (UG/L): 1.10E+00	CONSTANT CONCENTRATION (YES,NO)?	no
	TIME FRAME (YRS): - 24	TRY NEW GOAL:	3.34E+33
		ACCEPTABLE!	INCREASE
SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Kc:	1.00	INFILT(FY/YR):	1.00E+00
KI (L/KG):	3.60E+00	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	2.30E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	1.5	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3)	1.7	BULK DENSITY (G/CM^3):	1.7
		Kd (L/KG):	3.60E+00
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3)	1.7	BULK DENSITY (G/CM^3)	1.7
Kd (L/KG):	3.60E+00	Kd (L/KG):	3.60E+00
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>z0</sub> (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	1
Kd (L/KG):	3.60E+00	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, A <sub>z</sub> (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, A <sub>y</sub> (FT):	2.5	CONC. IN UPGRADIENT GROUNDWATER, CU2 (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
<b>PREDICTED IMPACTS:</b>			<b>TIME OF MAXIMUM (YR)</b>
SATURATED LAYER CONCENTRATION:	7.57E-34 (UG/L)		3.84
FENCE LINE CONCENTRATION:	1.91E-54 (UG/L)		13.44

# 2ADNT SR-4

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX	
ECTran Version 2.0 for Excel 4.0 & 5.0 Copyright 1997		TETRA TECH NUS, INC.	
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/10/2002
CONTAMINANT: 2ADNT SR-4	EXPOSURE POINT: (UNDERS, FL) UNDERS	LEACHATE CONCENTRATION (YES,NO)?	no
HALF-LIFE (YRS): 1.00E+00	UNDERS: Under source, FL: Fenceline	INPUT SOLID-PHASE CONCENTRATION (MG/KG)	2.300E+00
SPECIFIC ACTIVITY (Ci/g): 0.00E+00	WATER CRITERIA (UG/L): 1.10E+00	CONSTANT CONCENTRATION (YES,NO)?	no
	TIME FRAME (YRS): 50	TRY NEW GOAL:	2.91E+21
		ACCEPTABLE!	INCREASE
SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FT/YR):	1.00E+00
Ki (L/KG):	3.60E+00	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	2.30E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	1.5	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3):	1.7	BULK DENSITY (G/CM^3):	1.7
		Kd (L/KG):	3.60E+00
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3):	1.7	BULK DENSITY (G/CM^3):	1.7
Kd (L/KG):	3.60E+00	Kd (L/KG):	3.60E+00
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>z0</sub> (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	1
Kd (L/KG):	3.60E+00	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, A <sub>z</sub> (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, A <sub>y</sub> (FT):	2.5	CONC. IN UPGRADIENT GROUNDWATER, CU2 (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
PREDICTED IMPACTS:			TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	8.69E-22 (UG/L)		19
FENCE LINE CONCENTRATION:	3.81E-31 (UG/L)		37

# 2A DNT SR-5

ECTran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/10/2002
<b>CHEMICAL CHARACTERISTICS</b>		<b>ITERATIVE DECISION-MAKING BOX</b>	
CONTAMINANT: 2ADNT SR-5	EXPOSURE POINT: (UNDERS, FL) UNDERS	LEACHATE CONCENTRATION (YES,NO) ?	no
HALF-LIFE (YRS): 5.00E-01	UNDERS: Under source, FL: Fenceline	INPUT SOLID-PHASE CONCENTRATION (MG/KG)	2.300E+00
SPECIFIC ACTIVITY (Ci/g): 0.00E+00	WATER CRITERIA (UG/L): 1.10E+00	CONSTANT CONCENTRATION (YES,NO)?	no
	TIME FRAME (YRS): - 120	TRY NEW GOAL:	9.55E+33
		ACCEPTABLE!	INCREASE
<b>SOURCE-TERM INFORMATION</b>		<b>ENGINEERING CONTROL INFORMATION</b>	
K <sub>e</sub> :	1.00	INFILT(FI/YR):	5.00E-01
K <sub>i</sub> (L/KG):	3.60E+00	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	2.30E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	1.5	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM <sup>3</sup> ):	1.7	BULK DENSITY (G/CM <sup>3</sup> ):	1.7
		K <sub>d</sub> (L/KG):	3.60E+00
		K <sub>d</sub> (L/KG):	3.60E+00
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM <sup>3</sup> ):	1.7	BULK DENSITY (G/CM <sup>3</sup> ):	1.7
K <sub>d</sub> (L/KG):	3.60E+00	K <sub>d</sub> (L/KG):	3.60E+00
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
<b>SATURATED LAYER</b>			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>z0</sub> (FT/YR):	0.5
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0.5
K <sub>d</sub> (L/KG):	3.60E+00	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, A <sub>z</sub> (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, A <sub>y</sub> (FT):	2.5	CONC. IN UPGRADIENT GROUNDWATER, CU <sub>2</sub> (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
<b>PREDICTED IMPACTS:</b>			<b>TIME OF MAXIMUM (YR)</b>
SATURATED LAYER CONCENTRATION:	2.65E-34 (UG/L)		2.4
FENCE LINE CONCENTRATION:	5.52E-48 (UG/L)		19.2

# 2ADNT SR-6

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX	
ECTran Version 2.0 for Excel 4.0 & 5.0 Copyright 1997		TETRA TECH NUS, INC.	
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/10/2002
CONTAMINANT: 2ADNT SR-6	EXPOSURE POINT: (UNDERS, FL) UNDERS	LEACHATE CONCENTRATION (YES,NO) ?	no
HALF-LIFE (YRS): 5.00E-01	UNDERS: Under source, FL: Fenceline	INPUT SOLID-PHASE CONCENTRATION (MG/KG)	2.300E+00
SPECIFIC ACTIVITY (Ci/g): 0.00E+00	WATER CRITERIA (UG/L): 1.10E+00	CONSTANT CONCENTRATION (YES,NO)?	no
	TIME FRAME (YRS): - 120	TRY NEW GOAL:	2.83E+24
		ACCEPTABLE!	INCREASE
SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FY/YR):	1.50E+00
Ki (L/KG):	3.60E+00	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	2.30E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	1.5	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3):	1.7	BULK DENSITY (G/CM^3):	1.7
		Kd (L/KG):	3.60E+00
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3):	1.7	BULK DENSITY (G/CM^3):	1.7
Kd (L/KG):	3.60E+00	Kd (L/KG):	3.60E+00
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>20</sub> (FT/YR):	1.5
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	1.5
Kd (L/KG):	3.60E+00	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, Az (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, Ax (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	2.5	CONC. IN UPGRADE GROUNDWATER, CU2 (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
PREDICTED IMPACTS:			TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	8.95E-25 (UG/L)		2.4
FENCE LINE CONCENTRATION:	4.09E-39 (UG/L)		16.8

# 4A DNT Base Run

ECTran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/10/2002
<b>CHEMICAL CHARACTERISTICS</b>		<b>ITERATIVE DECISION-MAKING BOX</b>	
CONTAMINANT: 4ADNT BASE RUN	EXPOSURE POINT: (UNDERS. FL) UNDERS	LEACHATE CONCENTRATION (YES,NO)?	no
HALF-LIFE (YRS): 5.00E-01	UNDERS: Under source, FL: Fenceline	INPUT SOLID-PHASE CONCENTRATION (MG/KG)	6.300E+00
SPECIFIC ACTIVITY (Ci/g): 0.00E+00	WATER CRITERIA (UG/L): 1.10E+00	CONSTANT CONCENTRATION (YES,NO)?	no
	TIME FRAME (YRS): - 32	TRY NEW GOAL:	2.25E+27
		ACCEPTABLE!	INCREASE
<b>SOURCE-TERM INFORMATION</b>		<b>ENGINEERING CONTROL INFORMATION</b>	
Ke:	1.00	INFILT(FY/YR):	1.00E+00
Ki (L/KG):	3.60E+00	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	6.30E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	1.5	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3)	1.7	BULK DENSITY (G/CM^3):	1.7
		Kd (L/KG):	3.60E+00
		Kd (L/KG):	3.60E+00
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3)	1.7	BULK DENSITY (G/CM^3)	1.7
Kd (L/KG):	3.60E+00	Kd (L/KG):	3.60E+00
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
<b>SATURATED LAYER</b>			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>z0</sub> (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADE AREA INFILTRATION RATE, q (FT/YR)	1
Kd (L/KG):	3.60E+00	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, Az (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, Ax (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	2.5	CONC. IN UPGRADIENT GROUNDWATER, CU <sub>2</sub> (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
<b>PREDICTED IMPACTS:</b>		<b>TIME OF MAXIMUM (YR)</b>	
SATURATED LAYER CONCENTRATION:	3.08E-27 (UG/L)		8.96
FENCE LINE CONCENTRATION:	3.95E-41 (UG/L)		22.4

# 4ADNT SR-1

ECTran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/10/2002
CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX	
CONTAMINANT: 4ADNT SR-1	EXPOSURE POINT: (UNDERS, FL) UNDERS	LEACHATE CONCENTRATION (YES,NO) ?	no
HALF-LIFE (YRS): 5.00E-01	UNDERS: Under source, FL: Fenceline	INPUT SOLID-PHASE CONCENTRATION (MG/KG)	6.300E+00
SPECIFIC ACTIVITY (Ci/g): 0.00E+00	WATER CRITERIA (UG/L): 1.10E+00	CONSTANT CONCENTRATION (YES,NO)?	no
	TIME FRAME (YRS): - 32	TRY NEW GOAL:	3.23E+18
		ACCEPTABLE!	INCREASE
SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FT/YR):	1.00E+00
Ki (L/KG):	1.20E+00	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	6.30E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	1.5	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3):	1.7	BULK DENSITY (G/CM^3):	1.7
		Kd (L/KG):	1.20E+00
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3):	1.7	BULK DENSITY (G/CM^3):	1.7
Kd (L/KG):	1.20E+00	Kd (L/KG):	1.20E+00
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>z0</sub> (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	1
Kd (L/KG):	1.20E+00	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, A <sub>z</sub> (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, A <sub>y</sub> (FT):	2.5	CONC. IN UPGRADIENT GROUNDWATER, CU <sub>2</sub> (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
<b>PREDICTED IMPACTS:</b>		<b>TIME OF MAXIMUM (YR)</b>	
SATURATED LAYER CONCENTRATION:	2.15E-18 (UG/L)		7.68
FENCE LINE CONCENTRATION:	8.85E-26 (UG/L)		16

# 4A DNT SR-2

ECTran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/10/2002
CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX	
CONTAMINANT:	4ADNT SR-2	EXPOSURE POINT: (UNDERS. FL) UNDERS	LEACHATE CONCENTRATION (YES,NO)? no
HALF-LIFE (YRS):	5.00E-01	UNDERS: Under source, FL: Fenceline	INPUT SOLID-PHASE CONCENTRATION (MG/KG) 6.300E+00
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	WATER CRITERIA (UG/L): 1.10E+00	CONSTANT CONCENTRATION (YES,NO)? no
		TIME FRAME (YRS): - 48	TRY NEW GOAL: 2.10E+37
			ACCEPTABLE! INCREASE
SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(Ft/YR):	1.00E+00
Ki (L/KG):	1.08E+01	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	6.30E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	1.5	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3)	1.7	BULK DENSITY (G/CM^3):	1.7
		Kd (L/KG):	1.08E+01
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3)	1.7	BULK DENSITY (G/CM^3)	1.7
Kd (L/KG):	1.08E+01	Kd (L/KG):	1.08E+01
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>20</sub> (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	1
Kd (L/KG):	1.08E+01	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, A <sub>z</sub> (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, A <sub>y</sub> (FT):	2.5	CONC. IN UPGRADIENT GROUNDWATER, CU2 (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)	
SATURATED LAYER CONCENTRATION:	3.30E-37 (UG/L)		7.68
FENCE LINE CONCENTRATION:	3.68E-63 (UG/L)		30.72

# 4A DNT SR-3

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX	
ECTran Version 2.0 for Excel 4.0 & 5.0 Copyright 1997		TETRA TECH NUS, INC.	
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/10/2002
CONTAMINANT: 4ADNT SR-3	EXPOSURE POINT: (UNDERS, FL) UNDERS	LEACHATE CONCENTRATION (YES,NO) ?	no
HALF-LIFE (YRS): 2.50E-01	UNDERS: Under source, FL: Fenceline	INPUT SOLID-PHASE CONCENTRATION (MG/KG)	6.300E+00
SPECIFIC ACTIVITY (CV/g): 0.00E+00	WATER CRITERIA (UG/L): 1.10E+00	CONSTANT CONCENTRATION (YES,NO)?	no
	TIME FRAME (YRS): - 24	TRY NEW GOAL:	3.34E+33
		ACCEPTABLE!	INCREASE
SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(Ft/YR):	1.00E+00
Ki (L/KG):	3.60E+00	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	6.30E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	1.5	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3):	1.7	BULK DENSITY (G/CM^3):	1.7
		Kd (L/KG):	3.60E+00
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3):	1.7	BULK DENSITY (G/CM^3):	1.7
Kd (L/KG):	3.60E+00	Kd (L/KG):	3.60E+00
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>20</sub> (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	1
Kd (L/KG):	3.60E+00	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, A <sub>z</sub> (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, A <sub>y</sub> (FT):	2.5	CONC. IN UPGRADIENT GROUNDWATER, CU <sub>2</sub> (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
PREDICTED IMPACTS:			TIME OF MAXIMUM (YR)
SATURATED LAYER CONCENTRATION:	2.07E-33 (UG/L)		3.84
FENCE LINE CONCENTRATION:	5.22E-54 (UG/L)		13.44

# 4ADNT SR-4

ECTran Version 2.0 for Excel 4.0 & 5.0

TETRA TECH NUS, INC.

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SITE: White Oak-Site 7 CTO 239

INVESTIGATOR:

JPS

DATE: 5/10/2002

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX	
CONTAMINANT:	4ADNT SR-4	EXPOSURE POINT: (UNDERS, FL)	UNDERS
HALF-LIFE (YRS):	1.00E+00	UNDERS: Under source, FL: Fenceline	1.10E+00
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	WATER CRITERIA (UG/L):	
		TIME FRAME (YRS):	50
		LEACHATE CONCENTRATION (YES,NO) ?	no
		INPUT SOLID-PHASE CONCENTRATION (MG/KG)	6.300E+00
		CONSTANT CONCENTRATION (YES,NO)?	no
		TRY NEW GOAL:	2.91E+21
		ACCEPTABLE!	INCREASE
SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:		INFILT (FT/YR):	1.00E+00
Ki (L/KG):	1.00	LENGTH (FT):	60
	3.60E+00	WIDTH (FT):	340
DEPLETING SOURCE:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
WASTE CHARACTERISTICS:		THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	6.30E+00	HOW MANY SUBLAYERS (1 - 10)?	3
INPUT FOLLOWING PARAMETERS:		TOTAL THICKNESS (UP TO 30 FT) (FT):	10
THICKNESS (FT):	1.5	SATURATION RATE:	0.7
SATURATION RATE:	0.7	POROSITY:	0.43
POROSITY:	0.43	BULK DENSITY (G/CM^3):	1.7
BULK DENSITY (G/CM^3)	1.7	Kd (L/KG):	3.60E+00
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3)	1.7	BULK DENSITY (G/CM^3)	1.7
Kd (L/KG):	3.60E+00	Kd (L/KG):	3.60E+00
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>z0</sub> (FT/YR):	1
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	1
Kd (L/KG):	3.60E+00	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, A <sub>z</sub> (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, A <sub>y</sub> (FT):	2.5	CONC. IN UPGRADIENT GROUNDWATER, CU2 (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
PREDICTED IMPACTS:		TIME OF MAXIMUM (YR)	
SATURATED LAYER CONCENTRATION:	2.38E-21 (UG/L)		19
FENCE LINE CONCENTRATION:	1.04E-30 (UG/L)		37

# 4ADNT SR-5

EC/Tran Version 2.0 for Excel 4.0 & 5.0		TETRA TECH NUS, INC.	
Copyright 1997			
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/10/2002
<b>CHEMICAL CHARACTERISTICS</b>		<b>ITERATIVE DECISION-MAKING BOX</b>	
CONTAMINANT:	4ADNT SR-5	EXPOSURE POINT: (UNDERS, FL) UNDERS	LEACHATE CONCENTRATION (YES,NO)? no
HALF-LIFE (YRS):	5.00E-01	UNDERS: Under source, FL: Fence line	INPUT SOLID-PHASE CONCENTRATION (MG/KG) 6.300E+00
SPECIFIC ACTIVITY (Ci/g):	0.00E+00	WATER CRITERIA (UG/L): 1.10E+00	CONSTANT CONCENTRATION (YES,NO)? no
		TIME FRAME (YRS): - 32	TRY NEW GOAL: 2.79E+33
			ACCEPTABLE! INCREASE
<b>SOURCE-TERM INFORMATION</b>		<b>ENGINEERING CONTROL INFORMATION</b>	
Ke:		INFLT(FT/YR):	5.00E-01
Ki (L/KG):	1.00	LENGTH (FT):	60
	3.60E+00	WIDTH (FT):	340
DEPLETING SOURCE		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
WASTE CHARACTERISTICS:		THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	6.30E+00	HOW MANY SUBLAYERS (1 - 10)?	3
INPUT FOLLOWING PARAMETERS:		TOTAL THICKNESS (UP TO 30 FT) (FT):	10
THICKNESS (FT):	1.5	SATURATION RATE:	0.7
SATURATION RATE:	0.7	POROSITY:	0.43
POROSITY:	0.43	BULK DENSITY (G/CM^3):	1.7
BULK DENSITY (G/CM^3)	1.7	Kd (L/KG):	3.60E+00
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3)	1.7	BULK DENSITY (G/CM^3)	1.7
Kd (L/KG):	3.60E+00	Kd (L/KG):	3.60E+00
INITIAL SOIL CONC. (MG/KG):	0	INITIAL SOIL CONC. (MG/KG):	0
<b>SATURATED LAYER</b>			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>20</sub> (FT/YR):	0.5
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	0.5
Kd (L/KG):	3.60E+00	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, A <sub>z</sub> (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, A <sub>x</sub> (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, A <sub>y</sub> (FT):	2.5	CONC. IN UPGRADIENT GROUNDWATER, CU2 (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
<b>PREDICTED IMPACTS:</b>			<b>TIME OF MAXIMUM (YR)</b>
SATURATED LAYER CONCENTRATION:	2.48E-33 (UG/L)		9.6
FENCE LINE CONCENTRATION:	6.89E-47 (UG/L)		23.04

# 4ADNT SR-6

CHEMICAL CHARACTERISTICS		ITERATIVE DECISION-MAKING BOX	
ECTran Version 2.0 for Excel 4.0 & 5.0 Copyright 1997		TETRA TECH NUS, INC.	
SITE: White Oak-Site 7 CTO 239		INVESTIGATOR: JPS	DATE: 5/10/2002
CONTAMINANT: 4ADNT SR-6	EXPOSURE POINT: (UNDERS, FL) UNDERS	LEACHATE CONCENTRATION (YES,NO) ?	no
HALF-LIFE (YRS): 5.00E-01	UNDERS: Under source, FL: Fenceline	INPUT SOLID-PHASE CONCENTRATION (MG/KG)	6.300E+00
SPECIFIC ACTIVITY (CV/g): 0.00E+00	WATER CRITERIA (UG/L): 1.10E+00	CONSTANT CONCENTRATION (YES,NO)?	no
	TIME FRAME (YRS): 32	TRY NEW GOAL:	7.58E+23
		ACCEPTABLE!	INCREASE
SOURCE-TERM INFORMATION		ENGINEERING CONTROL INFORMATION	
Ke:	1.00	INFILT(FY/YR):	1.50E+00
Ki (L/KG):	3.60E+00	LENGTH (FT):	60
DEPLETING SOURCE:		WIDTH (FT):	340
WASTE CHARACTERISTICS:		IS THERE A CLAY LINER LAYER (YES,NO)?	NO
INITIAL SOLID-PHASE CONCENTRATION (MG/KG):	6.30E+00	THE FOLLOWING DATA ARE NOT USED IN THIS CALCULATION	
INPUT FOLLOWING PARAMETERS:		HOW MANY SUBLAYERS (1 - 10)?	3
THICKNESS (FT):	1.5	TOTAL THICKNESS (UP TO 30 FT) (FT):	10
SATURATON RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3):	1.7	BULK DENSITY (G/CM^3):	1.7
		Kd (L/KG):	3.60E+00
IS THERE A TYPE 1 LAYER (YES,NO)?	yes	IS THERE A TYPE 2 LAYER (YES,NO)?	yes
HOW MANY SUBLAYERS (1 - 10)?	10	HOW MANY SUBLAYERS (1 - 10)?	10
TOTAL THICKNESS (UP TO 30 FT) (FT):	2.20E+01	TOTAL THICKNESS (UP TO 30 FT) (FT):	21.5
SATURATION RATE:	0.7	SATURATION RATE:	0.7
POROSITY:	0.43	POROSITY:	0.43
BULK DENSITY (G/CM^3):	1.7	BULK DENSITY (G/CM^3):	1.7
Kd (L/KG):	3.60E+00	Kd (L/KG):	3.60E+00
INITIAL SOIL CONC (MG/KG):	0	INITIAL SOIL CONC (MG/KG):	0
SATURATED LAYER			
TOTAL SATURATED ZONE THICKNESS, B (FT):	20	VERTICAL SEEPAGE VELOCITY, V <sub>20</sub> (FT/YR):	1.5
HORIZONTAL SEEPAGE VELOCITY, V (FT/YR):	139	DOWNGRADIENT AREA INFILTRATION RATE, q (FT/YR)	1.5
Kd (L/KG):	3.60E+00	SPECIFY MIXING DEPTH (Computed from formula if input NO)	20
POROSITY:	0.43	MIXING DEPTH, H (FT):	20.0
VERTICAL DISPERSIVITY, Az (FT):	0.25	TIME OF PUMPING STOP, P&T (YEARS):	0
LONGITUDINAL DISPERSIVITY, Ax (FT):	25.0	AGE (YRS):	0
LATERAL DISPERSIVITY, Ay (FT):	2.5	CONC. IN UPGRADIENT GROUNDWATER, CU2 (UG/L)	0
INITIAL CONC. (ug/L):	0	DISTANCE TO F.L.:	500
<b>PREDICTED IMPACTS:</b>		<b>TIME OF MAXIMUM (YR)</b>	
SATURATED LAYER CONCENTRATION:	9.14E-24 (UG/L)		8.96
FENCE LINE CONCENTRATION:	5.52E-38 (UG/L)		22.4

**APPENDIX C**

**COST ESTIMATES**