U. S. Army
Environmental
Center

FINAL
ARDC TEST FACILITY
DECISION DOCUMENT
FORT DIX U.S. ARMY INSTALLATION
FORT DIX, NEW JERSEY

Prepared for:

KEMRON Environmental Services, Inc.
McLean, Virginia

Prepared by:

Harding ESE, Inc.
Portland, Maine

Project No. 56298

MAY 2003

Printed on Recycled Paper

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DECLARATION OF THE DECISION DOCUMENT

SITE NAME AND LOCATION

The Armament Research and Development Center (ARDC) is located at the Fort Dix U.S. Army Installation (Fort Dix) in Burlington and Ocean County, New Jersey.

STATEMENT OF BASIS AND PURPOSE

This Decision Document (DD) presents the Selected Remedy for the ARDC, which was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Re-authorization Act of 1986 (SARA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (United States Environmental Protection Agency [USEPA], 1990). This decision is based on the Administrative Record for this site.

ASSESSMENT OF SITE

The response action selected in this DD is necessary to protect human health and the environment from potential exposure to contaminants previously released at this site that may endanger public health or welfare.

DESCRIPTION OF SELECTED REMEDY

The Selected Remedy utilizes Excavation/Off-site Treatment and/or Disposal of approximately 130 cubic yards of tetrachloroethene (PCE) contaminated soil. Excavation of contaminated soil to the groundwater interface would remove the source of contamination at the ARDC, and allow natural processes such as dispersion, dilution, and biodegradation to address residual contamination in groundwater, surface water and sediment.

The Selected Remedy would consist of the following:

- Excavation of surface soil exceeding remediation goals;
- Treatment and/or disposal of excavated soil at an off-site treatment, storage, and disposal facility;
- Amendment of the Fort Dix Master Plan in lieu of deed restrictions to limit future use and development of the site; and
- Environmental sampling and long-term monitoring to determine the effectiveness of natural process in other media.

STATUTORY DETERMINATIONS

The Selected Remedy attains the mandates of CERCLA §121, and, to the extent practicable, the National Contingency Plan (NCP). More specifically, the Selected Remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. This remedy would only satisfy the statutory preference for treatment as a principal element of the remedy, if both required and provided by the accepting treatment, storage, and disposal facility.

Because implementation of this remedy will result in pollutants or contaminants remaining on-site initially, a five-year review will be required to ensure that the remedy remains protective of human health and the environment.

DATA CERTIFICATION CHECKLIST

The following information is included within the Decision Summary section of this DD. Additional information not covered in this document can be found in the Administrative Record file for this site.

- Chemicals of concern and their respective concentrations.
- Baseline risk represented by the chemicals of concern.
- Cleanup levels established for chemicals of concern and the basis for these levels.
- How source materials constituting principal threats are addressed.
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment.
- Potential land and groundwater use that will be available at the site as a result of the Selected Remedy.
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy costs estimates are projected.
- Key factors that led to selecting the remedy.

DECLARATION

The Army, with concurrence of the New Jersey Department of Environmental Protection (NJDEP) has determined that the Selected Remedy for the ARDC is Excavation/Off-site Disposal and/or Treatment.

United States Department of the Army

JUN 26 2003

David M. Lowry
Colonel, U. S. Army
Commanding, Fort Dix, NJ

Date

1.0 SITE NAME, LOCATION, AND DESCRIPTION

Fort Dix U.S. Army Installation (Fort Dix) is located approximately 20 miles southeast of Trenton, New Jersey (Figure 1-1). Fort Dix consists of a Cantonment Area, a Training Area, and a Range and Impact Area. The Cantonment Area occupies approximately one-third of the installation. A much smaller area southeast of the Cantonment Area is designated the Training Area, and the installation's eastern two-thirds is designated the Range and Impact Area. McGuire Air Force Base is situated between the Cantonment Area and the Range and Impact Area.

The Armament Research and Development Center (ARDC) is located in the Range and Impact Area near the northern Fort Dix boundary, approximately 2,000 feet west of Brindle Lake. The ARDC is currently not in service; however, the site is occasionally used as an encampment for visiting troops. Two locked chain-link fences controlled by the Fort Dix Range Control limit access to the site. A site map identifying important features of the site is attached (Figure 1-2)

Several areas of concern within the ARDC have been identified based on historical activities and previous investigations. The U.S. Army (Army), as the lead agency, has prepared this Decision Document (DD) to present the Selected Remedy for the ARDC. The Army has prepared the DD, and will conduct remedial activities, with guidance from New Jersey Department of Environmental Protection (NJDEP) and United States Environmental Protection Agency (USEPA), the support agencies.

2.0 SITE HISTORY AND RESPONSE ACTIVITIES

This DD addresses contamination at the ARDC. The following description is based on historical information and site investigations outlined in the Final Remedial Investigation (RI) (Harding Lawson Associates [HLA, 2000]).

2.1 SITE HISTORY

Fort Dix, initially called Camp Dix, was established on July 8, 1917, as a cantonment area and training post for World War I troops (ICF Kaiser Engineers, Inc. [ICF], 1997). After the war, the camp served as a demobilization center, and from 1922 to 1926 it was used as a training ground for active Army, Army Reserve, and National Guard units. The camp was inactive from 1926 to 1933, then from 1933 to 1939 it served as a reception, discharge, and installation facility, and its name was changed to Fort Dix. The installation served as a reception and training center during World War II; after the war, it was used as a separation center. In 1947, Fort Dix was designated as a basic training center and is currently used for that purpose. Prior to October 1992, Fort Dix was a government-owned installation under the jurisdiction of the U.S. Army Training and Doctrine Command (ICF, 1997). Its mission was to conduct basic combat training and advanced individual training, and to provide combat support and support to Reserve and National Guard units. In October 1992, the major command was shifted to Forces Command. In 1996, the post was officially designated the U.S. Army Training Center at Fort Dix. In October 1997, the major command became the U.S. Army Reserve Command.

The ARDC was historically the location for testing and analysis of weapons at Fort Dix. A wide variety of small arms (up to 40-millimeter weapons) were tested at the facility. Testing generally evaluated physical response of weapons and munitions to the extreme physical conditions to which they may be exposed. The tests reportedly did not include mixing, storage, replacement, or disposal of chemicals or radioisotopes.

The Installation Restoration Program was developed by the U.S. Department of Defense to evaluate problems related to suspected past releases of hazardous materials at U.S. Department of Defense facilities. The Installation Restoration Program is the reason behind initiation of investigation activities at the Fort Dix facility.

2.2 RESPONSE ACTIVITIES

The enforcement activities that have been conducted at the ARDC are summarized as follows:

- The Preliminary Assessment/ Site Investigation was conducted in 1987, and included the collection and analysis of surface soil samples (EA Engineering, Science, & Technology, 1989)

- The Phase I (Dames & Moore, 1992) RI and Phase II (Dame & Moore, 1993) RI conducted in, 1988 and 1990, focused on potential contamination associated with the Fuel Storage Area.

- Based on previous investigations, the United States Army Corp of Engineers (USACE) directed that an additional RI be conducted to identify the extent and condition of affected areas at the ARDC and to develop baseline human-health and ecological risk assessments of the contamination.

- The RI was conducted in three separate phases. Phase 1 was conducted between December 1996 and March 1997, Phase 2 was conducted in August of 1998, and Phase 3 was conducted in February of 1999

- The Final RI Report for the ARDC was published in June 2000 (HLA, 2000).

- The Final Feasibility (FS) for the ARDC was published in July 2001 (Harding ESE, Inc. [Harding ESE], 2001).

- The ARDC Proposed Plan was submitted for public review in October 2002. A public comment period was held from December 17, 2002 to January 17, 2003 and a public meeting concerning the Final Proposed Plan was held on January 8, 2003.

3.0 COMMUNITY PARTICIPATION

The RI/FS Reports and the Proposed Plan for the ARDC were made available to the public upon their finalization as required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). They can be found in the Administrative Record at the Burlington County Library in Westhampton, New Jersey, and at the Fort Dix Library (Building 5403) in Fort Dix, New Jersey. The notice of availability of these documents was published in the Burlington County Times on December 19, 2002 and in the Fort Dix Post on December 20, 2002. A public comment period was held from December 17, 2002 to January 17, 2003. In addition, a public meeting was held on January 8, 2003 to present the Proposed Plan to the community at large. At this meeting, representatives from the Army answered questions about problems at the site and the remedial alternatives. The responses to comments fielded during the public meeting and comment period are included in the Responsiveness Summary of this DD.

4.0 SCOPE AND ROLE OF REMEDIAL ACTION

This DD presents the Selected Remedy for the ARDC. The remedial action at the ARDC will address the surface soil source area through excavation/off-site treatment and/or disposal. Removal of the source area would address contaminated groundwater, surface water, and sediment, and increase the speed of attenuation by natural processes.

This remedial action includes excavation/off-site treatment and/or disposal of surface soil, implementation of institutional controls, long-term groundwater monitoring, and five-year site reviews. Institutional controls would prevent land use and development until risks to human health and the environment are addressed. Environmental sampling will monitor natural attenuation of residual contamination in groundwater, surface water, and sediment. The five-year site reviews would be conducted to evaluate whether the remedial action remains protective of human health and the environment.

5.0 SITE CHARACTERISTICS

Investigation activities were conducted between 1988 and 1999 at the ARDC. Development of the FS and subsequent selection of the Selected Remedy were based on the 1996 to 1999 RI. This RI was conducted at the ARDC in three separate phases. Phase 1 was conducted between December 1996 and March 1997, Phase 2 was conducted in August of 1998, and Phase 3 was conducted in February of 1999.

The objectives of the RI were to:

- Define the nature and distribution of the soil impacts near the Fuel Storage Area, where substantial total petroleum hydrocarbon (TPH) concentrations were detected in the past.
- Assess the condition of the water supply well. This included checking the physical condition of the well and pump, analytical sampling of the well, and pumping the well to evaluate the ability to affect shallow groundwater flow in the site vicinity.
- Assess impacts to groundwater from the reported septic leachfield associated with Building 9990, where the water supply well was located.
- Delineate the water-table configuration, and assess potential impacts from the Fuel Storage Area by installing monitoring wells.

These objectives were defined in the Final Technical Plan for the 13 sites (ABB Environmental Services [ABB-ES], 1995), which was approved by the USEPA Region II and the NJDEP.

The following activities were conducted as part of the RI field program:

- ground-penetrating radar survey of the former leachfield,
- collection of surface-soil samples for laboratory analyses,
- installation of exploratory soil borings and sampling of subsurface soil for laboratory analyses,
- installation of screened-auger borings and sampling of groundwater for field-laboratory analyses,
- collection of groundwater samples with a Geoprobe[SM] for field laboratory and off-site laboratory analysis,
- installation and sampling of a groundwater monitoring wells for laboratory analyses,
- sampling and geophysical logging of the water supply well,
- in-situ hydraulic conductivity testing,
- collection of surface-water and sediment samples for laboratory analyses,

- wetlands delineation,
- vertical and horizontal location surveys,

Based on analytical results from the water supply well, closure of the well was approved by the NJDEP and the well was abandoned on April 15, 1998, in accordance with NJDEP regulations. Groundwater in the vicinity of the former leachfield contains very low concentrations of toluene that do not exceed applicable standards. Former use of this area as a leachfield does not appear to have negatively impacted groundwater quality.

The Fuel Storage Area was identified as having been negatively impacted by disposal of chlorinated solvents to the ground surface in a small isolated area (See Figure 5-1). The only risks to humans or the environment identified at the Fuel Storage Area and adjacent drainage ditch was for construction worker exposure to tetrachloroethylene (PCE)-contaminated surface soil in the vicinity of the Fuel Storage Area, and future residential risks associated with trichloroethylene (TCE) and PCE in groundwater. It was determined however, that existing or potential risk from PCE and TCE contamination exist in all media except subsurface soil. PCE and TCE are the contaminants of concern (COCs) for the ARDC.

5.1 TOPOGRAPHY AND SURFACE-WATER HYDROLOGY

The ARDC is located near the northern boundary of Fort Dix in an area of flat-to-gently-rolling topography. Topography in the vicinity of the ARDC slopes gently to the north with a grade of 20 to 30 feet per mile (0.4 to 0.6 percent).

Precipitation runoff at the ARDC area is toward the east and southeast, into a drainage ditch located along the southern fence line southeast of the Fuel Storage Area. Water in the ditch flows in a northeasterly direction, eventually discharging into the outlet stream from Brindle Lake. The drainage ditch appears to receive groundwater discharge from the Fuel Storage Area.

5.2 GEOLOGY

The Cohansey/Kirkwood Formations are the primary surficial geologic formations at the ARDC. Soil-boring samples indicate that the Cohansey/Kirkwood Formations consist of fine to coarse sand with trace amounts of silt and clay. Natural-gamma-log data from water supply well at the ARDC indicate that the Cohansey/Kirkwood Formations extend to a depth of approximately 100 feet below ground surface (bgs).

The Vincentown Formation, which underlies the Kirkwood Formation, is characterized as fine sand, with little to trace silt and a distinctive dark-green-to-black color. Although not penetrated by soil borings at the ARDC, the Vincentown Formation was identified in the water supply well natural gamma log, beginning at 100 feet bgs and extending to approximately 150 feet bgs. The Manasquan Formation, which generally underlies the Kirkwood Formation, does not appear to be present at this site.

Underlying the Vincentown Formation are the Hornerstown and Navesink Formations, as identified in the water supply well natural gamma log. The Hornerstown Formation is characterized as a silty to clayey sand, generally lacking large fossils. The Navesink Formation is primarily clayey glauconite sand. Calcareous fossil fragments (up to 6 inches long) are plentiful, particularly in the basal beds. The natural gamma log indicates that the Hornerstown/Navesink Formations begin at approximately 150 feet bgs, and extend below the bottom of the water supply well at 204 feet bgs.

5.3 HYDROGEOLOGY

Shallow unconfined groundwater flow beneath the Fuel Storage Area at the ARDC is toward the southeast in the Cohansey/Kirkwood Formations. Shallow groundwater discharges to the drainage ditch southeast of the Fuel Storage Area. Results of in-situ hydraulic conductivity testing indicated a range of hydraulic conductivities from 0.27 foot per day (ft/d) to 1.0 ft/d. A flow velocity of 0.15 ft/d was calculated using the geometric means of hydraulic conductivity and horizontal gradients.

Water-level data from the water supply well and water-table monitoring wells at the Fuel Storage Area indicate a downward vertical gradient from the Cohansey/Kirkwood Formations to the underlying formations.

5.4 CONCEPTUAL MODEL

The hydrologic nature of the ARDC site has resulted in a connection between surface soil, shallow groundwater, and surface water/sediment media in the ditch. Precipitation and surface runoff infiltrate surface soil, providing a mechanism for leaching of contaminants to groundwater. A drainage ditch, located adjacent to the Fuel Storage Area, receives surface water run-off and discharging groundwater from beneath the contaminated surface soil in this area. Both surface water and sediments within this ditch appear to be impacted, at least in part, from surface water run-off and discharging groundwater.

5.5 NATURE AND DISTRIBUTION OF CONTAMINATION

The extent of the contamination in surface soil was developed based on a comparison of analytical data to the site-specific remedial goals. The approximate aerial extent of surface soil contamination to be removed was estimated at 1735 square feet (See Figure 5-1). The vertical extent of surface soil contamination is to two feet bgs. Therefore, the estimated volume of PCE-contaminated surface soil is to be removed is 130 cubic yards, with a maximum PCE concentration of 1000 milligrams/kilogram (mg/kg). Based on this concentration, the mass of PCE to be removed is an estimated four hundred pounds.

Groundwater contamination is limited to the downgradient portion of the Fuel Storage Area, where groundwater discharges to the drainage ditch. The vertical extent of contamination is limited to shallow groundwater, within 10 feet of the ground surface. The maximum concentrations of contaminants in groundwater were TCE at 8.9 micrograms/liter (µg/L) and PCE at 19 µg/L. TCE was detected at a maximum concentration of 0.0069 mg/kg in sediment. The maximum concentrations of PCE in surface water and sediment were 11 µg/L and 0.05 mg/kg, respectively. Site-related surface water and sediment contamination was detected in the vicinity of groundwater discharge to the drainage ditch, and immediately downgradient.

TCE and PCE are volatile organic compounds which are highly mobile in the saturated subsurface. Exposure has been linked to health effects such as skin rashes, and liver and kidney damage. These chemicals are also believed to potentially cause cancer.

Potential human receptors of site contaminants include current and future site workers as well as trespassing children. Aquatic life in the drainage ditch and in the forested wetlands northeast of the site, represent the most significant ecological receptors of site contaminants.

6.0 CURRENT AND POTENTIAL FUTURE LAND AND WATER USES

Fort Dix is a permanent Class 1 Army installation, occupying approximately 31,110 acres. It consists of a Cantonment Area, a Training Area, and a Range and Impact Area. The Cantonment Area occupies approximately one-third of the installation. A much smaller area southeast of the Cantonment Area is designated the Training Area, and the installation's eastern two-thirds is designated the Range and Impact Area. The ARDC is located within the Range and Impact Area, 2,000 feet to the west of Brindle Lake. McGuire Air Force Base is situated to the north, between the Cantonment Area and the Range and Impact Area.

Two locked chain-link fences controlled by the Fort Dix Range Control access to the ARDC. The site includes nine buildings, and was historically the location for testing and analyses of weapons at Fort Dix. Currently, the ARDC is not in service but is used as a training center and a bivouac area for visiting troops.

The future site and surrounding land-use conditions at the ARDC were assumed to be similar to current conditions, given that Fort Dix is assumed to remain a military base and support Department of Defense activities. Future residential use of the ARDC is not considered plausible, since the area is supplied with public water and will remain Fort Dix property; therefore, future residential exposure at the ARDC was not evaluated except for potential groundwater use.

7.0 SUMMARY OF SITE RISKS

7.1 HUMAN-HEALTH RISK ASSESSMENT

A human-health risk assessment was conducted to evaluate potential health risks to individuals under current or foreseeable future site conditions at the ARDC. The risk assessment is consistent with relevant guidance and standards developed by the USEPA, reflects comments and guidance received from the USEPA Region II and the NJDEP, and incorporates data from the scientific literature used in conjunction with professional judgment. The NJDEP, in general, follows the USEPA guidance for risk assessment and does not have additional guidance for risk assessment methodology. The following activities were conducted as part of the human-health risk assessment:

7.1.1 Selection of Chemicals of Potential Concern

The first step in the risk assessment was to summarize and analyze site data to identify site-related chemicals or Chemicals of Potential Concern (CPCs), defined as those chemicals that are present as a result of past activities at the ARDC. CPCs were chosen based on exceed of the site-specific screening criteria, presented in Section 8.0. The CPCs evaluated in detail for the ARDC site are presented in Table 7-1.

The following steps, which are in accordance with USEPA (1989) guidance, were used to summarize the analytical data for this risk assessment:

1. Data were summarized by contaminant location (e.g., surface soil)
2. Frequency of detection was calculated
3. The maximum detected concentration for each chemical was reported
4. Duplicate samples were averaged
5. The arithmetic mean was calculated for each chemical

7.1.2 Exposure Assessment

An exposure assessment was conducted to identify potential pathways by which human populations may be exposed to the chemicals of potential concern at the ARDC. A quantitative/qualitative evaluation of potential exposures was based on the concentrations of the CPCs. The exposure pathways evaluated include the following:

- Surface soil: current site visitor or security patrol, future use by commercial/ industrial worker
- Sediment: current and future use by trespassing child
- Surface water: current and future use by trespassing child
- Subsurface soil: future use by construction worker
- Groundwater: future use by resident

Table 7-1 presents the exposure point concentrations for the CPCs.

7.1.3 Toxicity Assessment

The objective of the toxicity (dose-response) assessment was to define the relationship between the dose (amount) of a substance and the likelihood that an adverse health effect (response) would result from exposure to that substance. Dose-response values were identified and used to estimate the likelihood of adverse effects as a function of human exposure to a chemical. Dose-response data is summarized in Tables 7-2 through 7-6.

7.1.4 Risk Characterization

In this final step of the risk assessment process, the exposure and toxicity information was integrated to develop both quantitative and qualitative evaluations of risk.

Carcinogenic risk is the incremental probability that an individual will develop cancer over a lifetime as a result of exposure to a carcinogen. The excess lifetime cancer risk is calculated as follows:

Risk = CDI x SF

where: risk = a unitless probability
CDI = chronic daily intake averaged over 70 years (mg/kg-day)
SF = slope factor $(mg/kg\text{-}day)^{-1}$

These risks are probabilities expressed in scientific notation (e.g. 1×10^{-6}). An excess lifetime risk of 1×10^{-6} would indicate that an individual has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. "Excess lifetime risk" indicates that it is additional risk other than that attributable to non-site related exposure (e.g., smoking or exposure to sunlight).

Noncarcinogenic risk is calculated by comparing the exposure level over a specified time (e.g., lifetime) to the reference dose (RfD) derived for a similar exposure. The RfD represents the level that an individual can be exposed to without experiencing deleterious health effects. The ratio of the exposure level to the RfD is called a hazard quotient (HQ).

The HQ is calculated as follows:

Non-cancer risk HQ = CDI/RfD

Where: CDI = chronic daily intake (mg/kg-day)
RfD = reference dose (mg/kg-day)

The sum of HQs for a given exposure pathway generates a hazard index (HI). A HI of greater than one indicates that site-related exposures may present a risk to human health.

The human-health risk assessment for the ARDC concluded that the COCs are TCE and PCE. Unacceptable health risks identified with the current and expected future exposures at the ARDC are limited to construction-worker exposure to PCE in the surface soil and future residential exposure to TCE and PCE in the groundwater. These risks exceeded the NJDEP acceptable excess lifetime cancer risk level of one in 1,000,000 ($1x10^{-6}$). Risks associated with exposure to subsurface soil, surface waters, and sediment, are within the USEPA cancer risk range of one in 10,000 ($1x10^{-4}$) to ($1x10^{-6}$). No noncancer risks (HI greater than one) to human health exist from exposure to site contaminants at the ARDC. Table 7-7 presents the receptor-specific risk characterization for the ARDC site.

7.1.5 Evaluation of Human Health Risk Assessment Uncertainties

In general, sources of uncertainty are categorized into site-specific factors (e.g., variability in analytical data, modeling results, and exposure-parameter assumptions) and toxicity factors. Toxicity information for many chemicals is very limited, leading to varying degrees of uncertainty associated with calculated toxicity values. Sources of uncertainty for calculating toxicity factors include extrapolation from short- to long-term exposures, amount of data (e.g., number of studies) supporting the toxicity factors, consistency of different studies for the same chemical, and responses of various species to equivalent doses. Uncertainties associated with the human-health risk assessment are presented in Table 7-8.

7.2 ECOLOGICAL RISK ASSESSMENT

The ecological risk assessment evaluated risks to aquatic life in the drainage ditch southeast of the site and in the forested wetlands northeast of the ARDC, because these areas provide the most significant ecological habitat associated with the site. Risks to terrestrial plants, soil invertebrates, and wildlife were also evaluated. Tables 7-9 through 7-12 represent the evaluated exposure pathways and CPCs.

Risks to aquatic life, terrestrial plants, and soil invertebrates were evaluated by comparing detected concentrations in surface water, sediment, and surface soil with screening values available in applicable guidance documents. Although some chemical concentrations in surface water or sediment slightly exceeded screening values, the low magnitude of any exceedances, and the overall consistency of these concentrations with Fort Dix background concentrations, suggests that aquatic organisms are not likely at risk from exposure to chemicals detected in surface water or sediment. Based on this comparison it was concluded that there is no significant risk to any of these receptor groups from exposure to chemicals detected in surface water, sediment, or surface soil.

The ecological risk assessment also evaluated risks to semi-aquatic and terrestrial wildlife (i.e., birds and mammals) from exposure to surface water, sediment, and surface soil. Risks to wildlife were evaluated by means of food-chain models that estimate exposures from surface water ingestion, incidental sediment ingestion, and ingestion of prey items that have accumulated contaminants in their tissue. Representative wildlife receptors evaluated included muskrat, white-footed mouse, mallard, American robin, raccoon, and barred owl. Based on the results of the food-chain model, it was concluded that there is no significant risk to semi-aquatic or terrestrial wildlife from exposure to contaminants in surface water, sediment, or surface soil.

The ecological risk assessment concluded that there is no significant risk to endangered species from exposure to chemicals at the ARDC.

The uncertainties associated with the ARDC Ecological Risk Assessment are outlined in Table 7-13.

7.3 RESPONSE TO THE SITE RISKS

The Selected Remedy in this DD is necessary to protect the public health or welfare from risks as a result of contaminants at the ARDC.

8.0 REMEDIATION OBJECTIVES

Response and remedial action objectives form the basis for identifying remedial technologies and developing remedial alternatives. This section identifies remedial response and remedial action objectives, and the remediation goals used in their development.

8.1 DEVELOPMENT OF REMEDIATION GOALS

Site-specific goals are developed based on chemical-specific ARARs. Chemical-specific ARARs are based on federal, state, and local environmental and health regulations regarding site contaminants, particularly the COCs identified in the risk assessment. The site-specific remediation goals (RGs) were developed for each media at the ARDC as described in the following subsections.

8.1.1 Groundwater Remediation Goals

In New Jersey, groundwater clean-up standards are established to protect groundwater classifications set forth under the New Jersey Ground Water Quality Standards (NJDEP, 1993a). The NJDEP established natural groundwater quality as the clean-up standard for contaminants in Class IA and I-Pinelands (Preservation Area) groundwater, which includes groundwater at Fort Dix. Under these requirements, the numerical criterion for an organic contaminant discovered at a contaminated site that is not the result of natural processes is zero. Because zero cannot be accurately measured using existing analytical instruments, the higher of New Jersey Groundwater Quality Standards, background, or laboratory practical quantitation levels (PQLs) for groundwater will be used to establish whether organic contaminant concentrations observed in groundwater exceed ARARs. If this value is higher than the USEPA Maximum Contaminant Level (MCL), then the MCL becomes the applicable standard, as long as the background value is higher than the MCL.

Because Fort Dix is within the New Jersey Pinelands Protection Area, if any remediation goal, for organic contaminants of concern, is higher that the present PQL, then the PQL becomes the remediation goal for that contaminant of concern.

For inorganics, "natural background" concentrations were established for groundwater by means of analytical results obtained from background groundwater monitoring wells on Fort Dix. Background groundwater analytical results are presented in the Background Constituent Concentration Statistical Report (BCCSR) (ABB-ES, 1996). The BCCSR also presents 95 percent upper confidence limits (UCLs) for the mean of background analyte concentrations. Groundwater analytical results greater than the 95 percent UCL for that constituent are considered "above background."

8.1.2 Surface Water Remediation Goals

New Jersey's standard for surface-water bodies in the Pinelands area is the natural surface-water quality. As with groundwater, natural background concentrations for organic constituents in surface water are considered to be zero. Because zero can only be measured with a certain degree of certainty, the higher of New Jersey Surface Water Quality Standards (New Jersey Annotated Code ([NJAC]7:9B), background, or PQLs for groundwater (NJAC7:9-6) are used in determining whether contaminant concentrations in surface water meet ARARs. If this value is higher than the USEPA Ambient Water Quality Criteria (AWQC), then the AWQC become the applicable standard, as long as the background value is higher than the AWQC.

Natural background concentrations for inorganics were established for surface water, as presented in the BCCSR (ABB-ES, 1996). The BCCSR presents 95 percent UCLs for the mean of background analyte concentrations. The BCCSR also presents 95 percent UCLs for the mean of some organic background analyte concentrations. These values are used in this report to distinguish site-related contamination from naturally occurring concentrations in surface water. Surface-water analytical results greater than the 95 percent UCL for that constituent mean are considered "above background."

The USEPA has stated that comparisons with surface-water criteria should be based on filtered sample analysis results to better assess bioavailability on subsequent effects.

8.1.3 Sediment Remediation Goals

Federal guidance for sediment quality criteria was published in the form of documents from USEPA's Office of Science and Technology, Health and Ecological Criteria Division (USEPA, 1993a,b,c,d,e). Each document addresses and establishes sediment quality criteria for the protection of benthic organisms for a few CPCs (e.g., phenanthrene, dieldrin, endrin, acenaphthene, and fluoranthene).

Within the NJDEP's hazardous-waste program, a tiered process is used in which contaminant levels in sediment are initially compared against established screening-level criteria. When levels of contaminants exceed screening criteria, subsequent evaluation is required to further characterize the magnitude of the threat posed by the particular sediment to ecological resources and, where appropriate, to human health (i.e., through shellfish/fish consumption). An exception to this policy can be made if there is a consensus that further work is not necessary. However, adequate justification must be presented to support the recommendation for no further action. It is the Army's intent to follow this tiered approach, by evaluating the chemical data collected from analysis of sediment samples first. If contaminant concentrations are found to exceed screening-level criteria, further investigation (i.e., bioassays and/or community-level bioassessment) may be performed unless adequate justification is available to support the recommendation for no further action.

The NJDEP Guidance for Sediment Quality Evaluations (NJDEP, 1998) presents two established screening level values for the purpose of identifying sediment contaminants of concern. Screening level values for inorganics, semi-volatile organic compounds (SVOCs), and pesticides and polychlorinated biphenyls (PCBs) are the Ontario Lowest Effects Levels (LEL) (Persaud et al., 1993). Screening level criteria for volatile organic compounds (VOCs) are obtained from Environment Canada's *The Development of Canadian Marine Environmental Quality Guidelines* (MacDonald et al., 1992).

For inorganic constituents, natural background concentrations were established for sediment, as presented in the BCCSR (ABB-ES, 1996). The BCCSR presents 95 percent UCLs for the mean of background analyte concentrations. Sediment analytical results greater than the 95 percent UCL for that constituent mean are considered "background."

8.1.4 Soil Remediation Goals

In New Jersey, soil clean-up criteria (SCC) are established to protect human health and the environment from exposure to chemically contaminated soil (NJDEP, 1999). These numbers represent maximum concentrations that NJDEP believes can be present in soil without adverse effects from long-term exposure. For screening purposes, soil data are compared to the higher to the higher of the lowest SCC value, background, and PQL.

Background concentrations for inorganic constituents were established for soil, as presented in the BCCSR (ABB-ES, 1996). The BCCSR presents 95 percent UCLs for the mean of background analyte concentrations. Soil analytical results greater than the 95 percent UCL for that constituent mean are considered " background."

Impact to groundwater SCC for inorganics was developed using the background level established in the BCCSR. If a background concentration for a specific analyte was not presented in the BCCSR, the analyte PQL was used.

Background concentrations presented in the BCCSR are used to evaluate ARDC analytical soil results (ABB-ES, 1996).

8.2 IDENTIFICATION OF REMEDIAL RESPONSE OBJECTIVES

Remedial response objectives are site-specific, qualitative clean-up objectives based on the nature and distribution of contamination, the resources currently or potentially threatened, and the potential for human and environmental exposure. Remedial response objectives for each medium of at the ARDC were formed based on environmental concerns defined in the human-health and ecological risk assessments and on remediation goals. Response objectives are used to define remedial action objectives and develop appropriate remedial alternatives. The identification of, and basis for, remedial response objectives for each medium are discussed in the following subsections.

8.2.1 Surface Soil Remedial Response Objectives

The human-health risk assessment completed for the ARDC indicated risks associated with the ingestion and inhalation of PCE in surface soil exceed the NJDEP acceptable risk level of $1x10^{-6}$. No other cancer or noncancer risks exceeded USEPA or NJDEP threshold values and the ecological risk assessment did not identify risks to potential receptors from surface soil contamination.

A comparison of surface soil analytical results to the NJDEP site-specific Impact to Groundwater Soil Cleanup Criteria identified exceedances of the criteria for the inorganic compounds copper, manganese, and sodium. Site-specific criteria for inorganic compounds are intended to be developed using the results of Synthetic Precipitate Leaching Procedure (SPLP) sample analysis; however, this analysis was not completed for ARDC Test Facility surface soil. For the ARDC, and as directed by the NJDEP, site-specific criteria were developed using the higher of the background value or the PQL. Use of background values for inorganic leaching to groundwater is likely overly conservative. Inorganic compounds have a tendency to sorb to soil particles and generally leach to groundwater only at very high concentrations. The concentrations identified in surface soil are not estimated to negatively impact groundwater, and are within the New Jersey Regional Background Range (ABB-ES, 1996). Analytical results from groundwater sampling do not indicate current inorganic contamination.

Based on these considerations, the following response objective was identified for ARDC surface soil:

- Protect potential commercial/industrial workers and potential ecological receptors from unacceptable risk resulting from exposure to PCE in surface soil (i.e., soil zero to 2 feet bgs).
- Ensure potential contaminant leaching from surface soil does not negatively impact other media.

8.2.2 Subsurface Soil Remedial Response Objectives

During the risk assessment process, subsurface soil sampling results were compared to the soil screening criteria to identify CPCs. The comparison identified exceedances of screening criteria for the inorganic compounds cadmium, chromium, copper, iron, nickel, selenium, thallium, vanadium, and zinc. The human-health risk assessment considered these compounds, but did not identify unacceptable current or future risks to potential human receptors from contaminants present in subsurface soil. The ecological risk assessment did not consider subsurface soil because ecological receptors generally are not exposed directly to this medium.

A comparison of subsurface soil analytical results to the NJDEP site-specific Impact to Groundwater Soil Cleanup Criteria identified exceedances of the criteria for the inorganic compounds cadmium, chromium, copper, iron, nickel, selenium, sodium, thallium, vanadium, and zinc. Site-specific criteria for inorganic compounds are intended to be developed using the results of SPLP sample analysis; however, this analysis was not completed for ARDC Test Facility subsurface soil samples. For the ARDC, and as directed by the NJDEP, site-specific criteria were developed using the higher of the background value or the PQL. Use of background values for inorganic leaching to groundwater is likely overly conservative. Inorganic compounds have a tendency to sorb to soil particles and generally leach to groundwater only at very high concentrations; therefore, the concentrations identified in subsurface soil are not estimated to negatively impact groundwater. Analytical results from groundwater sampling do not indicate current inorganic contamination.

To provide an estimate of the potential for leaching of inorganic contamination, the maximum concentrations were compared to 20 times the Toxicity Characteristic Leaching Procedure Regulatory Level. This comparison is often used to estimate the potential for waste to leach following disposal. Regulatory Levels are established by the USEPA for cadmium, chromium, and selenium. The maximum concentrations of these compounds were less than half the 20 times calculation. In addition, maximum concentrations of copper, nickel, vanadium, and zinc are within the New Jersey Background Range.

Based on these considerations, a response objective has not been identified for ARDC subsurface soil.

8.2.3 Groundwater Remedial Response Objectives

Although ARDC groundwater is currently not used for human consumption, the RI risk assessment conservatively evaluated groundwater for future domestic use. The human-health risk assessment indicated that the dermal and ingestion cancer risks for TCE, and PCE exceed the NJDEP cancer risk limit of $1x10^{-6}$ for individual contaminants. Noncancer risks did not exceed threshold values and the ecological risk assessment did not consider receptor exposure to groundwater. Ecological receptors are not exposed to groundwater directly because there is no point of contact (i.e., groundwater is diluted upon discharge to surface-water). Surface-water samples collected in the vicinity of groundwater discharge are used directly to evaluate exposures to ecological receptors. Therefore, groundwater was not further evaluated in the ecological risk assessment.

Groundwater in the vicinity of the ARDC currently is not used for any purpose and discharges to the drainage ditch approximately 50 feet south of the site. The existing water supply well, FTDIX-13, was abandoned in 1998. The nearest active supply well is located near Brindle Lake approximately ¾-mile from the ARDC Test Facility. The proposed future use of the ARDC includes continued use for U.S. Army training exercises, and continued controlled access to the site. Because concentrations of contaminants of concern presently exceed their corresponding application standards in groundwater, a Classification Exception Area (CEA) designation is necessary. The Army is currently in the process of designating the ARDC as a CEA.

Based on the results of the Final RI (HLA, 2000), the estimated extent of groundwater contamination is an area less than 40 feet by 40 feet. At the downgradient extent of the plume, groundwater discharges to the drainage ditch location south of the site. Samples collected near the expression of groundwater into the drainage ditch did not contain contaminant concentrations posing an unacceptable risk to human or ecological receptors. Continued groundwater discharge coupled with removal of the contaminant source area (i.e., surface soil remediation) should effectively contain and ultimately reduce the contamination extent.

Due to the dermal and ingestion cancer risks for TCE and PCE, the following response objective was identified for ARDC groundwater:

- Protect potential human receptors of groundwater used for domestic purposes and potential ecological receptors from unacceptable risks due to TCE and PCE contamination in groundwater.

8.2.4 Surface Water Remedial Response Objectives

No individual CPC cancer risks exceed the NJDEP acceptable cancer risk level of $1x10^{-6}$. Noncancer risk for exposure to surface water is 0.01, which is below the NJDEP and the USEPA target value of 1. Because the potential for future contamination of surface water from groundwater discharge exists at the ARDC site, the following response objective for surface water was identified:

- Protect potential human and ecological receptors from unacceptable risks that may result from PCE contamination in surface water at the ARDC.

8.2.5 Sediment Remedial Response Objectives

No individual CPC cancer risks exceed the NJDEP acceptable cancer risk level of $1x10^{-6}$. Noncancer risk for exposure to sediment is 0.3, which is below the NJDEP and the USEPA target value of 1. However, groundwater discharge to surface water and ditch sediments, represents the major pathway for PCE and TCE contamination transport. The potential for an increase in PCE and TCE concentrations in sediment exists, and therefore the following response objective was identified:

- Protect potential human and ecological receptors from unacceptable risks that may result from PCE and TCE contamination in sediment at the ARDC.

8.3 REMEDIAL ACTION OBJECTIVES

Remedial action objectives are medium- or site-specific goals developed for protection of human-health and the environment. Remedial action objectives for the ARDC specify contaminants of concern, exposure routes and receptors, and remediation goals. Current and potential future land and resource use, the human-health risk assessment, and the conceptual model for the site were all considered when establishing remedial action objectives.

To achieve the remedial response objectives, remedial action objectives for the ARDC site are as follows:

- Protect potential commercial/industrial workers from exposure to ARDC surface soil with concentrations of PCE exceeding 0.00081 mg/kg or the PQL, which ever is lower.

- Protect potential human receptors from groundwater used for domestic purposes with PCE concentrations greater than 1.0 µg/L or the PQL, which ever is lower, and TCE concentrations greater than 1.0 µg/L, or the PQL, which ever is lower.

- Protect potential human receptors from exposure to surface water with PCE concentrations greater than 0.8 µg/L or the PQL, which ever is lower, and TCE concentrations greater than 1.0 µg/L, or the PQL, which ever is lower.

- Protect potential human receptors from exposure to sediment with PCE concentrations greater than 0.00081 mg/kg or the PQL, which ever is lower, and TCE concentrations greater than 0.0028 mg/kg or the PQL, which ever is lower.

Remedial action objectives provide the framework for developing remedial alternatives and are formulated to achieve the overall USEPA and NJDEP goal of protecting human health and the environment.

9.0 DESCRIPTION OF ALTERNATIVES

In order to meet the established remedial action objectives, the Feasibility Study developed remedial alternatives for the ARDC site. Categories of remedial technologies and specific process options were identified based on a review of literature, vendor information, performance data, and lead agency experience in developing other Feasibility Studies under CERCLA. Process options that were considered as potentially capable of attaining the remediation goals were selected for screening.

Six remedial alternatives were developed for the ARDC site to be screened with respect to the criteria of effectiveness, implementability, and cost to meet the requirements of CERCLA and the NCP. Four alternatives (Alternative 1, 2, 5, and 6) were retained after this screening, and reviewed in greater detail. The four developed alternatives for the ARDC Feasibility Study are:

- No Action
- Limited Action
- Excavation/On-site Soil Vapor Extraction
- Excavation/Off-site Treatment and/or Disposal

Environmental sampling, including surface soil, groundwater, surface water, and sediment sampling, institutional controls, and five-year site reviews would be included under all alternatives except No Action. Sampling would be conducted on a quarterly basis to monitor contaminant concentrations and system effectiveness. At the completion of each year of monitoring data would be compiled and a statistical analysis would be conducted to determine contaminant concentration trends. Monitoring of the media (groundwater, surface water, and sediment) would continue until; 1) concentrations of COCs are at or below the applicable standards and 2) eight consecutive rounds of quarterly sampling and analysis demonstrate that COCs remain at or below applicable standards (no rebound effect). Should the contaminant levels not decrease and remain below the RGs, the need for an active groundwater treatment would be reassessed.

9.1 REMEDIAL ALTERNATIVE COMPONENTS

The following alternative descriptions outline implementation details, construction/design time to implement, and the estimated time necessary for implemented alternative to reach RGs. Costs include the capital, annual and periodic costs, and represent a net present worth based on seven percent discount rate.

Alternative 1: No Action

Alternative 1, the No Action Alternative, was retained as a baseline against which to compare other alternatives, as required by the NCP. Remedial actions, monitoring, further investigations, and site reviews would not be conducted as part of this alternative. As such, no costs are associated with this alternative. No substantial decrease in site contaminants is anticipated under this alternative.

Alternative 2: Limited Action

- Institutional controls actions such as implementation of a deed restriction and installation of additional fencing and warning signs
- Performing environmental sampling
- Five-year site reviews.

Time to Implement: 1 month
Time to Reach Remediation Goals: ~10 years
Net Present Worth: $166,368 (capital costs: $31,790)

Alternative 5: Excavation/On-site Soil Vapor Extraction

- Institutional controls actions such as implementation of a deed restriction
- Base-line sampling of groundwater, surface water, and sediment prior to excavation of the contaminated surface soil
- Excavation of surface soil exceeding the remediation goal
- Treating the soil in an on-site soil vapor extraction
- Confirmation sampling to determine if contaminated surface soil had been successfully removed.
- Excavated areas would be back-filled with clean fill, finished to the original grade, and vegetated, as necessary.
- Would require air emissions permitting
- Vapor collection and treatment system to be dismantled and transported off-site for decontamination, as specified in 40 CFR 264.
- Treated soil would be sampled prior to potential use as fill material.
- Five-year site review.

Time to Implement: 2-3 years
Time to Reach Remediation Goals: <5 years
Net Present Worth: $326,740 (capital costs: $181,080)

Alternative 6: Excavation/Off-site Treatment and/or Disposal

- Institutional controls actions such as implementation of a deed restriction
- Base-line sampling of groundwater, surface water, and sediment prior to excavation of the contaminated surface soil
- Excavation of surface soil exceeding the remediation goal
- Confirmation sampling to determine if contaminated surface soil had been successfully removed.
- Characterization sampling prior to soil excavation to determine if the excavated soil would be considered hazardous or non-hazardous waste for disposal.
- Transportation of excavated soil to off-site Treatment, Storage, and Disposal (TSD) Facility
- Off-site treatment by thermal desorption or incineration if needed.

- Excavated areas would be back-filled with clean fill, finished to the original grade, and vegetated, as necessary.
- Five-year site review.

Time to Implement: 2 weeks
Time to Reach Remediation Goals: <5 years
Net Present Worth: $224,581 (capital costs: $148,561)

9.2 EXPECTED OUTCOME OF REMEDIAL ACTION

Future use of the ARDC is expected to remain the same. Institutional controls will remain in place until RGs are achieved and five-year reviews are no longer required. A site closure report would be developed outlining restrictions, if any, for the ARDC. It is anticipated that unrestricted use of the ARDC site would be achieved within the time frames presented above.

10.0 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

The comparative analysis compares the alternatives with respect to the evaluation criteria for remedial alternatives. The purpose is to identify the advantages and disadvantages of each alternative, thereby aiding in the eventual selection of a preferred remedial alternative. An alternative must meet the first two of the evaluation criteria in order to be eligible for recommendation.

The nine evaluation criteria present a comparison of each alternative:

Overall Protection of Human Health and the Environment. Overall Protection of Human Health and the Environment addresses an alternatives ability to provide adequate protection and describes haw risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

Alternative-1: No Action does not provide protection for human health because contamination above the remediation goals would remain on site. The remaining alternatives do provide protection; and Alternatives-5 and Alternative-6 are more protective than Alternative-2. Alternative-2 would prevent human contact with contaminated soil through the use of fencing and access restrictions, but would not limit leaching of contaminants from surface soil. Alternatives-5 and Alternative-6 would remove contamination above the remediation goals from the site by excavating contaminated soil. Removal of contaminated soil would prevent leaching to other media.

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs). Compliance with ARARs addresses whether or not a remedial action will meet all Federal and state environmental laws. Most ARARs are divided into three categories: chemical-, location-, and action-specific.

The No Action Alternative would not reduce contaminant concentrations to the remediation goals, and therefore would not meet chemical-specific ARARs. The Limited Action Alternative would not comply with pertinent location- and action-specific ARARs, since natural attenuation processes do not meet the requirement of an active treatment, and can not be proven capable of reducing contaminant concentrations to below the remediation goals.

The two alternatives that incorporate excavation, Alternative-5 and Alternative-6, would remove contamination from the site. Location-specific ARARs pertaining to the location of the ARDC in the Pinelands, and action-specific ARARs relating to dust emission and hazardous waste generation and storage, would be complied with during alternative implementation.

Long-term Effectiveness and Permanence. Long-term Effectiveness and Permanence refers to an alternatives ability to maintain reliable protection of human health and the environment over time, once remediation goals have been met.

Alternatives-1 would not provide long-term effectiveness and permanence because residual contamination above the remediation goals would remain on site. Alternative-2 can not be assured of reducing contaminant levels below remediation goals, and therefore would not provide long-term protection. Alternative-5 and Alternative-6 propose removal of contaminated soil above the remediation goals, and either on-site treatment or off-site treatment and/or disposal.

Removal of contaminated soil would reduce contaminant levels in groundwater, surface water and sediment resulting from leaching of contaminants from surface soil. As a result, the excavation alternatives both would provide long-term effectiveness and permanence.

Reduction of Toxicity, Mobility, or Volume Through Treatment. Reduction of Toxicity, Mobility, or Volume through Treatment addresses the anticipated performance of the treatment technology an alternative employs. It indicates if an alternative will reduce potential health hazards by reducing contaminant toxicity, mobility, or volume.

Alternative-1 and Alternative-2 do not propose treatment of the surface soil, would not reduce the toxicity, mobility, or volume of contamination through treatment, and therefore would not satisfy the CERCLA preference for treatment.

Alternative-5: Excavation/On-site Soil Vapor Extraction would permanently reduce the volume and leaching to other media and satisfy the CERCLA preference for treatment. Alternative-6: Excavation/Off-site Treatment and/or Disposal would effectively remove the source of contamination in all media at the site. A reduction in contaminant toxicity, mobility, and/or volume would be achieved if surface soil were treated prior to disposal..

Short-term Effectiveness. Short-term Effectiveness addresses the period of time needed to achieve remediation goals and the potential adverse impacts on human health and the environment that may be posed during the construction and implementation of the remedial action.

Alternative-1 would not be effective in the short-term at controlling risk from site surface soil, potential future domestic use of groundwater, or surface water and sediment in the adjacent drainage ditch. Alternative-2 would not prevent volatilization of contamination, or prevent leaching to groundwater, surface water and sediment. Alternatives-5 and Alternative-6 would be effective in the short-term; contaminated soil, and the associated risk and potential for leaching to other media would be removed from the site within one week.

Potential risks to site workers during excavation activities would be managed with engineering controls and a site-specific Health and Safety Plan. The adjacent drainage ditch would likely require reconstruction following excavation activities proposed under Alternative-5 and Alternative-6; however, no significant environmental impacts are anticipated.

Implementability. Implementability pertains to the technical and administrative feasibility of an alternative, including the availability of materials and services needed to implement a particular action.

Alternative-1 would be the easiest to implement because no actions would be conducted. The remaining alternatives are all easily implemented; there are no technical or administrative difficulties associated with implementation. Excavation of surface soil and selected treatment technologies are well demonstrated.

Cost. Cost evaluates the estimated capital, operation, and maintenance costs of each remedial alternative in comparison to the other potential alternatives.

Alternative-1 does not have any associated capital or operation and maintenance costs. Alternative-2 (Limited Action) would be the least expensive of the remaining alternatives, followed by Alternative-6 and Alternative-5.

State/Support Agency Acceptance. State/Support Agency Acceptance indicates whether the state or federal regulatory agencies (the NJDEP and the USEPA) concur, oppose, or have no comment on the proposed alternatives.

The NJDEP and the USEPA have reviewed and commented on the Feasibility Study and support the Preferred Alternative.

Community Acceptance. The NJDEP and the USEPA have reviewed and accepted the Administrative Record for the ARDC. The NJDEP and the USEPA have accepted the Proposed Plan for the ARDC.

Community acceptance of the ARDC Proposed Plan was evaluated and based upon comments received at the public hearing and during the public comment period. This is documented in the transcript of the public meeting in Appendix A and in the Responsiveness Summary in Appendix B of this DD.

11.0 SELECTED REMEDY

Alternative 6, excavation/off-site treatment and/or disposal is the Selected Remedy for the ARDC based on the decision of the Army, in consultation with the USEPA and the NJDEP, and as accepted by the public during the public comment period.

The Selected Remedy would achieve substantial risk reduction by removing the source of contamination in soil, providing appropriate monitoring program for the remaining media and is cost-effective. This alternative would satisfy the following statutory requirements of CERCLA § 121(b): (1) be protective of human health and the environment; (2) comply with Applicable or Relevant and Appropriate Requirements; (3) be cost-effective; (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and (5) satisfy the preference for treatment as a principal element.

To determine the effectiveness of this remedy, a monitoring program for groundwater, surface water, and sediment would be implemented within six months of signing the Decision Document. For the groundwater-monitoring program, an appropriate number of source area and sentinel wells would be installed if necessary. Should the contaminant levels not decrease and remain above the applicable standards, the need for an active groundwater remedy would be assessed. Because concentrations of contaminants of concern presently exceed their corresponding applicable standards in groundwater, the CEA would be established.

11.1 DESCRIPTION OF THE SELECTED REMEDY

Excavation

The Selected Remedy would consist of excavation of soil exceeding RGs followed by transportation to an off-site TSD facility for treatment and/or disposal. The FS cost estimate was based on excavation of an estimated 130 cubic yards of surface soil (zero to two feet below ground). Prior to initiation of remedial activities, a site Work Plan detailing the actions to be taken would be prepared. In addition, site preparation activities, including identification of underground utilities and mobilization of personnel and equipment would take place. Construction equipment, such as a small backhoe and dump trucks would be used to complete the excavation. A base-line sampling event would be conducted for groundwater, surface water and sediment prior to excavation of the surface soil. In addition, characterization sampling also would be conducted prior to soil excavation to determine if the excavated soil would be considered hazardous or non-hazardous waste for disposal. Confirmation sampling would be conducted as part of excavation activities to determine if contaminated surface soil above the RG had been successfully removed. Four confirmation samples would be collected from the base of the excavation, and up to 12 confirmation samples would be collected from the sides of the excavation. Samples would be sent to an off-site laboratory for VOC analysis. Hot spot areas identified during excavation activities would be excavated to the groundwater interface, located less than four feet below ground surface. Excavated areas would be back-filled with clean fill, finished to the original grade, and vegetated, as necessary.

Off-site treatment and/or disposal

Excavated soil would be loaded into dump trucks, covered, and transported off-site for treatment and/or disposal. For purposes of costing and evaluation, it is assumed off-site treatment would not occur prior to placement in an off-site landfill; excavated soil would be considered a non-hazardous waste. Under these assumptions, soil would be disposed directly into a Subtitle D (non-hazardous waste) landfill. If treatment was conducted, treatment processes could include thermal desorption or incineration. Both processes use heat; the thermal desorption process uses low-temperatures to volatilize VOC contamination, and the incineration process uses much higher temperatures to incinerate contamination.

Environmental Sampling and Long-term Monitoring

Environmental sampling would be conducted as part of this alternative. Following restoration of the excavation site, six months would be allowed for equilibration of the system. At the end of the six months, a quarterly sampling program for groundwater, surface water and sediment would begin. Five groundwater samples and three surface water and sediment samples would be collected and sent to an off-site laboratory for VOC analysis. For FS costing purposes, it was assumed that quarterly sampling would be conducted for five years. At the completion of each year of monitoring (four quarterly rounds), data would be compiled and a statistical analysis (i.e. linear regression) would be conducted to determine contaminant concentration trends. If contaminant concentration trends indicate an increasing trend, the need for an active groundwater treatment system would be reassessed. Monitoring of the media (groundwater, surface water and sediment) would continue until; 1) concentrations of COCs are at or below the applicable standards and 2) eight rounds of quarterly (consecutive) sampling and analysis demonstrate that COCs of concern remain at or below applicable standards (no rebound effect).

One five-year site review would be conducted to evaluate whether this alternative is protective of human health and the environment and whether additional remedial actions should be initiated. The five-year site review would include an evaluation of whether further reviews are warranted. A site closure report would be written if both the five-year site review and previous sampling data indicated no further actions would be required.

11.2 Estimated Costs Of Selected Remedy

The cost estimate for the Selected Remedy was based on an estimate of the time necessary for completion of the alternative. The time-frame estimate was based on professional judgment and experience with similar remediation projects. The estimate is not fixed, and will be adjusted based on actual performance of the alternative during implementation and operation. Costs are intended to be within the target accuracy range of minus 30 to plus 50 percent of actual cost (USEPA, 1988). Because there is uncertainty associated with the in-place material volumes that may be treated or removed and disposed of, the treatment time, and the future cost of vendor services, costs should be viewed as estimates only. Cost uncertainties are discussed in the individual cost subsections.

The cost estimate includes a present-worth analysis to evaluate expenditures that occur over different periods. Present worth represents the amount of money that, if invested now and disbursed as needed, would be sufficient to cover costs associated with the remedial action over its planned life (USEPA, 1988). A discount rate of seven percent before taxes and after inflation was used to prepare the cost estimates (USEPA, 1993a).

The cost estimate includes a contingency to account for unforeseen project complexities such as adverse weather, the need for additional site characterization, health and safety issues, and increased construction standby times at 20 percent of direct capital costs. Details and further assumptions are included in each cost description.

Tables 11-1 and 11-2 provide a summary and detailed cost sheet as calculated in the Feasibility Study. These costs include:

- Capital or fixed costs (e.g., excavation activities)
- Operation and maintenance costs (e.g., quarterly monitoring)
- Contingency for indirect and unforeseen costs (20%)
- Net Present Worth (discount rate of seven percent before taxes and after inflation)

12.0 STATUTORY DETERMINATIONS

Under CERCLA §121 and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements (unless statutory waiver is justified), are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the Selected Remedy meets these statutory requirements.

12.1 THE SELECTED REMEDY IS PROTECTIVE OF HUMAN HEALTH AND THE ENVIRONMENT

The Selected Remedy, Alternative 6, will protect human health and the environment through excavation and off-site treatment and/or disposal of contaminated surface soil. Approximately 130 cubic yards of soil containing PCE concentrations above the RG would be excavated, whereby removing the source area. Removal of the source area would result in a decrease in contaminant levels for all site media. The RGs for the ARDC would be achieved in a relatively short time, and would consequently reduce or maintain the cancer risks from exposure to 1×10^{-6} and the Hazard Index to less than 1.0.

12.2 THE SELECTED REMEDY IS IN COMPLIANCE WITH ARARS

The Selected Remedy of excavation and off-site treatment and/or disposal of contaminated surface soil would comply with all ARARs.

Chemical, Location, and Action-Specific ARARs pertaining to the ARDC site include:

- NJDEP Soil Cleanup Standards
- National Primary Drinking Water Standards
- New Jersey Surface Water Standards
- Pinelands Comprehensive Management Plan (NJAC 7:50)
- Air emissions (40 Code of Federal Regulations [CFR] 264)
- NJDEP Air Pollution Control Regulations (NJAC 7:27)
- Confirmation sampling NJAC 7:26E-6.4(a)(2)
- At the request of NJDEP, the requirements, standards, and regulations of the Occupational Safety and Health Act (OSHA) are included as ARARs in this document and would be complied with during remedial activities (29 CFR 1910)

12.3 THE SELECTED REMEDY PROVIDES COST EFFECTIVENESS

Based on the following definition, the Army believes that the Selected Remedy is the most cost-effective of the alternatives that provide overall protection and long-term effectiveness to human receptors and the environment: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness" (NCP §300.430(f)(1)(ii)(D)). Of the alternative evaluated in detail during the FS, only the Limited Action alternative had a net present worth less than the Selected Remedy. However, under that alternative contamination would have remained on-site, and the risk for future exposure, regardless of institutional controls, would have existed. The Selected Remedy provides short-term effectiveness through removal and treatment and/or disposal of the source area.

12.4 THE SELECTED REMEDY UTILIZES PERMANENT SOLUTIONS AND TREATMENT

Removal of soil containing PCE contamination above the RG would eliminate the potential for human exposure to contaminated media and the associated risks. Excavation and removal of the soil would provide long-term effectiveness because removal of contamination is an irreversible process and would remove the source of contamination in groundwater, surface water and sediment at the site

For FS costing purposes, the alternative assumes that the excavated soil would not require pretreatment prior to disposal. Direct landfilling of soil without treatment, would provide some reduction in mobility because capping of the landfill would reduce contaminant leaching; however, it would not satisfy the CERCLA statutory preference for treatment as a principal component of a remedial action. Removal of the surface soil eliminates the potential for leaching of contaminants to groundwater, surface water, and sediment at the site.

12.5 FIVE-YEAR REVIEW REQUIREMENTS

Because the Selected Remedy will initially result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

13.0 DOCUMENTATION OF SIGNIFICANT CHANGES FROM RECOMMENDED ALTERNATIVE OF THE PROPOSED PLAN

The Proposed Plan for the ARDC was released for public comment in October 2002. The Proposed Plan identified the preferred alternative of excavation and off-site treatment and/or disposal. The Army has reviewed all comments received during the public comment period. It was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

ABB-ES	ABB Environmental Services, Inc.
ARAR	Applicable or Relevant and Appropriate Requirement
ARDC	Armament Research and Development Center Test Facility
Army	U.S. Army
AWQC	Ambient water quality criteria
BCCSR	Background Constituent Concentration Statistical Report
bgs	below ground surface
CDI	Chronic daily intake
CEA	Classification Exemption Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	chemical of concern
CPC	chemical of potential concern
DD	Decision Document
Fort Dix	Fort Dix U.S. Army Installation
FS	feasibility study
ft/d	feet per day
Harding ESE	Harding ESE, Inc.
HI	hazard index
HLA	Harding Lawson Associates
HQ	Hazard quotient
ICF	ICF Kaiser Engineers, Inc.
LEL	Ontario Lowest Effects Levels
mg/kg	milligram/kilogram
MCL	Maximum Contaminant Level
µg/L	micrograms per liter
NCP	National Contingency Plan
NJAC	New Jersey Annotated Code
NJDEP	New Jersey Department of Environmental Protection
O&M	operation and maintenance
OSHA	Occupational Safety and Health Act
PCB	Polychlorinated biphenyl
PCE	tetrachloroethylene
PQL	practical quantitation limit

RfD	Reference dose
RG	remediation goal
RI	remedial investigation
SARA	Superfund Amendments and Reauthorization Act
SCC	soil clean-up criteria
SF	Slope factor
SPLP	Synthetic Precipitation Leaching Procedure
SVOC	semivolatile organic compound
TCE	trichloroethylene
TPH	total petroleum hydrocarbons
TSD	treatment, storage, and disposal
UCL	Upper confidence level
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

REFERENCES

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FIGURES

FIGURES

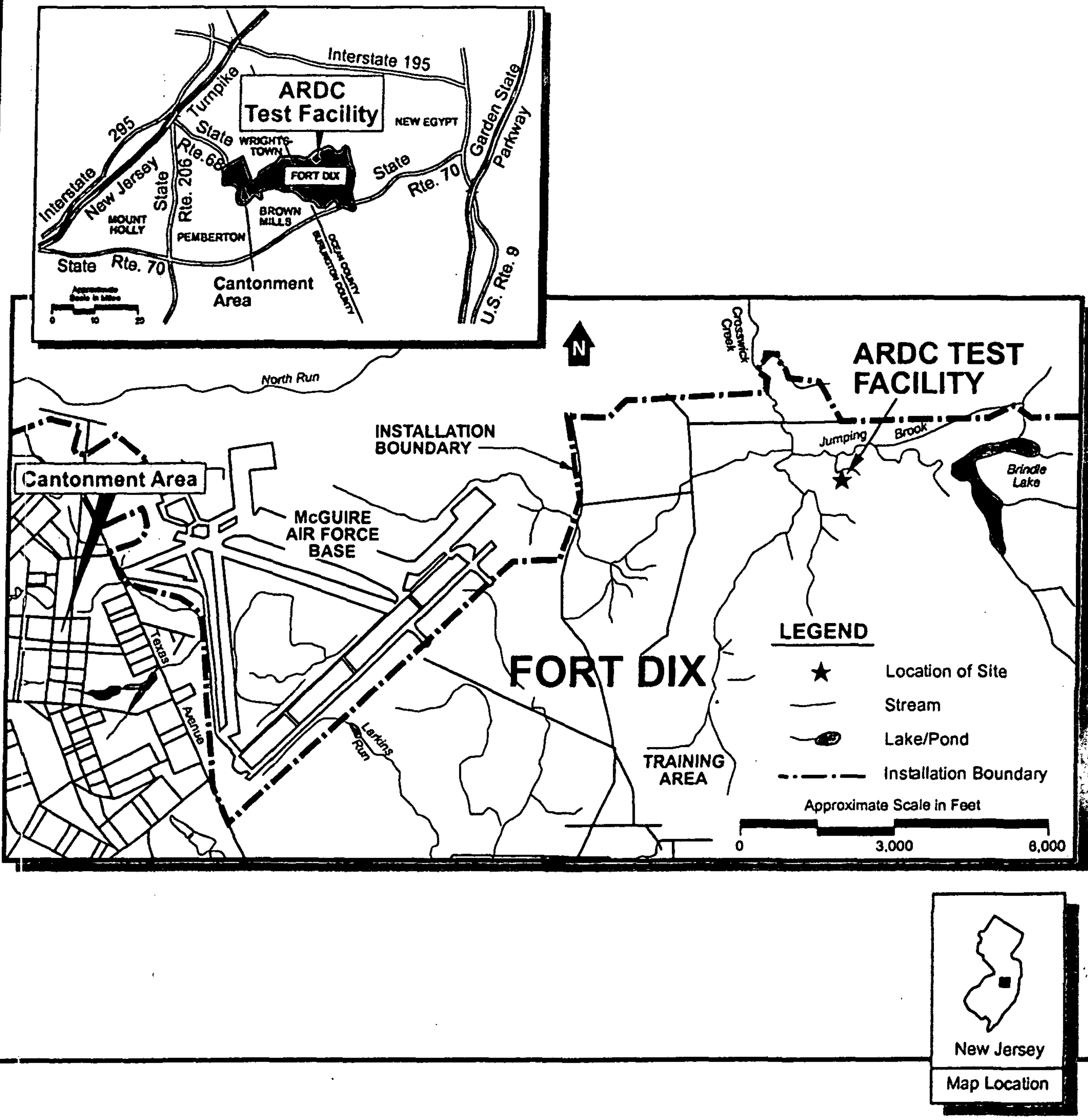

FIGURE 1-1
LOCATION OF ARDC SITE
ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

Harding ESE

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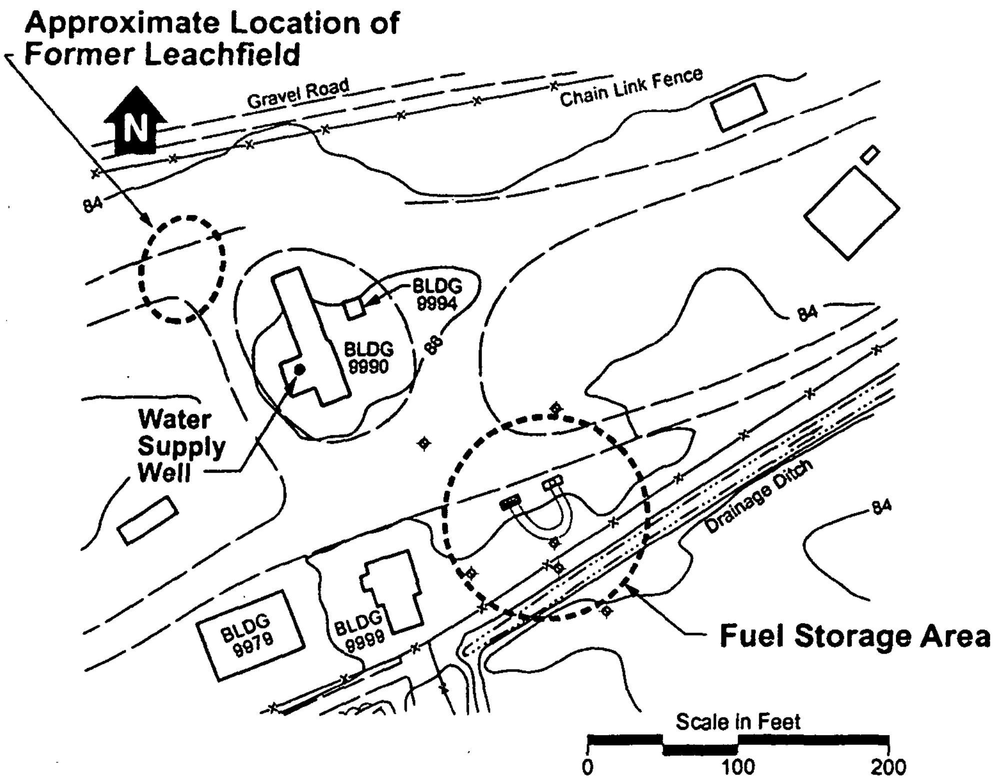


Legend

- —84— Ground Surface Elevation Contour (feet, MSL)
- Edge of Water
- Fence Line
- Edge of Gravel Road
- Stream Flow
- Monitoring Well

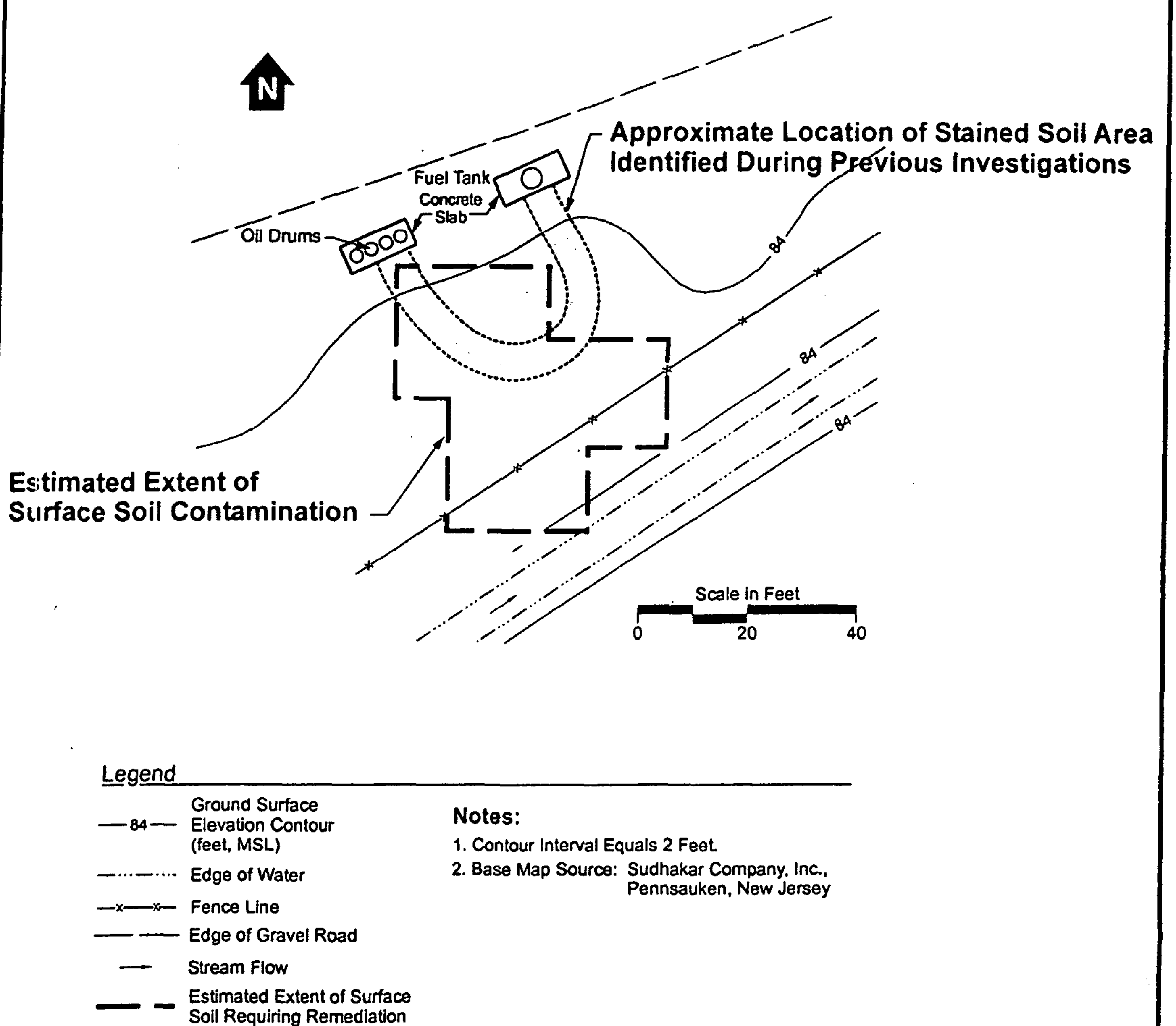
Notes:

1. *Contour Interval Equals 2 Feet.*
2. Base Map Source: Sudhakar Company, Inc., Pennsauken, New Jersey

FIGURE 1-2
ARDC INVESTIGATION LOCATIONS
ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

Harding ESE

W2002043a



Notes:

1. Contour Interval Equals 2 Feet.
2. Base Map Source: Sudhakar Company, Inc., Pennsauken, New Jersey

FIGURE 5-1
SURFACE SOIL CONTAMINATION AT THE ARDC
ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

Harding ESE

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TABLES

TABLE 7-1
SUMMARY OF CONTAMINANTS OF POTENTIAL CONCERN AND
EXPOSURE POINT CONCENTRATIONS

ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

EXPOSURE POINT	CONTAMINANT OF POTENTIAL CONCERN	FREQUENCY OF DETECTION	95 % UCL OF ARITHMETIC MEAN (µg/g)	MAXIMUM CONCENTRATION (µg/g)	EXPOSURE POINT CONCENTRATION (µg/g)
Surface Soil	Tetrachloroethene	5/13	105,000,000	220	220
	Trichloroethylene	1/13	1.92	0.92	0.92
	Phenanthrene	1/10	0.0247	0.082	0.0247
	Copper	36779	15.3	30.2	15.3
	Manganese	8/10	55.1	97.8	55.1
	Sodium	10/10	344	393	344
	Total Petroleum Hydrocarbons	23/31	218,000	48,400	48,400
Subsurface Soil	Tetrachloroethene	11/32	685	220	220
	Trichloroethene	3/32	0.15	0.92	0.15
	2-methylnaphthalene	1/25	0.0424	0.2	0.0424
	Phenanthrene	1/25	0.0255	0.082	0.0255
	Manganese	14/16	26.3	97.8	26.3
	Copper	10/16	8.0	30.2	8
	Selenium	2/16	0.2	0.603	0.223
	Sodium	16/16	354	405	354
	Total Petroleum Hydrocarbons	36/49	46,200	48,400	46,200
Groundwater	Dichloromethane	4/6	NA	9.2	9.2
	Tetrachloroethylene	1/6	NA	19	19
	Trichloroethylene	1/6	NA	8.9	8.9
	Bis(2-ethylhexyl)phthalate	1/4	NA	11	11
	Aluminum	4/4	NA	796	796
	Calcium	4/4	NA	4480	4480
	Magnesium	1/4	NA	1740	1740
Surface Water	Dichloromethane	3/4	NA	6.3	6.3
	Tetrachloroethylene	3/4	NA	11	11
	Trichloroethylene	3/4	NA	1.5	1.5
	Copper	3/4	NA	14.3	14.3
	Iron	4/4	NA	1710	1710
	Lead	4/4	NA	6.29	6.29
Sediment	Bis(2-ethylhexyl)phthalate	1/4	NA	4.6	4.6
	4,4'-DDD	2/4	NA	0.064	0.064
	4,4'-DDE	2/4	NA	0.0484	0.0484
	4,4'-DDT	2/4	NA	0.297	0.297
	Calcium	2/4	NA	419	419
	Iron	4/4	NA	12,700	12,700
	Magnesium	2/4	NA	228	228
	Manganese	2/4	NA	12.7	12.7
	Vanadium	1/4	NA	8.76	8.76

TABLE 7-2
ORAL DOSE-RESPONSE DATA FOR CARCINOGENIC EFFECTS

ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

Compound	Weight of Evidence	Oral Slope Factor $(mg/kg/day)^{-1}$	Test Species	Study Type	Tumor Type	Source
Aluminum	ND					
Calcium	ND					
Copper	D					
Iron	ND					
Lead	B2	ND				
Magnesium	ND					
Manganese	ND					
Sodium	ND					
Vanadium	ND					
4,4'-DDD	B2	2.4E-01	Mouse	Oral-diet	Liver	IRIS
4,4'-DDE	B2	3.4E-01	Mouse/hamster	Oral-diet	Liver	IRIS
4,4'-DDT	B2	3.4E-01	Mouse/rat	Oral-diet	Liver	IRIS
2-Methylnaphthalene	ND					
Bis(2-ethylhexyl)phthalate	B2	1.4E-02	Mouse	Oral-diet	Liver	IRIS
Phenanthrene	D					
Dichloromethane	B2	7.5E-03	Mouse	Oral-dw	Liver	IRIS
Tetrachloroethene	B2	5.2E-02 W	Mouse	Oral-gavage	Liver	NCEA, 1994
Trichloroethene	B2	1.1E-02 W	Mouse	Oral-gavage	Liver	NCEA, 1992
Total Petroleum Hydrocarbons	D					

ND - Not Determined
W - Withdrawn from IRIS
DW - Drinking water
mg - milligram
kg - kilogram
IRIS - Integrated Risk Information System
NCEA - National Center for Environmental Assessment

Weight of Evidence (Route-Specific):
A - Human carcinogen
B - Probable human carcinogen (B1 - limited evidence of cancer in humans;
B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)
C - Possible human carcinogen
D - Not classifiable as to human carcinogenicity
E - Evidence of lack of carcinogenicity to humans

Sources:
IRIS as of 7/99
NCEA, 1992, 1994

TABLE 7-3
ORAL DOSE-RESPONSE DATA
FOR NONCARCINOGENIC EFFECTS

ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

Compound	CHRONIC ORAL RfD (mg/kg-day)	SUBCHRONIC ORAL RfD[1] (mg/kg-day)	STUDY TYPE	CONFIDENCE LEVEL	CRITICAL EFFECT	TEST ANIMAL	UNCERTAINTY FACTOR	SOURCE
Aluminum	ND	ND						
Calcium	ND	ND						
Copper	4.0E-02 *	ND						HEAST
Iron	3.0E-01 **	ND						
Lead	ND	ND						
Magnesium	ND	ND						
Manganese (food)	1.4E-01	1.4E-01	Oral-diet	Medium	No effects observed	Human	1, 1 M	IRIS
Manganese (drinking water)	4.7E-02 !	ND						
Manganese (soil)	4.7E-02 !	ND						
Sodium	ND	ND						
Vanadium	7.0E-03	7.0E-03	Oral-DW	Low	No effects observed	Rat	100 H, A	HEAST
4,4'-DDD	5.0E-04 !!	5.0E-04						IRIS
4,4'-DDE	5.0E-04 !!	5.0E-04						IRIS
4,4'-DDT	5.0E-04	5.0E-04	Oral-diet	Medium	Liver lesions	Rat	100 H, A	IRIS
2-Methylnaphthalene	2.0E-02	ND						
Bis(2-ethylhexyl)phthalate	2.0E-02	2.0E-02 W	Oral-diet	Medium	Increased liver weight	Guinea pig	1,000 H,A,S	IRIS
Phenanthrene	ND	ND						
Dichloromethane	6.0E-02	6.0E-02	Oral-DW	Medium	Liver toxicity	Rat	100 H,A	IRIS
Tetrachloroethene	1.0E-02	1.0E-01	Oral-gavage	Medium	Hepatotoxicity	Mouse	1,000 H,A,S	IRIS
Trichloroethene	6.0E-03	ND						NCEA, 1995
Total Petroleum Hydrocarbons	ND	ND						

ND - No data available
W - RfD withdrawn from IRIS/HEAST
mg - milligram
kg - kilogram
DW - Drinking Water
IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables
USEPA - United States Environmental Protection Agency
NCEA - National Center for Environmental Assessment

Uncertainty factors: H - variation in human sensitivity
A - animal to human extrapolation
S - extrapolation from subchronic to chronic NOAEL
L - extrapolation from LOAEL to NOAEL
N - NOEL not attained
D - Lack of supporting data
M - addition modifying factor

SOURCES:
IRIS as of 7/99
NCEA, 1994a,b,c, 1995
HEAST, 1997

[1] Source for all subchronic RfDs is HEAST, 1995
* Value is drinking water value (1.3 mg/L) converted to a dose.
** An NCEA provisional support]value published in the Region III RBC Table; not a health based value
! RfD for manganese in food divided by a modifying factor of 3
!! DDT used as a surrogate

TABLE 7-4
INHALATION DOSE/RESPONSE DATA
FOR CARCINOGENIC EFFECTS

ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

Compound	Weight of Evidence	Inhalation Slope Factor* (mg/kg/day)šu-1›	Unit Risk (µg/m³)šu-1›	Test Species	Study Type	Tumor Type	Source
Aluminum	ND						
Calcium	ND						
Copper	D						IRIS
Iron	ND						
Lead	B2	ND	ND				IRIS
Magnesium	ND						
Manganese	D						IRIS
Sodium	ND						
Vanadium	ND						
4,4'-DDD	ND						IRIS
4,4'-DDE	ND						IRIS
4,4'-DDT	B2	3.4E-01	9.7E-05	Mouse	Oral-diet	Liver	IRIS
2-Methylnaphthalene	ND						
Bis(2-ethylhexyl)phthalate	B2	ND	ND				
Phenanthrene	D						
Dichloromethane	B2	1.7E-03	4.7E-07	Mouse	Inhalation	Liver	IRIS
Tetrachloroethene	B2	2.0E-03	5.9E-06 W				NCEA, 1992
Trichloroethene	B2	6.0E-03	2.0E-06 W				NCEA, 1992
Total Petroleum Hydrocabons	D						

ND - Not Determined
W - Withdrawn from IRIS
DW - Drinking water
mg - milligram
kg - kilogram
µg - microgram
IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables
NCEA - National Center for Environmental Assessment

* - Source of slope factor is HEAST, 1995 unless otherwise noted.
c - Calculated from unit risk [slope = (unit risk x 70 kg)/20 m³/day x 0.001 mg/ug]
I - Slope factor verified by IRIS staff

Weight of Evidence (Route-Specific):
A - Human carcinogen
B - Probable human carcinogen (B1 - limited evidence of cancer in humans;
B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)
C - Possible human carcinogen
D - Not classifiable as to human carcinogenicity
E - Evidence of lack of carcinogenicity to humans

Sources:
IRIS as of 7/99
HEAST, 1997
NCEA, 1992, 1994

TABLE 7-5
INHALATION DOSE/RESPONSE DATA FOR NONCARCINOGENIC EFFECTS

ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

COMPOUND	CHRONIC INHALATION RfC (mg/m3)	SUBCHRONIC [1] INHALATION RfC (mg/m3)	CHRONIC INHALATION RfD [2] (mg/kg-day)	SUBCHRONIC INHALATION RfD [2] (mg/kg-day)	STUDY TYPE	CONFIDENCE LEVEL	CRITICAL EFFECT	TEST ANIMAL	UNCERTAINTY FACTOR	SOURCE
Aluminum	ND	ND	ND	ND						
Calcium	ND	ND	ND	ND						
Copper	ND	ND	ND	ND						
Iron	ND	ND	ND	ND						
Lead	ND	ND	ND	ND						
Magnesium	ND	ND	ND	ND						
Manganese	5E-05	ND	1.4E-05	ND	Inhalation	Medium	Neurobehavioral impairment	Human	1,000 H, L, D	IRIS
Sodium	ND	ND	ND	ND						
Vanadium	ND	ND	ND	ND						
4,4'-DDD	ND	ND	ND	ND						
4,4'-DDE	ND	ND	ND	ND						
4,4'-DDT	ND	ND	ND	ND						
2-Methylnaphthalene	ND	ND	ND	ND						
Bis(2-ethylhexyl)phthalate	ND	ND	ND	ND						
Phenanthrene	ND	ND	ND	ND						
Dichloromethane	3.0E+00	3.0E+00	8.6E-01	8.6E-01	Inhalation	Low	Liver Toxicity	Rat	100 H, A	HEAST
Tetrachloroethene	ND	ND	ND	ND						IRIS
Trichloroethene	ND	ND	ND	ND						IRIS
Total Petroleum Hydrocarbons	ND	ND	ND	ND						

ND - No data available
W - RfD withdrawn from IRIS/HEAST
mg - milligram
kg - kilogram
µg - microgram
DW - Drinking Water
IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables
USEPA - United States Environmental Protection Agency

[1] Source for all subchronic RfCs is HEAST, 1995
[2] RfD calculated from RfC as follows:
RfD (mg/kg-d) = RfC (mg/m^3)/ 70 kg x 20 m^3/d
[3] HEAST Table 1: Subchronic and Chronic Toxicity
[4] There is a National Ambient Air Quality Standard for lead of 1.5 µg/m^3 averaged over three months

Uncertainty factors:
H - variation in human sensitivity
A - animal to human extrapolation
S - extrapolation from subchronic to chronic NOAEL
L - extrapolation from LOAEL to NOAEL
N - NOEL not attained
D - Lack of supporting data
M - additional modifying factor

SOURCES:
IRIS as of 7/99
HEAST, 1997

TABLE 7-6
DERMAL DOSE-RESPONSE DATA FOR CARCINOGENIC AND NONCARCINOGENIC EFFECTS

ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

COMPOUND	ORAL ABSORPTION EFFICIENCY	CHRONIC ORAL RfD [1] (mg/kg-day)	CHRONIC DERMAL RfD [2] (mg/kg-day)	SUBCHRONIC ORAL RfD [1] (mg/kg-day)	SUBCHRONIC DERMAL RfD [2] (mg/kg-day)	ORAL CSF[1] (mg/kg-day)□u-1□	ADJUSTED DERMAL CSF[3] (mg/kg-day)□u-1□
Aluminum	20%	ND	ND	ND	ND	ND	ND
Calcium		ND	ND	ND	ND	ND	ND
Copper	20%	4.0E-02	8.0E-03	ND	ND	ND	ND
Iron	2%	3.0E-01	6.0E-03	ND	ND	ND	ND
Lead		ND	ND	ND	ND	ND	ND
Magnesium		ND	ND	ND	ND	ND	ND
Manganese (food)		1.4E-01	ND	ND	ND	ND	ND
Manganese (drinking water)	4%	4.7E-02	1.9E-03	ND	ND	ND	ND
Manganese (soil)	4%	4.7E-02	1.9E-03	ND	ND	ND	ND
Sodium		ND	ND	ND	ND	ND	ND
Vanadium	3%	7.0E-03	2.1E-04	7.0E-03	2.1E-04	ND	ND
4,4'-DDD	20%	5.0E-04	1.0E-04	5.0E-04	1.0E-04	2.4E-01	1.2E+00
4,4'-DDE !	20%	5.0E-04	1.0E-04	5.0E-04	1.0E-04	3.4E-01	1.7E+00
4,4'-DDT	20%	5.0E-04	1.0E-04	5.0E-04	1.0E-04	3.4E-01	1.7E+00
2-Methylnaphthalene	100%	2.0E-02	2.0E-02	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	100%	2.0E-02	2.0E-02	2.0E-02 W	2.0E-02	1.4E-02	1.4E-02
Phenanthrene	91%	ND	ND	ND	ND	ND	ND
Dichloromethane	100%	6.0E-02	6.0E-02	6.0E-02	6.0E-02	7.5E-03	7.5E-03
Tetrachloroethene	100%	1.0E-02	1.0E-02	1.0E-01	1.0E-01	5.2E-02	5.2E-02
Trichloroethene	100%	6.0E-03	6.0E-03	ND	ND	1.1E-02	1.1E-02
Total Petroleum Hydrocarbons	91%	ND	ND	ND	ND	ND	ND

NOTES:

1 - See preceding Dose/Response Tables
2 - Dermal RfD = Oral RfD x Oral Absorption Efficiency
3 - Dermal CSF = Oral CSF / Oral Absorption Efficiency
W = Withdrawn from HEAST in FY 1993 update

! Value for DDT used as a surrogate

RfD - Reference Dose
CSF - Cancer Slope Factor
mg - milligram
kg - kilogram
ND - not determined
NA - Not Applicable

TABLE 7-7
RISK CHARACTERIZATION

ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

Scenario Timeframe:		Future				
Receptor Population:		Resident (Carcinogenic)				
Receptor Age:		Adult				
Medium	Exposure Point	Chemical of Concern	Ingestion Risk	Inhalation Risk	Dermal Risk	Exposure Routes Total
Groundwater	Groundwater-Domestic	Methylene Chloride	8.1E-07	8.1E-07	3.07462E-08	1.7E-06
	Groundwater-Domestic	Tetrachloroethylene	1.2E-05	1.2E-05	8.40477E-06	3.2E-05
	Groundwater-Domestic	Trichloroethylene	1.1E-06	1.1E-06	2.1151E-07	2.5E-06
					Total Risk=	**3.6E-05**

Notes:
Bis(2-ethylhexyl)phthalate not included in Risk Characterization based on determination that detections result from laboratory contamination.

Scenario Timeframe:		Future				
Receptor Population:		Resident (Non-carcinogenic)				
Receptor Age:		Adult				
Medium	Exposure Point	Chemical of Concern	Ingestion Risk	Inhalation Risk	Dermal Risk	Exposure Routes Total
Groundwater	Groundwater-Domestic	Methylene Chloride	1.1E-03	1.1E-03	0.000159425	2.3E-03
	Groundwater-Domestic	Tetrachloroethylene	1.3E-02	1.3E-02	0.037713699	6.4E-02
	Groundwater-Domestic	Trichloroethylene	1.0E-02	1.0E-02	0.007477626	2.8E-02
	Groundwater-Domestic	Aluminum	-	NA	-	-
	Groundwater-Domestic	Calcium	-	NA	-	-
	Groundwater-Domestic	Magnesium	-	NA	-	-
					Total Risk=	**9.4E-02**

TABLE 7-8
POTENTIAL SOURCES OF UNCERTAINTY

ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

Uncertainty	Effect	Justification
Likelihood of exposure pathways	Overestimate	Future pathways may not actually occur.
Tetrachloroethylene was detected at low concentrations in soil QC blank samples. It was determined that the majority of tetrachloroethylene reported in the 1996 data was false-positive data resulting from cross-contamination in the laboratory. Only the detections of 2 μg/g and 1,000 μg/g are thought to be representative.	Negligible	Although all detections were used in the assessment, only maximum concentrations were used as EPCs.
Exposure assumptions (e.g., frequency, duration)	Overestimate	Parameters selected are realistic and protective estimates of exposure.
Degradation of chemicals not considered	Overestimate	Risk estimates in most media are based on recent chemical concentrations. Concentrations tend to decrease over time as a result of degradation. In subsurface soil, some of the concentrations are from older data and may now have decreased.
Absorption of contaminants on inhaled particulates	Overestimate	Assumption of 100% absorption of chemicals on particulates is conservative.
Extrapolation of animal toxicity data to humans	Unknown, probably overestimate	Animals and humans differ with respect to absorption, metabolism, distribution, and excretion of chemicals. The magnitude and direction of the difference will vary with each chemical. Animal studies typically involve high-dose exposures, whereas humans are exposed to low doses in the environment.
Use of linearized, multistage model to derive cancer slope factors	Overestimate	Model assumes a non-threshold, linear-at-low-dose relationship for carcinogens. Many compounds induce cancer by non-genotoxic mechanisms. Slope factor is the 95% upper confidence limit of the cancer dose response curve.
Summation of effects (cancer risks and hazard indices) from multiple substances	Unknown	The assumption that effects are additive ignores potential synergistic and/or antagonistic effects. Assumes similarity in mechanism of action, which is not the case for many substances. Compounds may induce tumors or other toxic effects in different organs or systems.

TABLE 7-8
POTENTIAL SOURCES OF UNCERTAINTY

ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

UNCERTAINTY	EFFECT	JUSTIFICATION
Use of uncertainty factors in the derivation of reference doses	Unknown	Tenfold uncertainty factors are incorporated to account for various sources of uncertainty. Although some data seem to support the tenfold factor, its selection is somewhat arbitrary.
No toxicity values are available for lead and it is excluded from quantitative evaluation	Underestimate	The IEUBK model is not appropriate for use in the evaluation of lead ingestion by adults. This evaluation was performed qualitatively using suggested USEPA lead screening concentrations for soil and groundwater.
Inhalation of tetrachloroethylene in soil is evaluated both as a volatile and a particulate	Underestimate	Models to estimate exposure points of both volatilization and release of particulates are based on total concentration in soil; the soil concentration cannot be entirely released both as a volatile and a particulate.
Some analytes excluded from quantitative evaluation because no toxicity information is available	Underestimate	The exclusion of analytes without toxicity values from quantitative evaluation may bias estimates of risk low.
Volatilization and particulate emission factor are estimated	Unknown	Default parameters used when site-specific values not available; may result in overestimate or underestimate of actual volatilization and emission.
Dermal toxicity values derived from oral toxicity values	Unknown	Because diriect dermal values are not available, dermal toxicity is estimated from oral toxicity by application of an absorption factor.
Inhalation of VOCs released from surface water not evaluated	Underestimate	Concentrations of VOCs are low and any release is likely to be diluted and dispersed rapidly.
Compounds other than target compounds (i.e., tentatively identified compounds [TICs]) not quantitatively evaluated	Unknown, probably underestimated	Exclusion of TICs may bias risk estimates low.
Total petroleum hydrocarbon cannot be quantitatively evaluated	Underestimate	The composition of total petroleum hydrocarbon is variable; thus, no toxicity values are available.

TABLE 7-9
ECOLOGICAL RECEPTORS AND EXPOSURE PATHWAYS EVALUATED IN THE ECOLOGICAL RISK ASSESSMENT

ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

RECEPTOR SPECIES/GROUP	EXPOSURE PATHWAY
<u>Aquatic Life:</u>	
Invertebrates	Direct contact with and ingestion of surface water
Plants	Direct contact with and ingestion of sediment
Amphibians	
<u>Semi-aquatic Wildlife</u>:	
Muskrat	Ingestion of surface water
Mallard	Incidental ingestion of sediment
Raccoon	Ingestion of contaminated food items
<u>Terrestrial Wildlife</u>:	
White-footed mouse	Incidental ingestion of surface soil
American robin	Ingestion of contaminated food items
Barred owl	
Terrestrial Plants	Direct contact with surface soil
	Root uptake of surface soil CPCs
Soil Invertebrates	Direct contact with surface soil
	Ingestion of surface soil

TABLE 7-10
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF CONCERN
SURFACE SOIL

ARDC DECISION DOCUMENT
FORT DIX NEW JERSEY

Contaminant of Potential Concern	Range of Detected Concentrations			Average of all Concentrations	95% UCL in Soil	Background Concentration	Surface Soil Toxicity Value	Surface Soil Toxicity Value Source	HQ Value	Ecological COC
Copper	1.41	-	30.2	5.4	15.3	5.37	30	LC_{50}	1.0	No
Manganese	3.11	-	97.8	13.7	55.1	40.2	500	LOEC	0.2	No
Phenanthrene	0.082	-	0.082	0.020	0.025	0.670	25	LOEC	0.003	No
Tetrachloroethylene	1.7	-	220	19	105,000,000	-	150	LC_{50}	1.5	No*
Total Petroleum Hydrocarbons	39	-	48,400	5,300	218,000	-	-	-	-	No**

LC_{50} = Concentration lethal to 50% of the test population (USEPA, 1986)

LOEC =- Lowest observed effect concentration

* = Maximum concentration two orders of magnitude greater than second highest detection. Furthermore, it is less than twice the toxicity value.

** = TPH generally considered non-toxic, and is below concentrations at which ecological receptors are effected by coating.

TABLE 7-11
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF CONCERN
SURFACE WATER

ARDC DECISION DOCUMENT
FORT DIX NEW JERSEY

Analyte	Range of Detected Concentrations	Average of all Concentrations [c]	Background Concentration	Surface Water Toxicity Value	Surface Water Toxicity Value Source	HQ Value	Ecological COC
Arsenic	2.77 - 2.77	1.5	2.54 (CRL)	190	AWQC	0.015	No
Copper	7.2 14.3	9.2	5.0 (CRL)	1.5	AQUIRE	9.5	No*
Iron	915 - 1,710	1,300	4,280	NC	NC	-	No**
Lead	2.06 - 6.29	4.2	2.71	1.2	AWQC	5.2	No***
Tetrachloroethylene	5 - 11	5.6	1.6 (CRL)	510	AQUIRE	0.022	No
Trichloroethylene	0.86 - 1.5	0.93	0.5 (CRL)	2300	AQUIRE	0.001	No

Notes:
The 95% UCL was not calculated because there are fewer than 10 samples in the data set.
* = concentrations at ARDC consistent with non-site-related concentrations
** = Background exceeds detected range
*** = Background exceeds toxicity value
NC = Not calculated
CRL = Laboratory Certified Reporting Limit
HQ = Maximum detected concentration/ Toxicity value

TABLE 7-12
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF CONCERN
SEDIMENT

ARDC DECISION DOCUMENT
FORT DIX NEW JERSEY

Analyte	Range of Detected Concentrations	Average of all Concentrations	Background Concentration	Screening Toxicity Value	Screening Toxicity Value Source	HQ Value	Ecological COC
Iron	158 - 12,700	4,890	2,649	20,000	OME LEL	0.6	No
Manganese	4.44 - 12.7	4.1	8.04	460	OME LEL	0.03	No
Vanadium	8.76 - 8.76	3.5	3.39(CRL)	-	-	NC	No
4,4'-DDE	0.012 - 0.0484	0.016	0.00765(CRL)	0.0022	NOAA ER-L	22	No*
4,4'-DDT	0.012 - 0.0297	0.013	0.00707(CRL)	0.00158	NOAA ER-L	19	No*

Notes:
The 95% UCL was not calculated because there are fewer than 10 samples in the data set.
OME LEL = Ontario Ministry of the Environment Low Effects Level Provincial Sediment Quality Guidelines (Persaud et al., 1996)
NOAA ER-L = National Oceanic and Atmospheric Adminstration Effects Range- Low (long et al., 1994)
* = CRL and upstream non-site-related concentrations exceed screening criteria
CRL = Laboratory Certified Reporting Limits

TABLE 7-13
POTENTIAL SOURCES OF UNCERTAINTY IN ECOLOGICAL RISK ASSESSMENT

ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

POTENTIAL SOURCE	DIRECTION OF EFFECT ON RISK	JUSTIFICATION
Uncertainties Associated with CPC Selection Process		
Degradation of chemicals not considered	Overestimate	Risk estimates are based on recent chemical concentrations. Concentrations tend to decrease over time from degradation and the formation of daughter products.
No evaluation of tentatively identified compound (TIC) data	Underestimate	Risk was not calculated for potential exposure to TICs.
Use of estimated data (i.e., "J" qualified data)	Unknown	Using estimated data in the risk assessment may over- or underestimate the actual concentration of an analyte in site media.
Uncertainties Associated with Exposure Assessment		
Surface-soil sampling depths	Underestimate	Most terrestrial receptors will be exposed only within the first 6 inches of soil where contaminant concentrations are typically greatest. Sampling the upper 2 feet of soil provides a diluted soil exposure concentration. However, concentrations of VOCs are likely to be higher with greater depth.
Selection of CPCs for food-chain model - only chemicals with log $K_{ow} > 5$ (organics), measured BCF >300 (inorganics detected in surface water or sediment), or invertebrate BAFs >0.1 (inorganics detected in surface soil) were selected as CPCs for the food-chain model	Underestimate	The assessment focused on CPCs most likely to accumulate via the food chain. However, by basing this determination on log K_{ow} values for organics and fish BCFs/terrestrial invertebrate BAFs for inorganics, uncertainty is introduced and it is possible that chemicals that were eliminated as CPCs for the food- chain model may contribute to food-chain risk. Furthermore, averaging the log K_{ow}s for PAHs may have eliminated some chemicals from food-chain considerations that might otherwise have been retained. However, it is generally recognized that PAHs do not tend to bioaccumulate through the food-chain. Risks from non-accumulating CPCs were not evaluated. This may result in an underestimate of risk for CPCs; however, this pathway (i.e., incidental ingestion of CPCs) is generally an insignificant route of exposure.
Food chain model exposure parameter assumptions	Unknown	Some exposure parameters are from the literature and some are estimated. Efforts were made to select exposure parameters representative of a variety of species or feeding guilds, so that exposure estimates would be representative of more than a single species.
Assumption that receptor species will spend equal time at all habitats within home range	Unknown	Organisms will spend varying amounts of time in different habitats, thus affecting their overall exposures.
Food chain assumed to occur at site	Unknown	Occurrence of the food chain used in the models at the sites is unknown.
Maximum exposure scenarios	Overestimate	It is unlikely any receptor would be exposed concurrently to maximum concentrations of all CPCs.

TABLE 7-13
POTENTIAL SOURCES OF UNCERTAINTY IN ECOLOGICAL RISK ASSESSMENT

ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

POTENTIAL SOURCE	DIRECTION OF EFFECT ON RISK	JUSTIFICATION
Consumption of contaminated prey	Unknown	Toxicity to receptors may result in sickness or mortality, thus making fewer prey items available to predators. Predators may stop foraging in areas with reduced prey populations, or discriminate against, or, conversely, select contaminated prey. Furthermore, anthropogenic sources of contamination may not even have as great an impact on the predator/prey relationship as do climatic effects.
Use of surrogate values for invertebrate BAFs	Underestimate	Bioaccumulation data for earthworms are lacking for several metals. In these instances, mammal BAFs were used as surrogates. However, earthworms may actually bioaccumulate these metals to a greater degree than mammals.
No evaluation of dermal or inhalation exposure pathways	Underestimate	The dermal and inhalation exposure pathways are generally considered insignificant due to protective fur, feathers, chitinous exoskeletons, and the low concentration of contaminants under natural atmospheric conditions. However, under certain conditions, these exposure pathways may occur.
Continuous uptake and bioaccumulation of CPCs by soil biota	Unknown	Tissue and organ responses to CPC uptake are represented by a linear function, which is an oversimplification of a more complex system (i.e., trophic states and lipid concentrations may affect bioaccumulation, or contaminants may only be seasonally available).
Bioaccumulation of CPCs in leafy portions of plants	Overestimate	Ryan et al. (1988) states that compounds with log K_{ow}s > 5 are unavailable to plants due to soil sorption. Compounds with log K_{ow}s > 5 will be taken into the roots of plants, but are not easily transported into the leafy parts of plants (Briggs et al., 1982; and 1983). The sediment ingestion exposure model overestimates CPC exposure via plant ingestion to those receptors that only eat the leafy portions of plants.
Seasonal changes in receptor foraging habits	Unknown	The food-chain model does not consider variations in a receptor's foraging habits due to seasonal changes and breeding. For example, the robin will eat a high percentage of worms during the spring, but eats a high percentage of fruits during the summer when fruits are more abundant.
Uncertainties Associated with Effects		
Extrapolation of literature values from test species to representative wildlife species	Unknown	Species differ with respect to absorption, metabolism, distribution, and excretion of chemicals. The magnitude and direction of the difference will vary with each chemical.
Use of measurement endpoints	Overestimate	Although an attempt was made to have measurement endpoints reflect assessment endpoints, limited available ecotoxicological literature resulted in the selection of certain measurement endpoints that may overestimate assessment endpoints.

TABLE 7-13
POTENTIAL SOURCES OF UNCERTAINTY IN ECOLOGICAL RISK ASSESSMENT

ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

POTENTIAL SOURCE	DIRECTION OF EFFECT ON RISK	JUSTIFICATION
Lack of ingestion toxicity information for reptile and amphibian species	Unknown	Information is not available on the toxicity of contaminants to reptiles or amphibians resulting from dietary exposures; as a result, dietary exposures to these receptors were not quantitatively evaluated. Assuming the toxicities of analytes to mammals and birds are similar for these receptors, and to the extent that the dietary exposures for reptiles and amphibians are the same as for the tertiary consumers, an assumption can be made that dietary exposures to reptiles and amphibians would result in similar risk levels that would be predicted for predatory mammals and birds. However, risks to reptiles and adult amphibians remain unknown. Direct contact exposures to surface-water CPCs were evaluated for embryo-larval amphibians.
Extrapolation from LD_{50} to LOAEL	Unknown	Extrapolation from LD_{50} to LOAEL toxicity values was performed for chemicals for which no other mortality toxicity data were available for the species. This allows chemicals to be evaluated quantitatively that would otherwise be eliminated from the analysis. A factor of 0.2 was used to extrapolate between these values; this factor is frequently used in ERAs and is expected to be protective of 99.9% of the test population (USEPA, 1988a). However, these factors are estimates and actual differences between LD_{50}s and LOAELs will vary with each chemical and species.
Use of AWQC to evaluate impacts to aquatic life at the site	Overestimate	AWQC incorporate toxicity data for a large number of sensitive fish species that do not occur near the site due to the physical characteristics of the habitat (i.e., shallow water). Selection of invertebrate and amphibian toxicity reference values as well decreases this uncertainty.
<u>Uncertainties Associated with Risk Characterization</u>		
Population-level risk vs. community- or ecosystem-level risk	Overestimate	Defining ecological significance for common site-related receptors with limited home ranges is often difficult. Impact to one or more isolated populations may not have a meaningful impact on the ecosystem, unless competing species recolonize the disturbed habitats. This assessment conservatively treats impacts to a single indicator species population as a potentially significant risk of harm to the environment.
Risk evaluated for individual terrestrial receptors only	Overestimate	Effects on individual terrestrial organisms may occur with little population-level effects. However, as the number of affected individuals and the extent of contamination increases, the likelihood of population-level effects increases.
Multiple conservative assumptions	Overestimate	Cumulative impact of multiple conservative assumptions yields high risk to ecological receptors, and may result in risk at background concentrations or the prediction of risks when there is no potential for adverse effects.

TABLE 7-13
POTENTIAL SOURCES OF UNCERTAINTY IN ECOLOGICAL RISK ASSESSMENT

ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

POTENTIAL SOURCE	DIRECTION OF EFFECT ON RISK	JUSTIFICATION
Summation of effects (HIs)	Unknown	The assumption that effects are additive ignores potential synergistic or antagonistic effects. It assumes similarity in mechanism of action, which is not the case for many substances. Compounds may induce toxic effects in different organs or systems.

Notes:

AWQC = Ambient Water Quality Criteria
CPC = contaminant of potential concern
TIC = tentatively identified compounds
BAF = bioaccumulation factor
HIs = hazard indices

TABLE 11-1
SELECTED REMEDY COST SUMMARY

ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

CAPITAL AND FIXED COSTS

Item Description	Quantity	Units	Unit Cost	Present Worth
Alternative Preparation				
Work Plan Preparation	1	ls	$ 6,952	$ 6,952
Mobilization and Site Preparation				
Mobilization	1	ls	$ 1,250	$ 1,250
Site Preparation	1	ls	$ 4,875	$ 4,875
Soil Excavation and Sampling				
Soil Excavation	1	ls	$ 5,010	$ 5,010
Confirmation Testing	1	ls	$ 5,056	$ 5,056
Characterization Testing	1	ls	$ 948	$ 948
Transportation and Disposal				
Transportation	260	tons	$ 100	$ 26,000
Off-site Disposal to Subtitle D Landfill	260	tons	$ 200	$ 52,000
Site Restoration				
Backfill and Restoration	1	ls	$ 10,460	$ 10,460
Repair Fence	1	ls	$ 500	$ 500
Remove Decontamination Pad and Stockpile Area	1	ls	$ 750	$ 750
Implement Deed Restriction	1	ls	$ 10,000	$ 10,000
Subtotal				**$ 123,801**
Contingency	20%			$ 24,760
TOTAL CAPITAL COSTS (YEAR 1)				**$ 148,561**

O&M COSTS

Item Description	Years		Unit Cost	Present Worth
Field Sample Collection				
2 Events per year for Year 1	2	event	$ 3,722	$ 6,729
4 Events per year for Years 2-5	16	event	$ 3,722	$ 21,160
Groundwater Sample Off-site Analysis				
1 Baseline Event	1	event	$ 790	$ 738
2 Events per year for Year 1	2	event	$ 790	$ 1,428
4 Events per year for Years 2-5	16	event	$ 790	$ 7,367
Surface Water Sample Off-site Analysis				
1 Baseline Event	1	event	$ 474	$ 443
2 Events per year for Year 1	2	event	$ 474	$ 857
4 Events per year for Years 2-5	16	event	$ 474	$ 4,420
Sediment Sample Off-site Analysis				
1 Baseline Event	1	event	$ 525	$ 491
2 Events per year for Year 1	2	event	$ 525	$ 949
4 Events per year for Years 2-5	16	event	$ 525	$ 4,896
Data Evaluation Report				
1 Report per year for 5 years	5	event	$ 4,476	$ 18,352
Five Year Site Review	1	ls	$ 7,212	$ 5,142
Closure Report Preparation	1	ls	$ 4,272	$ 3,046
TOTAL O&M COSTS				**$ 76,019**
TOTAL FOR ALTERNATIVE SOIL-6 (Years 1-5)				**$ 224,581**

TABLE 11-2
COST DETAILS

ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Preparation								
Work Plan Preparation								
Senior Engineer	8	Hours	125.00	1,000	0	0	0	1,000
Engineering Support	40	Hours	84.00	3,360	0	0	0	3,360
Non-Engineer Support	8	Hours	74.00	592	0	0	0	592
ODCs	1	LS	3,000.00	0	0	0	2,000	2,000
TOTAL - Preparation				4,952	0	0	2,000	6,952
Mobilization								
Equipment Mobilization								
Dump Truck	2	ea	250.00	0	0	0	500	500
Front-end Loader/Backhoe combination	1	ea	500.00	0	0	0	500	500
Personnel	1	ls	250.00	0	0	0	250	250
TOTAL - Mobilization				0	0	0	1,250	1,250
Site Preparation								
Utility Clearance	1	LS	500.00	0	0	0	500	500
Remove Fence (portion)	1	ls	250.00	0	0	0	250	250
Build Stockpile Area	500	SF	0.75	0	0	0	375	375
Build Decontamination Area	2,500	SF	1.50	0	0	0	3,750	3,750
TOTAL - Site Preparation				0	0	0	4,875	4,875
Excavate Soils								
Backhoe and Operator	1.5	days	1,000.00	0	0	0	1,500	1,500
Dump Truck and Driver	1.5	days	500.00	0	0	0	750	750
Laborer - 2 EA	30	hours	50.00	1,500	0	0	0	1,500
Construction Oversight	15	hours	84.00	1,260	0	0	0	1,260
TOTAL - Excavate Soils				2,760	0	0	2,250	5,010
Confirmation Testing								
Soil Sample Analysis (24 hour TAT)								
VOC Analysis (Method 8260B)	16	sample	316.00	0	0	0	5,056	5,056
SVOC Analysis	0	sample	736.00	0	0	0	0	0
Inorganic Analysis	0	sample	400.00	0	0	0	0	0
TOTAL - Confirmation Testing				0	0	0	5,056	5,056
Characterization Testing								
Soil Sample Analysis (24 hour TAT)								
VOC Analysis (Method 8260B)	3	sample	316.00	0	0	0	948	948
SVOC Analysis	0	sample	736.00	0	0	0	0	0
Inorganic Analysis	0	sample	400.00	0	0	0	0	0
TOTAL - Characterization Testing				0	0	0	948	948
Transportation and Disposal								
Transportation of Excavated soils	260	tons	100.00	0	0	0	26,000	26,000
Off-Site Disposal	260	tons	200.00	0	0	0	52,000	52,000
TOTAL - Transportation and Disposal				0	0	0	78,000	78,000
Site Restoration								
Backfill and Restoration								
Dozer and Operator	1.5	days	1,000.00	0	0	0	1,500	1,500
Dump Truck and Driver	1.5	days	500.00	0	0	0	750	750
Laborer - 2 EA	60	hours	50.00	3,000	0	0	0	3,000
Construction Oversight	30	hours	84.00	2,520	0	0	0	2,520
Fill Material	130	cy	20.00	0	0	0	2,600	2,600
Fertilize, Seed, Mulch	1,800	sf	0.05	0	0	0	90	90
TOTAL- Backfill and Restoration				5,520	0	0	4,940	10,460
Repair Fence	1	ls	500.00	0	0	0	500	500
Remove Decon Pad and Stockpile Area	1	ls	750.00	0	0	0	750	750
Implement Deed Restriction								
Permit Preparation	1	ea	7,500.00	0	0	0	7,500	7,500
Permit Fee	1	ea	2,500.00	0	0	0	2,500	2,500
TOTAL - DEED RESTRICTION				0	0	0	10,000	10,000

TABLE 11-2
COST DETAILS

ARDC DECISION DOCUMENT
FORT DIX, NEW JERSEY

Item	Qty.	U of M	U.P.	Labor	Equipment	Material	Other	TOTAL
Environmental Sampling (per event)								
Sample Collection								
Staff Engineer	16	hours	84.00	1,344	0	0	0	1,344
Project Technician	16	hours	63.00	1,008	0	0	0	1,008
Supplies	1	LS	750.00	0	750	0	0	750
ODCs								
Shipping	2	ea	100.00	0	0	0	200	200
Transportation	0	trips	500.00	0	0	0	0	0
Rental Vehicle	2	days	75.00	0	0	0	150	150
Lodging	2	days	75.00	0	0	0	150	150
Per Diem	4	days	30.00	0	0	0	120	120
TOTAL - Environmental Sampling				2,352	750	0	620	3,722
Groundwater Sample Analysis (per event)								
VOC Analysis	5	sample	158.00	0	0	0	790	790
SVOC Analysis	0	sample	368.00	0	0	0	0	0
Pesticide								
Inorganic Analysis	0	sample	200.00	0	0	0	0	0
TOTAL - Groundwater Sample Analysis				0	0	0	790	790
Surface Water Sample Analysis (per event)								
VOC Analysis	3	sample	158.00	0	0	0	474	474
SVOC Analysis	0	sample	368.00	0	0	0	0	0
Pesticide								
Inorganic Analysis	0	sample	200.00	0	0	0	0	0
TOTAL - Surface Water Sample Analysis				0	0	0	474	474
Sediment Sample Analysis (per event)								
VOC Analysis (Method 8260B)	3	sample	175.00	0	0	0	525	525
SVOC Analysis	0	sample	402.00	0	0	0	0	0
Pesticide		sample		0	0	0	0	0
Inorganic Analysis	0	sample	271.00	0	0	0	0	0
TOTAL - Sediment Sample Analysis				0	0	0	525	525
Data Evaluation Report (per event)								
Data Validator	8	Hours	125.00	1,000	0	0	0	1,000
Senior Engineer	4	Hours	125.00	500	0	0	0	500
Engineering Support	20	Hours	84.00	1,680	0	0	0	1,680
Non-engineering Support	4	Hours	74.00	296	0	0	0	296
ODCs	1	LS	1,000.00	0	0	0	1,000	1,000
TOTAL - Data Evaluation				3,476	0	0	1,000	4,476
Five Year Site Review								
Site Visit								
Engineering Support	20	Hours	84.00	1,680	0	0	0	1,680
Project Technician	20	Hours	63.00	1,260	0	0	0	1,260
Report								
Senior Engineer	8	Hours	125.00	1,000	0	0	0	1,000
Engineering Support	20	Hours	84.00	1,680	0	0	0	1,680
Non-engineering Support	8	Hours	74.00	592	0	0	0	592
ODCs	1	LS	1,000.00	0	0	0	1,000	1,000
TOTAL - Five-Year Site Review				6,212	0	0	1,000	7,212
Closure Report Preparation								
Senior Engineer	8	Hours	125.00	1,000	0	0	0	1,000
Engineering Support	20	Hours	84.00	1,680	0	0	0	1,680
Non-Engineer Support	8	Hours	74.00	592	0	0	0	592
ODCs	1	LS	1,000.00	0	0	0	1,000	1,000
TOTAL - Closure Report Preparation				3,272	0	0	1,000	4,272

APPENDIX A

APPENDIX A

TRANSCRIPT OF PUBIC MEETING
FINAL PROPOSED PLAN
ARMAMEMENT RESEARCH AND DEVELOPMENT AREA
FORT DIX, NEW JERSEY

TOWNSHIP OF NEW HANOVER
COUNTY OF BURLINGTON - STATE OF NEW JERSEY

X-----------------------X
In RE: :
:
PUBLIC MEETING : TRANSCRIPT OF
THE PROPOSED PLAN FOR : PROCEEDINGS
THE ARMAMENT RESEARCH :
AND DEVELOPMENT CENTER :
X-----------------------X

New Hanover Township Municipal Building
2 Hockamick Road
Cookstown, New Jersey 08511

January 8, 2003
7:00 P.M.

PRESENT:

MARSHALL G. NELSON
Department of the Army

GLENN L. DAUKAS, P.G.
Harding ESE

COLE TRANSCRIPTION AND RECORDING SERVICE
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OCEAN GATE, NEW JERSEY 08740
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ORIGINAL

MR. NELSON: I'd like to welcome you to our public meeting to discuss the proposed plan for remediation at the Armament Research and Development Center site. This meeting is being recorded. So if you -- so that we can produce a transcript for the, for the administrative record. If you make a comment or would like to make a comment, please identify yourselves so we'll know who, who made the comment.

I'm Marshall Nelson. I'm the project manager for the installation restoration program at Fort Dix. And I guess we probably ought to all identify ourselves so we know who's here. So I've done my part.

Glenn, you want to identify yourself?

MR. DAUKAS: My name is Glenn Daukas. I'm with Harding ESE, and I'm the project manager for the ARDC, Armament Research and Development Center site that we'll be discussing tonight.

MR. NELSON: Ken?

MR. SMITH: I'm Ken Smith from the Environmental branch at Fort Dix.

MR. COSTELLO: Jim Costello from the firm of Conti Environmental.

MR. NELSON: Haiyesh?

MR. SHAH: Haiyesh Shah from the New

Jersey Department of Environmental Protection.

MR. DeMURLY: John DeMurly, USEDA.

MR. NELSON: Thank you.

The, the site we're gonna discuss is located in the range area at Fort Dix. It was acquired for testing and evaluation of weapons in the 1940s, and weapons evaluations ceased in the late 1980s, early 1990s. Environmental assessments at Fort Dix began in the 1970s. There was an enhanced preliminary assessment that identified 42 areas requiring environmental evaluation; and, the site that we're discussing tonight is AREE Number 6.

A remedial investigation of the site was completed by Harding Lawson MACTEC in June 2000, and leading to this proposed plan that we're going to talk about tonight. Future actions would consist of completing a decision document and Fort Dix would then seek funding for remediation of the site. This meeting's a requirement of the Comprehensive Environmental Response Compensation and Liability Act, CERCLA; and, I'll introduce Glenn Daukas from Harding Lawson, who will give the presentation.

MR. DAUKAS: Thank you, Marshall.

I'm going to turn on this projector.

As Marshall mentioned, we're here

tonight to talk about the proposed plan for the ARDC. Again, my name is Glenn Daukas. I'm the project manager for the site from Harding ESE.

Brief area historical development. Marshall already mentioned that the site is in the northern area of the range. It's historically used for the evaluation of weapons and munitions from the '40s to the '90s. Reportedly, wastes were disposed of at the photographic workshop fuel storage facility. That included USTs and some 55-gallon drums for storage. A 25-gallon diesel fuel was reported in '90 -- '84, excuse me, and in 1987 oil staining was also observed at this location. Just to give you a brief visual, the contam area and this area down here and the ARDC site next to Brindell Lake.

Brief overview of the site characteristics. The ARDC is flat, gently rolling topography. The site is bordered on the south and east with manmade drainage ditch which is draining in this wetland area here. It goes down and hooks up with a tributary which discharges to Jumping Brook. We have the former X-ray area located here; former leach field; a Fort Dix 13 production drinking well; and, the fuel storage area which is the focus of tonight's discussion.

A brief summary of the previous investigations were conducted in 1987; a preliminary assessment site investigation by ES&E; a phase one and two by Dames & Moore in '88 and 1990; and, in 1996 we became involved and conducted a remedial investigation that was based on the results of all of the previous investigations. That investigation primarily focused on three areas which we've mentioned before, which is the former leach field, the Fort Dix 13 well and the fuel storage area. Our investigations included the installation and sampling of screened augers, installation and sampling of monitoring wells, subsurface soil sampling, surface water sediment sampling, ground penetrating radar survey, and wetlands delineation. Based on that investigation, no contamination was detected at either the old leach field or the Fort Dix 13 well. Fort Dix 13 was abandoned in 1998.

The contaminant assessment for the surface soil was primarily consisted of PCE and TCE. PCE was detected in excess of the screening criteria of 1 milligram per kilogram. The highest concentration of PCE detected was 220 milligrams per kilogram which is used in the proposed plan. However, in 1996, at the same sample location, a concentration of 1,000 milligrams per kilogram was detected. That sample, that location was sampled again in '98 and was at 220 milligrams per kilogram.

The area of the soil contamination is approximately 35 feet wide and extends approximately 40 feet north of the drainage ditch into the fuel storage area and the drainage ditches. Right along this access. The high, highest contamination of the soil was located at ARS-10 and resampled again ARS-20 for those two hits.

Based on the data collected to date, there does not appear to be an impact of the subsurface soil; and, the ground water contaminant assessment again indicates that there has been some contamination with PCE and TCE with concentrations of 19 micrograms per liter and 8.9 micrograms per liter at the highest hits respectively. Again, that water was collected between the fuel storage area and the drainage ditch. Both analytical and ground water elevation data indicate that the contamination is contained along the fence line and to the south side, south side -- excuse me -- north side of the drainage ditch. Ground water is flowing from both directions into the drainage ditch. That is on the north side of the drainage ditch. It is flowing south into it. On the south side of the drainage ditch it is flowing north and discharging into it for the shallow surface water.

Continuing the assessment for the surface water again indicated PCE and TCE were the primary contaminants, and they are consistent with the surface soil and ground water contamination. The concentrations for PCE, the highest concentration was 11 micrograms per liter, and TEC was 1.5 micrograms per liter. Those high, two locations, I can show you in a second, are co-located adjacent to where the high concentrations of soil and ground water. No PCE nor TCE was detected upstream off gradient of the site. What we can see here is the highest concentrations were located again adjacent to the fuel storage area. There were two lower detections as you move down, downstream towards where this drainage ditch intersects the unnamed tributary.

We do have an inset here which gives you an overview of the ground water contamination located with the high hits of the surface water contamination. Again the high hits of the surface soil contamination; and, as you'll see in a second, also, the higher hits of the, any sediment contamination that was detected.

Again, sediment primarily was PCE/TCE.

Again co-located with surface water and ground water hits. Concentrations for PCE in the sediments were up to 5.05 milligrams per kilogram, and TCE up to .0069 milligrams per kilogram.

Several pesticides were detected above the screening criteria along the fence line. However, it is believed and determined that those concentrations are associated with the historic use of pesticide to control weeds along the fence line.

The developed conceptual model for the site is that the fuel storage area has been negatively impacted by the disposal of chlorinated solvents along the fence line in the soil, surface soil adjacent to ARS-10, as I pointed out earlier. The data suggests that the chlorinated solvents in the surface soil are leaching into the shallow ground water which is moving approximately 50 feet or less and discharging into the drainage ditch. Alternatively or in, at the same time chlorinated soil that may also have been transported to the drainage ditch via precipitation runoff and associated soil erosion.

Human health risk assessments were conducted as part of the feasi -- excuse me -- part of the remedial investigation. The primary contaminants of concern again are PCE and TCE. Exposure scenarios included surface soil, current site visitors, security patrol, future use by commercial industrial worker; sediment current, and future use by trespassing child; surface water, current and future use by trespassing child; subsurface soil, future use by construction worker; and ground water, future use by residents.

The results of the human health risk assessment indicated that for surface soil the cancer risk for PCE exceeded 1 times 10 to the minus 6 for industrial worker ingestion and inhalation exposure pathways. The noncancer risk, it has an index of 1.0, was not exceeded. Subsurface soil, no unacceptable cancer or noncancer risks were identified. Ground water, the cancer risk for PCE and TCE were adult resident ingestion, dermal contact and inhalation pathways were exceeded, did exceed the 1 times 10 to the minus 6. Again, there was no noncancer risk. And surface water sediment, there were no unacceptable cancer or noncancer risks identified.

An ecological risk assessment was also conducted. PCE, TCE and inorganics were the primary chemicals of potential concern in surface water and surface soil, and pesticides, DDT and its metabolites, DDE and DDD, and inorganics were the primary contaminants of concern in the sediment. The results the ecological risk assessment indicated that there were no significant risks to receptors from the media and chemicals of concern at the site. And also there were no ecological risks associated to endangered species from exposure at the site.

Based on all that information we went on and conducted a feasibility study, and the feasibility study purpose was to develop, screen, evaluate remedial alternatives to reduce human health and ecological risks based on the contaminants identified in the various media. This slide presents a very brief process of the RIFS. Going through, I won't belabor this unless there are any questions regarding this slide.

Remedial response objectives were created, and for surface soil the response objective is protect potential commercial/industrial workers from unacceptable risks resulting from exposure to PCE. Subsurface soil, no response objectives were formed since no risks were identified. Ground water, protect human receptors from ground water use for domestic purposes from PCE and TCE concentrations. Surface water, protect human receptors from exposure to PCE and TCE concentrations. And the sediment was to protect ecological receptors from exposure to PCE and TCE concentrations.

The remedial action objectives include for surface soil, again to protect the commercial/industrial workers from concentrations of PCE exceeding 0.00081 milligrams per kilogram. Ground water protection for human receptors for ground water use for domestic purposes from PCE and TCE concentrations greater than 1 microgram per liter. Surface water, protection of human receptors from exposure to PCE and TCE concentrations greater than .08 micrograms per liter and 1.0 micrograms per liter respectively. And sediment, to protect ecological receptors from exposure to PCE and TCE concentrations greater than 0.00081 milligrams per kilogram and 0.00028 milligrams per kilogram respectively.

Now because Fort Dix is in the New Jersey Pinelands Protection Area, if any of the remedial goals for organic contaminants of concern are greater than the present PQL, then the PQL becomes the remediation goal and that change will be taken care of during the design phase of this investiga, of this project. It will most likely increase the volume of soil potential to be excavated and may actually include a small portion of some sediments.

The alternatives developed for the ARDC

area include a no action, a limited action, low permeability cover enhanced bioremediation with land treatment, excavation with on-site soil vapor extraction and excavation with offsite treatment and/or disposal.

Alternatives 1, 2, 5 and 6 were retained for detailed evaluation. Alternatives 3 and 4 were dropped out in the screening process. The remaining alternatives will be reviewed in accordance with the NCP analysis criteria which include the overall protection of human healthy environment, compliance with ARARs, long-term effectiveness in performance -- and permanence, excuse me, reduction in toxicity, mobility and volume through treatment, short-term effectiveness, implementability, cost, state acceptance and community acceptance. The preferred alternative must meet the first two criteria. The remaining criteria are used for comparisons.

Alternative 1, no action. Basically is retained as required by the NCP to provide a baseline against which to compare other alternatives. This alternative was dropped out because it does fail to meet one of the first two criteria and, which is protection of human health and the environment.

Alternative 2, which is limited action,

includes the implementation of institutional controls, conducting environmental sampling, conducting two five-year site reviews. This alternative was dropped because it fails to comply with pertinent ARARs, and in specific, the natural attenuation does not meet requirements of an active treatment.

Alternative 5, excavation, on-site soil vapor extraction, includes the installation of a portable soil treatment system, soil vapor treatment system, excavation of the soil, treatment of the excavation and soil on-site in the SVE system, backfill impacted areas with a clean fill using treated soils as fill at the ARDC, implementation of deed restrictions, conducting sampling to evaluate effectiveness, conducting a five-year site review. This alternative does meet the NCP screening criteria.

However, the cost for this alternative is greater than alternative 6, which brings us to our last alternative and preferred alternative, which is the excavation, offsite treatment and/or disposal. The components of this alternative shown here in a little more detail are basically the same as alternative 5, with the exception of the excavated material being transported and treated and/or disposed of at a facility offsite.

Why was alternative 6 selected? The excavation and offsite treatment and/or disposal of contaminated surface soil would remove contamination above the RGs, remedial goals, provide an appropriate monitoring program for remaining media, prevent migration, and provide for potential beneficial re-use of the remediated soil. In addition, this alternative is the most cost effective and protective of those considered for the surface soil.

So at this point, for the continuation of the CERCLA process for the ARDC site, we will be, as we are tonight, presenting the preferred remedy of the proposed plan and seeking public review and comment on that. The next step would be to produce the decision documents which presents the selected remedy, and will also discuss any potential changes based on public comment. Following that, as Marshall indicated earlier, remedial action design and then the implementation of the remedial action.

This last slide shows a summary of the alternatives and associated capital costs, operation and maintenance costs and total costs. And as you can see, there's a significant difference in total costs between alternative soil 5 and alternative soil 6.

If anybody has any questions, I would

be happy to address them.

MR. NELSON: Maybe you should just point out (inaudible).

THE REPORTER: I'm sorry, you're not close enough to the microphone to be picked up for the record.

MR. DAUKAS: Yeah.

MR. NELSON: Marshall Nelson.

Maybe you should just point out that we would do compliance testing after the excavation to make sure that we are in compliance with the criteria.

MR. DAUKAS: Right. We can go back to the slide and go through the actual details of the components.

In component alternative 6, the detailed components would be to prepare a work plan based on the approval of the work plan mobilized to the site, conduct a baseline analytical sampling of ground water, surface water and sediment prior to excavation, excavate surface soil exceeding the RGs using a backhoe or whatever implement is required, sample the, to confirm that the soil has been removed and does meet the remedial goals. The excavated soil would be transported offsite to a treatment and/or disposal facility. The backfill, the area excavated would be backfilled and regraded with clean fill. The impacted area would be revegetated. The implementation of deed restrictions, and then conduct analytical sampling of the ground water, surface water and sediment post excavation. And then complete a five-year site review and prepare site closure reports.

Well, Thank you very much. Have a pleasant evening.

(Meeting concluded at 7:25 p.m.)

CERTIFICATE

I, ISABEL E. COLE, Certified Court Transcriber, AOC #101, and Notary Public of the State of New Jersey, do hereby certify the foregoing transcript to have been prepared from a tape recording made by COLE TRANSCRIPTION AND RECORDING SERVICE and is true and accurate to the best of my knowledge and ability.

Isabel E. Cole AOC #101
COLE TRANSCRIPTION AND RECORDING SERVICE
Dated: January 21, 2003

APPENDIX B

RESPONSIVENESS SUMMARY

RESPONSIVENESS SUMMARY

The U. S. Army (Army) held a 30-day comment period, from December 17, 2002 to January 17, 2002, to provide an opportunity for the public to comment on the Proposed Plan and other documents developed for the Armament Research and Development Area (ARDC) at Fort Dix, New Jersey. The Proposed Plan, prepared in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), is the document that presented the Army's preferred remedial alternative for the ARDC. The preferred remediation alternative for the ARDC is excavation and off-site treatment and/or disposal.

This Responsiveness Summary addresses comments received by the Army during the public comment period and the public meeting, conducted on January 8, 2003. All documents on which the Army's recommendations are based were placed in the Administrative Record for review. The following presents the comments received and the Army's responses.

U.S. Army Project Manager, Marshall Nelson had the following comment:

Comment 1: "Maybe you should just point out that we would do compliance testing after the excavation to make sure that we are in compliance with the criteria."

Response, Haring ESE Project Manager, Glenn Daukas: "In component Alternative 6, the detailed components would be to prepare a work plan, based on the approval of the work plan mobilize to the site, conduct a baseline analytical sampling of groundwater, surface water and sediment prior to excavation, excavate surface soil exceeding the RGs using a backhoe or what ever implement is required, sample to confirm that the soul has been removed and does meet the required remedial goals. The excavated soil would be transported to offsite to a treatment and/or disposal facility. The excavated area would be backfilled and regarded with clean fill. The impacted area would be revegetated. The implementation of deed restrictions, and then conduct analytical sampling of the groundwater, surface water, and sediment post excavation, and then complete a five-year site review and preparation of site closure reports."

No other comments were received.

Fort Dix: Armament Research and Development Center (ARDC) Administrative Record

Remedial Investigation-Feasibility Study

Doc #	Document Title	Doc Date	Document Type	Recipient/Affiliation	Author/Affiliation
100000	Letter Re: USAEC ESPS Fort Dix, New Jersey; Contract No. DACA 331-96-D-0024; ARDC Test Facility; Remedial Investigation/ Feasibility Study; Transmittal of Draft Remedial Investigation Report	8/8/97	Draft RI Report	Dan Sullivan KEMRON Environmental	Glenn L. Daukas, ABB Environmental Svcs., Inc.
100001	ARDC Test Facility, Fort Dix, NJ Memorandum Requesting Review of CENAB-EN-HM 8/18/97 Multiple Memorandum; Review of Draft Remedial Investigation Report by Geotechnical and Water Resources Branch; Comments Upload to ARMS Central	8/27/97	Draft RI Report	Chief, HTRW Branch ATTN: Phillip Scarito FYI to: Marshall Nelson, Ft. Dix	Dennis E. Webb, P.E. Chief, Geotechnical & Water Resources Branch
100002	Comments Received from CENWO-HX-C	8/29/97	Draft RI Report	Georgian, Disc: CHM CENWO-HX-C	Unknown
100003	Letter Re: Draft Remedial Investigation Report for the Fort Dix Armament Research and Development Center (ARDC) Test Facility Site	9/7/97	Draft RI Report	John DeMurley, USEPA cc: Haiyesh Shah, NJDEP Kathleen Swigon of Pinelands Commission	John DeMurley, USEPA
100004	Letter Re: Draft Remedial Investigation Report, ARDC Test Facility Data Item A009, Fort Dix, New Jersey; USEPA and NJDEP Comments	4/7/98	Draft RI Report	Peter M. Tranchik, P.E. DOA-RDPW cc: Marshall Nelson of Fort Dix Haiyesh Shah, NJDEP bcc: Bob Wing, SPB-FFS	John DeMurley, USEPA
100005	Response to USACE Baltimore District Comments on August '97 Draft RI Report, Contract No. DACA331-96-D-0024, Armament Research and Development Center (ARDC) Test Facility, Remedial Investigation-Feasibility Study	Unknown	Response to Comments	Marshall Nelson, Ft. Dix cc: P. Scarito, USACE-Balt. S. Maloney, KEMRON File	Glenn Daukas ABB Environmental Svcs.
100006	Fax w/attached Letters: November 10, 1997 Re: Review and Comments by NJDEP on the September 1997 Remedial Investigation Report for ARDC Test Facility, Fort Dix, NJ Memorandum Requesting; February 05, 1997 Letter from NJDEP Re: Changes to the Safe Drinking Water Act and the Effect on the Ground Water Quality Standards	11/14/97	Comments	Marshall Nelson, Ft. Dix	Semers, Inc.
100007	Draft ARDC Remedial Investigation Report, Response to NJDEP Comments Dated November 10, 1997 from Mr. Haiyesh Shah	May '98	Response to Comments	Unknown	KEMRON

Fort Dix: Armament Research and Development Center (ARDC) Administrative Record

RI/FS Sampling Data

Entry	Document Title	Doc Date	Document Type	Recipient Affiliation	Author Affiliation
100008	Draft ARDC Remedial Investigation Report, Response to NJDEP Second Round Comments Dated December 31, 1997 from Mr. Haiyesh Shah	5/12/98	Response to Comments	Marshall Nelson, Ft. Dix	KEMRON
100009	Final Remedial Investigation ReportARDC Test Facility Data Item 009 Volume I of II Text, Figures, and Tables	Jun '00	Final Report	Marshall Nelson, Ft. Dix	KEMRON
100010	Final Feasibility Study Report ARDC Test Facility Data Item A009	Jul '01	Final Report	Marshall Nelson, Ft. Dix	KEMRON
101000	Memorandum Re: Planned Field Investigations at the ARDC Test Facility	11/19/96	Site Investigation	George Plankenhorn Combat Readiness Division	Linda Chominski DOA-Fort Dix
101001	Fort Dix 13 Production Well Sampling Preliminary Data Results	1/16/97	RI Sampling Data	Marshall Nelson, Ft Dix	Glen Daukas, ABB-ES
101002	Response to NJDEP Request for Additional Information Production Well FTDX-13, Armament Research and Development Site (ARDC)	4/14/97	RI Sampling Data QAPP	Marshall Nelson, Ft Dix cc: Rod Pendleton and Monique Poirier of ABB-ES File 2.5.1	Glenn L. Daukas, ABB Environmental Svcs., Inc.
101003	Response to NJDEP Request for Additional Information, Production Well FT DIX-13, Armament Research and Development Site (ARDC), Revised Analytical Results Table	6/2/97	RI Sampling Data	Marshall Nelson, Ft. Dix cc: Rod Pendleton and Monique Poirier of ABB-ES	Glenn L. Daukas, ABB Environmental Svcs., Inc.
101004	Letter Re: Fort Dix IRP1 Sites, Pemberton Township, Burlington County Referencing Response for Groundwater Investigation Data for Well FTDX-13 ARDC, and Acceptance of Proposal for No Further Investigation and Closure of Well of FTDX-13	6/10/97	Consent Decree	Peter M. Tranchik, P.E. DOA-RDPW cc: John DeMurley, USEPA Todd DeJesus of Pinelands Commission	Haiyesh Shah, NJDEP
101005	Letter Re: Draft Remedial Investigation Report for the Fort Dix Armament Research and Development Center (ARDC) Test Facility Site; Proposed Work Plan for Further Delineation of Soil and Groundwater Contamination in the Fuel Storage Area	5/29/98	Draft RI Report Proposed Work Plan	John De Murley, USEPA cc: Haiyesh Shah, NJDEP Todd DeJesus of Pinelands Commission	Peter M. Tranchik, P.E. DOA-RDPW
101006	Fort Dix IRP1 Sites, Pemberton Township, Burlington County Referencing NJDEP Review of 6/3/98 Letter Proposing Supplemental Remedial Investigation at ARDC and Acceptance of Proposal	6/10/98	RI Sampling Data	John De Murley, USEPA cc: Peter M. Tranchik of DOA-RDPW Todd DeJesus of Pinelands Commission	Haiyesh Shah, NJDEP

Fort Dix: Armament Research and Development Center (ARDC) Administrative Record

RI/FS Sampling Data

Doc #	Document Title	Doc Date	Document Type	Recipient/Affiliation	Author/Affiliation
101007	Letter Re: Additional Soil and Groundwater Sampling, Draft Remedial Investigation Report for the Fort Dix Armament and Research Center (ARDC) Test Facility Site, Fort Dix, NJ	6/24/98	RI Sampling Data	Peter M. Tranchik, P.E. DOA-RDPW	John DeMurley, USEPA
101008	Fax w/Attachments Re: Screening Levels for Use in Remedial Investigations	8/13/98	RI Sampling Data	Steve Cardon KEMRON Environmental	Nancy Roka Harding Lawson Assoc.
101009	Letter Intended to Serve as Work Plan for Additional Soil and Ground-water Sampling, Contract No. DACA331-96-D-0024, ARDC Test Facility, Remedial Investigation-Feasibility Study, Per NJDEP Requests	6/2/98	Work Plan	Marshall Nelson, Ft. Dix cc: R. Pendleton, ABB-ES File	Glenn Daukas ABB Environmental Svcs.
101010	Letter Re: Additional Groundwater Sampling, Draft Work Plan, Contract No. DACA331-96-D-0024, ARDC Test Facility, Remedial Investigation-Feasibility Study, Letter Intended to Serve as Work Plan to Address Sampling Necessary to Delineate/Bracket Identified Groundwater Contamination	12/10/98	Work Plan	Marshall Nelson, Ft. Dix cc: R Pendleton, HLA File	Glenn Daukas Harding Lawson Assoc.
101011	Letter Re: Fort Dix Sites, Pemberton Township, Burlington County, Review by NJDEP of UST Sites December 11, 1998 Letter Providing Response to NJDEP Comments for Site Investigation Reports at Buildings 5351, 5342 and 5202; IRP1 Sites December 11, 1998 Submission Proposing Additional Groundwater Contamination Characterization at ARDC Site; Certified Letter No. P127638818	12/16/98	Response to Comments	Peter M. Tranchik, P.E. cc: John DeMurley, USEPA Todd DeJesus of Pinelands Commission Faxed to Marshall Nelson, Fort Dix on 12/16/98	Haiyesh Shah, NJDEP
101012	Letter Re: Draft Remedial Investigation Report for Fort Dix Armament Research and Development Center (ARDC) Test Facility Site Referencing Enclosure of Work Plan for Additional Groundwater Sampling Necessary to Delineate the Area of Groundwater Contamination Identified in August 1998.	12/29/98	Work Plan	Peter M. Tranchik, P.E. cc: Haiyesh Shah, NJDEP Todd DeJesus of Pinelands Commission	John DeMurley, USEPA

Fort Dix: Armament Research and Development Center (ARDC) Administrative Record

Quality Assurance Project Plans

Doc #	Document Title	Doc Date	Document Type	Recipient Affiliation	Author Affiliation
102000	Modifications to Field Screening Methods, Contract No. DACA331-96-D-0024, Delivery Order No. 3, Armament Research and Development Center (ARDC) Test, Remedial Investigation/Feasibility Study, Field Screening Methodologies	12/9/96	QAPP	Dan Sullivan, KEMRON cc: Marshall Nelson, Ft. Dix Phil Scarito, USACE File 2.51	Glenn L. Daukas ABB Environmental Svcs.
102001	Fort Dix IRP1 Sites, Pemberton Township, Burlington County, RE: NJDEP Comments on ABB 12/9/96 Letter Proposing Minor Modifications to 13 Sites Quality Assurance Project Plan (QAPP)	12/12/96	QAPP	Michael W. Burns U.S. Army at Fort Dix	Haiyesh Shah, NJDEP
102002	Letter Re: IRP 13 Sites Laboratory Testing, Quality Assurance Plan (QAPP), Fort Dix, NJ	2/11/97	QAPP	Michael W. Burns U.S. Army at Fort Dix cc: Marshall Nelson, Ft. Dix Linda Chominski, Ft. Dix-ENRD Haiyesh Shah, NJDEP	John DeMurley, USEPA
102003	Fax w/Attached 4/9/98 Letter from Suzanne Tramontana to John DeMurley Referencing Data Quality Objectives	4/13/98	QAPP	Marshall Nelson, Ft. Dix	John DeMurley, USEPA

Fort Dix: Armament Research and Development Center (ARDC) Administrative Record

Guidance Documents and Technical Literature

Doc #	Document Title	Doc Date	Document Type	Recipient/Affiliation	Author/Affiliation
103000	Letter Re: USAEC ESPS Fort Dix, NJ, Contract No. DACA331-96-D-0024 Delivery Order No. 3, Armament Research and Development Center (ARDC) Test, Remedial Investigation/Feasibility Study, Soil Sampling Equipment Decontamination	11/22/96	Guidance Document	Dan Sullivan, KEMRON cc: Marshall Nelson, Ft. Dix Phil Scarito, USACE Hopeton Brown, USAEC File	Glenn L. Daukas, ABB Environmental Svcs., Inc.
103001	Memorandum Re: Fort Dix Armament Research and Development Center Soil Sampling Equipment Decontamination Procedures, USEPA Finds Revised Procedures Correspond to Requirements for Non-Aqueous Sampling Equipment Decontamination as Specified in the NJDEP's Field Sampling Procedures Manual	12/3/96	Guidance Document	Marshall Nelson, Ft. Dix cc: Haiyesh Shah, NJDEP	Sharon Jaffess USEPA
103002	Letter Re: NJDEP Finds Revised Procedure for Revised Soil Sampling (Non-Aqueous) Equipment Decontamination Procedures for ARDC Acceptable	12/5/96	Guidance Document	Michael W. Burns DOA-RDPW cc: Sharon Jaffess, USEPA Todd DeJesus of Pinelands Commission	Haiyesh Shah, NJDEP
103003	Modifications to Field Screening Methods; Contract No. DACA-331-96-D-0024, Armament Research and Development Center (ARDC) Test, Remedial Investigation/Feasibility Study, Transmittal of Fort Dix 13 Technical Memorandum	3/11/97	Technical Literature	Marshall Nelson, Ft Dix cc: D. Sullivan, KEMRON w/attachments File	Glenn L. Daukas, ABB Environmental Svcs., Inc.
103004	Letter Re: Final Technical Work Plan 13 Sites RI/FS Referencing 9/25/95 Letter; and Investigation of Well FTDX-13 at ARDCite	3/18/97	Technical Literature	Haiyesh Shah, NJDEP cc: John DeMurley of USEPA Kathleen Swigon of Pinelands Commission	Michael W. Burns Dept. of Defense
103005	Letter Re: Federal Facilities Agreement between U.S. Environmental Protection Agency and the U.S. Dept. of the Army dated September '91, In Accordance with Section XVI of the Agreement 30 Day Period of Review May be Extended Additional 20 Days by Written Notice	3/1/98	Guidance Document	John DeMurley, USEPA cc: Robert Wing, USEPA Haiyesh Shah, NJDEP Todd DeJesus of Pinelands Commission	Peter M. Tranchik, P.E. DOA-RDPW

Fort Dix: Armament Research and Development Center (ARDC) Administrative Record

Guidance Documents and Technical Literature

Doc ID	Document Title	Doc Date	Document Type	Recipient Affiliation	Author Affiliation
103006	Letter Responding to Request for Information on Rare Species for Fort Dix Site 3/8 (FTTA) and Site 6 (ARDC)	5/14/97	Technical Literature	Nancy Roka, ABB-ES cc: Lawrence Niles Thomas Hampton NHP File # 97-4007415	Thomas F. Breden NJDEP
103007	Fax w/Attachments Re: ARDC Laboratory Validation for Chemical Analysis in Support of USACE Hazardous and Toxic Waste Programs	8/19/98	Technical Literature	Marshall Nelson, Ft. Dix	Steve Cardon KEMRON Environmental
100006 (Cross Reference)	Fax w/attached Letters: November 10, 1997 Re: Review and Comments by NJDEP on the September 1997 Remedial Investigation Report for ARDC Test Facility, Fort Dix, NJ Memorandum Requesting; February 05, 1997 Letter from NJDEP Re: Changes to the Safe Drinking Water Act and the Effect on the Ground Water Quality Standards	11/14/97	Guidance	Marshall Nelson, Ft. Dix	Semers, Inc.
103008	NJDEP Sediment Quality Criteria	Unknown	Guidance	Unknown	NJDEP
103009	Memorandum Re: Planned Field Investigations at the ARDC Test Facility, Citing NJDEP Regulations Requiring Abandoned Wells Be Sealed, and Plans to Have Water Supply Well at Bldg. 9990 Sealed	11/19/96	Guidance	Force Projection Directorate Combat Readiness Division, Building 5524 Attn: George Plankenhorn CF: Mr. Knighten of Water Filtration Plant Mr. Durham, Range Control Ms. Johnson, EPSD Mr. Santilli, EPSD	Linda D. Chominski DOA-ENRD
103010	Letter Re: USAEC ESPS Fort Dix, New Jersey Contract No. DACA331-96-D-0024, Delivery Order No. 03, Armament Research and Development Center (ARDC) Test Facility, Remedial Investigation-Feasibility Study, Soil Sampling Equipment Decontamination Procedures for the ARDC	11/22/96	Guidance	Dan Sullivan, KEMRON cc: Marshall Nelson, Ft. Dix Phil Scarito, USACE Hopeton Brown, USAEC File	Glenn L. Daukas ABB Environmental Svcs.
103011	Memorandum Re: Fort Dix Armament Research and Development Center, Soil Sampling Equipment Decontamination Procedures, Citing USEPA Review of Proposed Revised Procedures, Procedures Correspond to Requirements for Non-Aqueous Sampling Equipment Decontamination Specified in NJDEP Field Sampling Procedures Manual, EPA Concurs Provided Revision Acceptable to NJDEP	12/3/96	Guidance	Marshall Nelson, Ft. Dix cc: Haiyesh Shah, NJDEP	Sharon Jaffess, USEPA Emergency & Remedial Response Division, Federal Facilities Section
103012	Letter Re: Fort Dix Sites, Pemberton Township, Burlington County, Revised Soil Sampling (Non-Aqueous) Equipment Decontamination Procedures for ARDC Test Facility, NJDEP Accepts Revised Procedure	12/5/96	Guidance	Michael W. Burns DOA-RDPW cc: Sharon Jaffess, USEPA Todd DeJesus of the	Haiyesh Shah, NJDEP

Fort Dix: Armament Research and Development Center (ARDC) Administrative Record

Guidance Documents and Technical Literature

Doc #	Document Title	Doc Date	Document Type	Recipient/Affiliation	Author/Affiliation
103013	Letter Re: Application #91-0820.14, 13 IRP Sites-ARDC Test Facility, Fort Dix, Plumsted Township, Citing Receipt and Review of August '97 Draft Remedial Investigation Report, In Accordance with Memorandum of Agreement All Interim Cleanup Activities May Proceed Under NJDEP Oversight	10/1/97	Guidance	Haiyesh Shah, NJDEP cc: Marshall Nelson, Ft. Dix	Todd DeJesus of the Pinelands Commission
103014	Fax w/attached Information on Geoprobe Small Diameter Monitoring Wells, Sub-Contractor Researching NJDEP Acceptance of Sampling Points	12/1/98	Technical Literature	Marshall Nelson, Ft. Dix	Rod Pendleton Harding Lawson Assocs.

Enforcement Documents

Doc #	Document Title	Doc Date	Document Type	Recipient/Affiliation	Author/Affiliation
104000	Letter Re: Final Technical Work Plan 13-Sites RI/FS, Requesting Notification that Information Provided Establishes Historical TPH Concentrations	5/19/97	RI/FS - Final Tech. Work Plan	Haiyesh Shah, NJDEP cc: John DeMurley of USEPA Kathleen Swigon of Pinelands Commission	Peter M. Tranchik DOA-RDPW
104001	Letter Re: Fort Dix IRP1 Sites, Pemberton Township, Burlington County, NJDEP Request for Summary Table for Groundwater Analytical Data as follows: Name of Contaminant, Sample Location-Depth, Sampling Date, Analysis Date, Analytical Method, Method Detection Limit, Result, Applicable Regulatory Standard, Exceed Standard (Y/N); Provide Summary of Quality Assurance/Quality Control Associated with Groundwater Sampling and Analysis	3/27/97	Request for Information	Michael W. Burns DOA-RDPW cc: John DeMurley, USEPA Todd DeJesus of the Pinelands Commission	Haiyesh Shah, NJDEP

Proposed Plan

Doc #	Document Title	Doc Date	Document Type	Recipient/Affiliation	Author/Affiliation
105000	The Proposed Plan for the ARDC	Oct-02	Final	Marshall Nelson, Ft Dix	Harding ESE, Inc.