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E-MAIL TRANSMITTING COMMENTS AND PROPSED CHANGES TO DRAFT DECISION DOCUMENT LIGHTER AMPHIBIOUS RESUPPLY CARGO (LARC) 60 AREA FORT STORY VA

12/21/2007

COMMONWEALTH OF VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

file: 6C.19.b
6D.6

Bateman, Joanna G Ms CIV USA IMCOM

From: Smith,Wade [wmsmith@deq.virginia.gov]
Sent: Friday, December 21, 2007 10:57 AM
To: Bateman, Joanna G Ms CIV USA IMCOM
Cc: Pace, Tony; Michel, Amber A Miss CTR USA IMCOM; Webster,Amy; McMurray,Patricia
Subject: RE: Decision Document - LARC 60 Site - DEQ Comments

Attachments: DD Table of Contents-WMS.doc; Draft DD - Section 1-WMS.doc; Draft DD - Section 2-WMS.doc


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Draft DD - Section 2-WMS.doc (...

Thank you for giving the DEQ the opportunity to comment on the Draft Decision Document associated with the LARC 60 Maintenance Area at Fort Story.

The Draft Decision Document was received by the DEQ (electronically) on October 23, 2007.

The DEQ's comments are attached (Track Changes via Microsoft Word).

However, please note that the attached comments do not include comments from DEQ's toxicologist/risk assessor.

These additional comments, if any, are anticipated to be completed by February 1, 2008.

Upon your acceptance of the proposed changes and upon your submittal of the requested revisions,

the DEQ will issue an official letter for your files.

Please let me know if you have any questions.

Sincerely,

Wade M. Smith

Remediation Project Manager

Virginia Department of Environmental Quality

Office of Remediation Programs

Phone: (804) 698-4125

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wmsmith@deq.virginia.gov

-----Original Message-----
From: Pace, Tony [mailto:TPace@PIRNIE.COM]
Sent: Tuesday, October 23, 2007 2:33 PM
To: Smith,Wade
Cc: Michel, Amber A Miss CTR USA IMCOM; Bateman, Joanna G Ms CIV USA IMCOM
Subject: LARC 60 Decision Document

Wade,

I have attached the Draft Decision Document for the LARC 60 site for your review and comment. I tried to send a pdf of the report this morning but the file was too large. I have attached the word files for the text; excel files for the tables, and a pdf of the figures.

Get back to me with any questions or comments.

Anthony Pace

Associate - Malcolm Pirnie, Inc.

701 Town Center Dr, Suite 600

Newport News, VA 23606

Phone: 757-873-4434

Cell: 757-532-4386

Fax: 757-873-8723

tpace@pirnie.com

TABLE OF CONTENTS
DECISION DOCUMENT

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LIST OF TABLES

Comment [t1]: Please add date to table header.

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Comment [t2]: Tables 2-1 through 2-6: Please include a reference to the sample date on each of these tables.

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LIST OF FIGURES

Comment [t3]:
Figures 2-1 through 2-3:
Please indicate the location of the following areas that are referenced throughout this Decision Document:
coastal dune complex;
central sand ridge;
concrete wash rack pad;
north gate;
Outfall 001;
drainage ditch;
Sandbox Area;
Building 808 (not Building 817);
Building 810 (not Building 816).

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This Decision Document (DD) has been modeled after the Environmental Protection Agency (EPA) Record of Decision format for CERCLA National Priorities List (NPL) sites. The EPA guidance document entitled *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents*, EPA 540-R-98-031, July 1999, has been utilized for preparation of this document.

1.1 SITE NAME AND LOCATION

This DD has been prepared for the Lighter Amphibious Resupply Cargo (LARC) 60 Maintenance Area site (hereafter referred to as the LARC 60 site) at Fort Story, Virginia. The LARC 60 area, which is the maintenance and wash rack area for LARC 60 vehicles, is located in the sand flat area that lies between the coastal dune complex to the north and the central sand ridge to the south.

1.2 STATEMENT OF BASIS AND PURPOSE

This DD presents the Selected Remedy (No Further Action) for environmental media at the LARC 60 site on the U.S. Army installation designated as Fort Story, Virginia. The Selected Remedy (No Further Action) was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The U.S. Army, as owner/operator and the "Lead Agency" (terms that are defined in the NCP) prepared this decision in consultation with the Virginia Department of Environmental Quality (VDEQ) as a "Support Agency". The Army selects the remedy in accordance with CERCLA in consultation with and concurrence by VDEQ.

1.3 ASSESSMENT OF THE SITE

The Lead Agency has determined that no remedial action is necessary to protect public health and welfare or the environment; however, because various volatile and semivolatile organic compounds (VOCs and SVOCs) have previously been detected above EPA Maximum Contaminant Levels (MCLs), two additional groundwater monitoring events involving the collection of samples from seven wells (MW-115 [upgradient well], MW-117, 6MW-3S, 6MW-5S, 6MW-7, 6MW-9, and 6MW-11) will be conducted to confirm that these contaminants continue to stay below the MCLs. All contaminants were below the MCLs as noted in a May 2007 groundwater monitoring event.

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Comment [t1]:
Please include an explanation for including MW-115.
Sampling this well was not mentioned in the Proposed Plan.

Comment [t2]:
Please include the language from the Final RI Report Addendum stating that every effort should be made to locate 6MW-8.

1.4 DESCRIPTION OF SELECTED REMEDY

No CERCLA action is necessary for the LARC 60 site.

No Further Action is necessary at the LARC 60 site based on the limited contamination detected at the site, the trends indicating that contaminants of concern (COCs) concentrations in groundwater are decreasing due to numerous fate mechanisms, and the results of the baseline risk assessment that did not identify receptors and potentially exposed populations.

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Two additional groundwater monitoring events with analysis for VOCs and SVOCs will be conducted to confirm that COC concentrations are below MCLs. However, if a site-related MCL exceedence occurs during either of the two sampling events, then the Army will implement the contingency of conducting two additional rounds of groundwater monitoring after completion of the original two events to confirm that a site-related concern exists or that the exceedence was an anomalous event. If the monitoring events indicate that COC concentrations exceed MCLs and the concentrations are not simply an anomalous event, then a re-assessment of potential risks and remedies will be warranted.

1.5 STATUTORY DETERMINATIONS

None of the CERCLA §121 statutory determinations are necessary in this section because a No Further Action remedy is being selected.

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Based on the conclusions (as stated in Section 1.3 above) of the revised risk assessment provided in the *Final Remedial Investigation (RI) Addendum Report*, dated September 2007, prepared by Malcolm Pirnie, Inc., no remedial action is necessary to ensure protection of human health and the environment. Because this No Further Action remedy will not result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a five-year review will not be required.

AUTHORIZING SIGNATURES

_____

Andrew W. Bowes
Colonel, U.S. Army
Garrison Commander

2.1 SITE NAME, LOCATION, AND DESCRIPTION

This Decision Document (DD) presents the U.S. Army's selected remedy (No Further Action) for the LARC 60 site at Fort Story, Virginia. The site is known as Site 06 (FTSTY-06) – LARC 60 Maintenance Area. The Fort Story EPA ID Number is VA6210020875 and the RCRA EPA ID Number is VA1213720815. The Defense Environmental Restoration Account (DERA) is the source for investigation and cleanup funds for this site.

Fort Story is located in southeastern Virginia within the city of Virginia Beach, Virginia. Fort Story occupies an area of approximately 1,451 acres and is situated on Cape Henry, which roughly divides the waters of the Chesapeake Bay to the north and the Atlantic Ocean to the east.

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Fort Story currently trains Army personnel in amphibious and Logistics Over-the-Shore (LOTS) operations. Fort Story is the only available facility that has the necessary natural terrain features and beaches, sand, surf, variable tide conditions (bay and ocean) and hinterlands, all of which are normally experienced by amphibious and LOTS operations. In addition, Fort Story contains beach training areas, tactical training areas and a series of trails throughout the installation. The deep water ship anchorage, off-road driving areas and soil of sufficient bearing strength for the heavy vehicles are indispensable in amphibious training, LOTS training and the testing of new equipment, doctrines and techniques. From 1914 until the present, activities at Fort Story have included the following:

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- Utilization as a coastal artillery garrison
- Headquarters of the Harbor Defense Command
- Location of a convalescent hospital during World War II
- Amphibious operations training facility

The LARC 60 site, which is the maintenance and wash rack area for LARC 60 vehicles, is located in the sand flat area that lies between the coastal dune complex to the north and the central sand ridge to the south. The LARC 60 site includes Buildings 1081, 1082, 1083 and 1088. During the 1950s, the wash rack area was first used as the barge amphibious resupply cargo (BARC) motor pool and maintenance facility. In 1964, the BARC vehicle was phased out and the LARC 60 vehicle was prototyped. Presently, Fort Story is the only base on the East Coast available to the Army Transportation Corps for amphibious training. In 1982, the LARC 60 facility was modified with the construction of a concrete wash rack pad. Approximately 39 catch basins are located throughout the LARC 60 site, which are used for collection of storm and wash water. Heavy equipment is currently stored awaiting maintenance and operated on the concrete wash rack and Sandbox Area. A former 10,000-gallon underground storage tank (UST) was located at the north gate of the LARC 60 vehicle motor pool approximately 600 feet south of the

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wash rack area. This UST was installed in 1983 and used for storing used oil and degreasers. The LARC 60 site is presented on **Figure 2-1**.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

This section summarizes the site history and site investigations. No federal or state enforcement activities have been undertaken at either site.

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2.2.1 Site History

A former 10,000-gallon UST was located at the north gate of the LARC 60 vehicle motor pool approximately 600 feet south of the wash rack area. This UST, installed in 1983, was used for storing used oil and degreasers. Although James M. Montgomery, Inc.'s (JMM) April 1990 field visits to this area identified soil-stained zones around the UST, there are no reports of tanks failing or leaking documented. These soil-stained areas may have been caused by overfilling or spillage during use. In 1987, the U.S. Army Environmental Hygiene Agency sampled the UST and found it contained oil, water, 1,1,1-trichloroethane and chromium. In September 1992, the Environmental Restoration Company (ERC) removed the waste oil UST and excavated petroleum-stained soils an additional three feet from the sides and bottom of the excavation. The specific volume of soils removed is not known.

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2.2.2 Previous Investigations

A summary of previous investigations conducted at the site is provided below.

PREVIOUS INVESTIGATIONS		
Investigation	**Description**	**Results**
U.S. Army Environmental Hygiene Agency Risk Assessment (June1987)	Health risk assessment of soil contamination.	No unacceptable human health threat exists to workers at the site.
James M. Montgomery PA/SI (January 1992)	PA/SI conducted to determine presence of contamination at site.	Total petroleum hydrocarbons (TPH) and metals detected in soils. TPH and VOCs detected in groundwater.
ERC Initial Abatement (September 1992)	UST Initial Abatement Measures Report prepared for UST and soils removal	10,000 gallon UST and associated petroleum-stained soils removed from excavation.
IT Corporation Removal Action (November 1994)	Removal action conducted to remediate soils.	Treated TPH contaminated soils on site via bioremediation.

PREVIOUS INVESTIGATIONS		
Investigation	**Description**	**Results**
Environmental Technology UST Investigation (February 1995)	UST investigation with soil and groundwater samples collected.	Numerous VOCs and TPH were detected in groundwater.
Earth Technology Soil Sampling Event (April 1995)	Collection of additional soils data in the former UST excavation area.	PID results indicated that petroleum contamination was present in the soil zone above the water table but below the former excavation depth.
Malcolm Pirnie Remedial Investigation (2002)	Performance of an RI including the collection of soil, groundwater, sediment, and surface water samples	Numerous VOCs, SVOCs, and metals detected in site media.
Malcolm Pirnie Groundwater Pilot Scale Study (2004)	Injection of sodium permanganate in the former source area to evaluate the effectiveness of destruction of groundwater contaminants	VOC and SVOC concentrations decreased in the injection area
Malcolm Pirnie RI Addendum (September 2007)	Re-evaluation of risk based on additional data collected in May 2007	All groundwater contaminants were detected below EPA drinking water standards and no human health or ecological risk identified

U.S. Army Environmental Hygiene Agency Risk Assessment

The U.S. Army Environmental Hygiene Agency (USAEHA) conducted a Health Risk Assessment in June 1987 at the LARC 60 Maintenance Area to determine if an unacceptable health threat exists to workers at the site. USAEHA detected grease, oil, lead and chromium in soil north of the wash rack (Sandbox Area). For the contaminants, the excess, upper bound, lifetime cancer risk estimate calculated was within the range considered acceptable to the EPA. In addition, the hazard index derived was less than one, indicating that non-carcinogenic health effects would not be expected. Based on the quantitative risk assessment, USAEHA concluded that an unacceptable human health threat does not exist to workers at the site.

James M. Montgomery, Inc. (JMM) Preliminary Assessment/Site Investigation

Preliminary Assessment/Site Investigation (PA/SI) activities were conducted in 1991 and 1992 by James M. Montgomery, Inc. (JMM, 1992). JMM conducted the PA/SI to determine the presence of significant contamination at eight sites including the LARC 60 Maintenance Area.

At the facility, several analytes were detected in the soil at levels above the trigger levels (i.e., Virginia UST standards for TPH, Toxic Substance Control Act [TSCA] standards for polychlorinated biphenyls [PCBs], and background concentrations for all other contaminants). The site has two main areas of possible environmental concern: the wash rack area, which has an oil/water separator (OWS), and the former UST area. Total fuel hydrocarbons, copper, zinc, and lead were detected above trigger levels at the site.

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As with soil samples, numerous analytes were detected in groundwater above trigger levels at the wash rack and UST areas. Benzene, vinyl chloride, total fuel hydrocarbons, and 1,1-DCE were detected above trigger levels.

A Remedial Investigation/Feasibility Study (RI/FS) was recommended at the LARC 60 Maintenance Area and three other sites.

ERC Initial Abatement Measures Study

On September 28, 1992, ERC removed one 10,000 gallon UST that contained used oil from Building 1081. Based on the report, the removal of the UST resulted in an excavation depth of approximately 12.5 feet below land surface (BLS). The initial excavation was reported to be to a depth of 9.5 feet BLS with an additional three feet of petroleum-contaminated soil removed from the sides and bottom of the excavation. According to the report, the stained soils were placed back into the excavation.

Three grab samples were collected by ERC personnel from the bottom of the excavation while one composite soil sample was collected from the staged soils. These soil samples were analyzed for total petroleum hydrocarbons (TPH) by EPA Method 418.1. TPH concentrations in the samples from the bottom of the excavation ranged from 36,353 to 62,823 milligrams per kilogram (mg/kg) while the composite samples from the staged soil pile had a TPH concentration of 12,173 mg/kg.

IT Corporation Removal Action

IT Corporation (IT, 1994) conducted several rapid response removal actions at Fort Story in 1994, including the LARC 60 Maintenance Area. IT Corporation reported that the following activities were performed at the site:

- Disposal off-site of two piles of soil believed to contain F-listed solvents.
- Designed and installed an in-situ bioremediation system for the treatment of TPH-contaminated soils.

- Excavated and treated approximately 14,600 cubic yards of soil within the LARC 60 Sandbox Area to a TPH level of less than 50 parts per million (ppm). The soils were transferred to the bioremediation system for treatment.

- Placed remediated soils back in the excavated area. However, due to the presence of heavy oils and greases in the soils, the 50 ppm treatment goal could not be reached with the bioremediation process. TPH concentrations remaining in treated soils ranged from non-detect to 4,800 ppm with an average concentration of 229 ppm (by Method 8015) and 751 ppm (by USEPA Method 418.1) remaining in soils.

Environmental Technology of North America, Inc., UST Investigation

In February 1995, Environmental Technology of North America, Inc. (ETI) through a USACE, Norfolk District contract, collected soil and groundwater samples by direct push technology (DPT) from the former UST pit at the southern end of the site to determine groundwater quality in that location. TPH, toluene, ethylbenzene and xylene were detected in soils from the pit and from stockpiled soils. Numerous chlorinated organics were detected in the groundwater sample including TPH (180 mg/l), tetrachloroethene (2,700 micrograms per liter (µg/l)), trichloroethene (8,800 µg/l), and cis 1,2-dichloroethene (5,200 µg/l).

Earth Technology Soil Sampling Event

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Based on continuing issues with the data provided in the ERC Initial Abatement Measures study report, the VDEQ requested additional information and clarification. The ERC report indicated that an excavation 9.5 feet BLS was observed after the tank removal followed by an additional three feet of petroleum-stained soils removed from the bottom and the sides of the excavation. According to ERC's report, the excavation was then backfilled with the contaminated soil. Based on this information, the VDEQ requested sampling of the backfill soils. Upon mobilization to the site and performance of the field activities, Earth Tech made the following observations:

- The excavated pit had been backfilled with clean sand, lithologically different from the native material.
- The depth of the excavation did not extend beyond 9.5 feet BLS.
- Soil from the original excavation activities were stockpiled adjacent to the excavation and not placed back into the excavation.

In April 1995, Earth Tech collected soil samples from the backfill material and the native soils underlying the backfilled soils. Field observations of the underlying soil material indicated higher photoionization detector (PID) readings than those in the backfill material, but showed no

evidence of fuel-saturated soils or free product. Based on the data collection effort, no additional excavation of material was warranted from the former UST excavation area.

Malcolm Pirnie Remedial Investigation

Malcolm Pirnie completed a RI in 2002 with submission of the Final RI report in December 2002. A summary of the nature and extent of contaminant and the risk assessment will be presented in Section 2.5 and Section 2.7, respectively.

Malcolm Pirnie Groundwater Pilot Scale Study

Malcolm Pirnie contracted with In-Situ Oxidative Technologies, Inc. (ISOTEC) to perform sodium permanganate ($NaMnO_4$) injections throughout the course of the Pilot Study. Liquid concentrate was used for both injection events at the site. ISOTEC used a recirculating mixer assembly to mix the $NaMnO_4$ with potable water obtained from a nearby fire hydrant. One hundred and ten pounds (lbs) (approximate 1% solution) of $NaMnO_4$ solution per point for both injection events was planned. However, due to the need for a higher dose for the second event (based on groundwater data after the 1st injection, which indicated that the initial injection with a lower dose was not adequate to reduce the VOC concentrations), approximately 550 lbs (8% solution) per point was injected during the 2nd event.

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The zone of treatment included an interval from 10 feet to 30 feet below land surface (bls) with the groundwater table present at a depth of approximately 10 feet bls. Five injection points located upgradient of monitoring well MW-117 (well with highest contaminant concentrations on-site) were utilized for delivery of the permanganate. Based on the thickness of the treatment zone (20 feet), each injection point was divided into five 4-foot intervals (10 to 14 feet bls, 14 to 18 feet bls, 18 to 22 feet bls, 22 to 26 feet bls, and 26 to 30 feet bls), with each interval receiving permanganate. The study consisted of the injection of approximately 85 gallons of reagents into each injection point interval. Oxidants were delivered into the subsurface under a constant low-pressure (20 to 30 psi) system in an effort to distribute materials in a homogeneous fashion through the injection interval. A flow rate of 4 to 5 gallons per minute was utilized for delivery of the oxidant into the subsurface.

During the 1st injection event of the Pilot Study in Month Year, approximately 2,125 gallons of a 1% solution of $NaMnO_4$ were injected at five injection points (425 gallons per point) on August 12 and 13, 2003. A volume of 2,125 gallons of the 1% $NaMnO_4$ solution equals approximately 550 lbs of permanganate delivered to the subsurface during the 1st injection event. The zone of treatment for the 2nd injection event was the same as the zone described for the 1st injection event. The 2nd injection event consisted of the injection of approximately 55 gallons of reagents into each injection point interval. During the 2nd injection event of the Pilot Study in Month Year, approximately 1,375 gallons of an 8% solution of $NaMnO_4$ were injected at five injection points

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(275 gallons per point) on May 13, 2004. The volume of 1,375 gallons of the 8% $NaMnO_4$ solution equals approximately 2,750 lbs of permanganate delivered to the subsurface during the 2nd injection event.

Details of the Groundwater Pilot Scale Study can be found in the RI Addendum, dated September 2007.

Malcolm Pirnie RI Addendum

To address a revised risk assessment and to summarize groundwater monitoring data collected in May 2007, Malcolm Pirnie completed a RI Addendum in September 2007. A summary of the groundwater results and the revised risk assessment conclusions are presented in Section 2.5 and Section 2.7, respectively.

2.3 COMMUNITY PARTICIPATION

The Malcolm Pirnie Final Remedial Investigation (RI) report (dated December 2002), Final RI Addendum Report (dated September 2007), Proposed Plan (dated September 2007), and this Decision Document for the LARC 60 site at Fort Story, Virginia are available to the public at the Fort Eustis Environmental and Natural Resource Division office, the Fort Story Library, and the City of Virginia Beach Oceanfront Area Library.

The National Contingency Plan (NCP) requires public participation in the selection of a remedy for a site. The notice for public comment to the Proposed Plan was placed in the Virginia Pilot on September 7, 2007 and in The Wheel on September 13, 2007 with the 30-day public comment period ending on October 7, 2007. A public meeting was held at the Virginia Beach Oceanfront Area Library on September 24, 2007.

2.4 SCOPE AND ROLE OF RESPONSE ACTION

Except for two additional groundwater monitoring events to confirm that residual contaminant concentrations remain below EPA MCLs, no additional response action is warranted at this site.

However, if (as a result of either of the two rounds of sampling) a site-related COC MCL exceedence occurs, then the Army will implement the contingency of conducting two additional rounds of groundwater sampling (beyond the two already agreed upon) to confirm that a site-related concern exists or that the exceedence was an anomalous event. If it is a site-related concern, then the Army will reevaluate appropriate response actions.

2.5 SITE CHARACTERISTICS

The following section provides an overview of the site's physical characteristics, such as geology, and describes the nature and extent of site contamination.

2.5.1 Physical Site Characteristics

Surface Topography and Hydrology

The LARC 60 site is located in the sand flat area that lies between the coastal dune complex to the north and the central sand ridge to the south. The majority of the site is a paved maintenance area with no significant topographic relief. Surface runoff and wash water from the majority of the site is controlled by a storm drain system. A system of 39 catch basins and an oil/water separator is used to collect storm and wash water from the site. The water flows into a drainage outfall line and then into the Chesapeake Bay at Outfall 001. This point is monitored through a National Pollution Discharge Elimination System (NPDES) permit by the Virginia Department of Environmental Quality (DEQ), Water Division. Surface runoff from the Sandbox Area drains into a drainage ditch located along the northern boundary of the Sandbox Area. The ditch is a storm water collection area with no discharge point.

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Geology and Hydrogeology

The site lithology was established based on borings conducted during the PA/SI and RI field activities. Borehole logs provided lithologic data for five permanent monitoring wells and two piezocone borings from the current investigation. The sediments underlying the LARC area consist of sand deposits of the Kennon and Columbia Group that are of Holocene and Pleistocene Age respectfully. Drilling penetrated the upper forty feet of sediments and these were described with respect to lithology and sedimentary features by the site geologist. The following table provides a summary of the lithologic units:

DEPTH (BLS)	USCS SOIL TYPE	DESCRIPTION
0 – 2	SP	Asphalt. Fine sand, well sorted, with heavy minerals, moderately sorted.
2 – 18	SM	Medium to fine sand, with heavy minerals, moderately sorted.
18 – 35	SW	Coarse to medium sand, subrounded, with lenses of gravel and medium sand of heavy minerals; with layers of fine to medium sand and sand of heavy minerals.

DEPTH (BLS)	USCS SOIL TYPE	DESCRIPTION
35 – 46	SC	Fine sand, with heavy minerals, with lenses of cohesive, plastic clay.

The measured depth to groundwater at the site ranged from 2.80 to 9.91 feet BLS. Water level data from on-site wells indicates that the water table elevation ranges from approximately 4.81 to 6.33 NGVD. Though locally variable in magnitude and direction, the prevailing hydraulic gradient for the site is in a northward direction toward the coastline as presented on **Figure 2-2**. Estimated hydraulic conductivity values range from 1.99 x 10^{-3} to 1.84 x 10^{-2} centimeters per second (cm/sec) with an average value of 7.42 x 10^{-2} cm/sec as established by the PA/SI.

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To evaluate possible tidal influence on water table elevations, water levels for monitoring wells 6MW-3S, 6MW-4, and MW-118 were recorded by a data logger from May 17 through May 19, 1995. No measurable amount of precipitation was recorded by the rain gauge, though the inside of the gauge was moist. Over the test period, groundwater levels varied no more than 0.19 feet. Data indicate a generally lowering water table, but do not indicate any trends in groundwater elevation that are attributable to tidal influence.

Archaeological and Historical Information

In April 2003, the Secretary of the Interior determined that Fort Story was a historic district based on the installation's Cold War and World War II significance. All structures built prior to 1978 and associated archaeological deposits are components of this district.

2.5.2 Remedial Investigation Sampling Activities

The following sections outline the specific RI field activities performed at the LARC 60 site at Fort Story. Initial specific activities, which were conducted in February and April 1995, were based on the Scopes of Services for the project dated 17 August 1994. Additional groundwater samples were collected in 2003, 2004, and 2007 for additional site characterization and evaluation of the performance of the Groundwater Pilot Scale Study conducted in 2004.

2.5.3 Nature and Extent of Contamination

Analytical data for the field investigations are presented in **Tables 2-1 through 2-7**.

Soil

A summary of the nature and extent of soil contamination is provided as follows:

Former UST Area

- Acetone, tetrachloroethene (PCE), and toluene were detected in several surface and subsurface soil samples collected in the Former UST Area of the site. Concentrations of the VOCs varied from surface to deeper depths with no apparent trends. The lateral extent of surficial VOC contamination is limited to a relatively small area around the former UST excavation.

- TPH as Heavy Oils was detected in two surface soil samples collected in the vicinity of the former UST pit. The presence of TPH in the surface soils and not in the subsurface soils in the vicinity of the UST pit is probably due to transport of sediment from the soil pile or from the deposition of some TPH-contaminated soil in this area during excavation activities. The lateral extent of surficial contamination is limited to a small area around the former UST excavation.

- Numerous metals were detected in soils in this area with concentrations typically decreased with depth. The lateral extent of metal contamination was not defined, however, metal concentrations, except for arsenic at SB-01, and was at least one order of magnitude lower than the EPA screening criteria.

OWS Area

- Acetone, methylene chloride, methyl ethyl ketone (MEK), and toluene were detected in several surface and subsurface soil samples collected in the OWS area of the site. PCE and trichloroethene (TCE) were only detected in one soil boring located in the concrete pad near the Sandbox Area.

- TPH as Heavy Oils was detected in the majority of surface and subsurface soil samples collected in this area. TPH concentrations decreased with depth in all borings sampled in the OWS Area. TPH as Heavy Oils was also detected at three sample depths in soil boring #4, which is located upgradient of the OWS. The source of the TPH in this area is unknown.

- Various metals were detected in at least one of the four samples collected from the two borings. Metal concentrations typically decreased with depth. The lateral extent of metal contamination was not defined. Their concentrations were lower than the risk screening criteria.

Sandbox Area

- Methylene chloride, MEK, styrene, PCE, toluene and TCE were detected in numerous surface and subsurface soil samples collected in and downgradient of the Sandbox Area.

Concentrations of the VOCs varied from surface to deeper depths with no apparent trends. No patterns were indicated in the lateral distribution of VOCs within the Sandbox Area.

- Numerous metals were detected in soil samples collected. However, their concentrations were at least one order of magnitude lower than the EPA screening criteria.

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- TPH as Heavy Oils was detected in the majority of surface and subsurface soil samples collected in this area. The source of the TPH in this area is probably from past wash rack, operations and maintenance activities in this area and from current LARC vehicle operation and storage activities (i.e., leaks from heavy equipment).

- Numerous metals were detected in soil samples collected. However, except for arsenic at SB-20, their concentrations were at least one order of magnitude lower than the EPA screening criteria.

- The bioremediation activities conducted by IT Corporation in 1994 significantly reduced the concentration of TPH in the Sandbox Area soils especially the lighter end hydrocarbons and probably PAH compounds typically associated with petroleum products, however, as confirmed during IT's post-remediation sampling, TPH as Heavy Oils is still present in the majority of the soils within the Sandbox Area with concentrations ranging from 77 to 1,500 *mg/kg*. However, only low concentrations of VOCs and no PAHs were detected in surface and subsurface soils in the Sandbox Area indicating that the bioremediation was effective in reducing or eliminating the source of the hazardous constituents typically associated with petroleum hydrocarbons.

Exceedences of the EPA screening criteria for the site soils are presented on **Figure 2-3**.

Groundwater

A summary of the nature and extent of groundwater contamination is provided as follows:

Former UST Area

- Numerous sampling locations within and downgradient of the former UST contained TPH, BTEX, PCE and/or one or more of its degradation products (TCE and cis 1,2-DCE).

- Based on the assumption that the former UST was the source of the release, the lateral distribution of these contaminants implies these compounds have migrated with groundwater from the former UST location downgradient to the northeast with the leading edge located at DPT #11 and trailing edge at the former UST pit.

- No FFP was detected in the groundwater in the Former UST Area.

- The vertical extent of contamination was delineated through the collection of samples from one deep DPT point (DPT #17) and several deep wells (6MW-3D and 6MW-2, which are screened from 30 to 40 feet below grade. The vertical extent of contamination is limited to above 39.5 feet below grade.

- The concentration for total and dissolved arsenic, iron, and manganese exceeded the EPA RBCs for tap water at Well MW-117. No other sampling locations in the Former UST Area detected concentrations of total or dissolved metals above the screening criteria.

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The concentration for total and dissolved arsenic, iron, and manganese exceeded the EPA RBCs for tap water at Well MW-117. No other sampling locations in the Former UST Area detected concentrations of total or dissolved metals above the screening criteria.¶

OWS Area

- Although detected in total samples in 1995, dissolved arsenic was not detected, which indicates that arsenic is associated with the sediment in the groundwater sample. Neither total nor dissolved arsenic was detected in 6MW-3S from the 2000 sampling event.

- Various total and dissolved metals including aluminum, iron, and manganese were detected throughout the OWS area above the EPA RBCs for tap water.

Sandbox Area

- Total aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, vanadium, and zinc were detected in DPT samples in the Sandbox Area at concentrations greater than EPA RBCs for tap water. Since no dissolved metals analysis is available for these two locations, no conclusions can be made with regard to whether the detected concentrations are associated with sediments in the groundwater sample or in a dissolved state in groundwater. All concentrations of total and dissolved metals were from two locations; therefore, no trends could be discerned with respect to vertical and lateral distribution.

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Site Wide Assessment

Groundwater samples have been collected from monitoring wells across the site in numerous monitoring events since 1995. The locations of these wells are presented on **Figure 2-2**. As shown in **Table 2-7**, numerous VOCs, as well as two PAHs (naphthalene and 2-methylnaphthalene), have been detected in wells at the site over the 12-year monitoring period. However, historically VOCs have only exceeded the MCL (or RBC when an MCL was not available) in four wells (MW-117, 6MW-3S, 6MW-7, and 6MW-9) at the site. It should be noted that the 2003 6MW-9 exceedence (1 µg/L for 1,4-dichlorobenzene) appears to be the result of cross-contamination, since it also was detected in the associated method blank for that sample.

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A summary of the MCL exceedences by sampling event is presented in the following table:

VOC	MCL Exceedences by Sampling Event				
	1995	2000	2003	2004	2007
Cis 1,2-DCE		MW-117: 1,900 µg/L		6MW-3S: 100 µg/L	None
PCE	MW-117: 8.5 µg/L		6MW-7: 11 µg/L	6MW-3S: 62 µg/L	None
TCE	MW-117: 18 µg/L			6MW-3S: 140 µg/L	None
Vinyl chloride		MW-117: 8.6 µg/L 6MW-3S: 3.1 µg/L		6MW-3S: 9.7 µg/L	None

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The effects of the sodium permanganate injections on groundwater quality in the former source area is evident by the continued decrease in VOC concentrations in MW-117, which is located directly downgradient of the former source area where the injections took place. It should be noted that there was a downward trend in VOC concentrations in MW-117 prior to the injections as noted in the 2003 groundwater data from MW-117. From the 1995 to 2000 to 2003 monitoring events, concentrations of cis 1,2-DCE, ethylbenzene, PCE, toluene, TCE, xylenes and vinyl chloride decreased. The post-injection data for MW-117 (2004 to 2007) suggests a continued downward trend with cis 1,2-DCE concentrations decreasing from 24 to 2 µg/L, PCE from 0.67 µg/L to non-detect, and xylenes from 65 to 13 µg/L.

Historically, the most impacted downgradient well has been 6MW-3S with cis 1,2-DCE, PCE, TCE, and vinyl chloride exceeding the MCLs in the 2004 monitoring data. Although still detected in 2007, none of these compounds exceed their respective MCL. Monitoring well 6MW-9 is located directly downgradient of 6MW-3S but none of these compounds were detected in 2007.

Due to the noted presence of naphthalene and 2-methylnaphthalene above the EPA RBCs for tap water during the RI sampling event, PAHs were analyzed as well during the May 2007 monitoring event. Naphthalene and 2-methylnaphthalene were only detected in one well (MW-117) during this monitoring event at concentrations of 5.1 and 5.3 µg/L, respectively. Although no EPA MCL has been established for these two compounds, their concentrations are below the EPA RBCs for tap water of 24 µg/L for 2-methylnaphthalene and 6.5 µg/L for naphthalene. The naphthalene detect of 5.3 µg/L is also less than the EPA lifetime health advisory of 100 µg/L. No such advisory has been established for 2-methylnaphthalene.

There are several reasons for the decreasing trends downgradient including: (1) impact of the sodium permanganate injections upgradient have greatly decreased the concentrations of these VOCs at the source area thereby reducing the mass of VOCs present that can continually leach into groundwater or be transported downgradient, (2) with the reduction of source mass

concentrations, infiltration, which is high because of the sandy soils and shallow groundwater present reduces concentrations throughout the site, and (3) albeit slow because of the relatively flat groundwater gradient, dispersion of contaminants will have somewhat of an effect on VOC concentrations.

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Sediment

A summary of the nature and extent of sediment contamination is provided as follows:

- TPH as Heavy Oils is present in the ditch north of the Sandbox Area due to surface transport of soil from the Sandbox Area during heavy precipitation events. Due to stagnant conditions, an accumulation of TPH-contaminated sediment occurs in the ditch with no transport occurring.

- Metals are present in sediment in the ditch but as previously discussed, with concentrations lower than EPA screening criteria.

Exceedences of the EPA screening criteria for the site sediment from the drainage ditch north of the Sandbox Area are presented on **Figure 2-3**.

Surface Water

A summary of the nature and extent of surface water contamination is provided as follows:

- Based on vertical elevations established for the two surface water locations in the ditch, the ditch intersects the shallow water table. The elevations were consistent with the groundwater elevations in that area.

- During dry weather conditions, the water (if any) present in the drainage ditch will be groundwater that has seeped into the ditch. Surface water results were also consistent with contaminant concentrations detected in DPT points in the Sandbox Area and in monitoring well 6MW-3S. Acetone and total metals are present in the ditch but, as previously discussed, with the exception of manganese, which was greater than the EPA RBC for tap water, with concentrations lower than EPA screening criteria.

Exceedences of the EPA screening criteria for the site surface water from the drainage ditch north of the Sandbox Area are presented on **Figure 2-3**.

2.5.4 Fate and Transport of Contaminants

A summary of the fate and transport for compounds at the LARC 60 site is provided below:

- The chlorinated hydrocarbons detected in groundwater are believed to be also

associated with a release from the former UST as confirmed by groundwater sampling in February 1995 by Environmental Technology and Malcolm Pirnie during the current investigation.

- TPH as Heavy Oils would be expected to be transported along with the soil/sediment to which it is adsorbed. This is probably occurring as storm runoff as well as by runoff during equipment maintenance activities at the wash rack immediately north of the oil/water separator.

- No groundwater samples contained TPH as Heavy Oils as expected since the aqueous solubility of the compound is very low and concentrations in soils were not significant.

- The presence of TPH - Light Ends and chlorinated hydrocarbons in groundwater underlying the oil/water separator and Sandbox Areas is most likely the result of migration of these compounds from the former UST area.

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- As presented in the previous section, due to natural processes and the sodium permanganate injection pilot scale study, VOC and SVOC concentrations have continued to decrease at the site with current concentrations ranging from non-detect to less than EPA drinking water standards.

2.6 CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

This section provides a characterization of current and future site uses, and identifies the potentially exposed populations at or near the site with regard to the current situation and potential future conditions.

Current Situation

The site is currently used as an equipment maintenance area. Because the site is fenced and locked after 5 p.m. daily, potential exposures to the general public and/or trespassers would not be significant because their presence on the site would be expected to be for only a short time, and not routine. Additionally, site soil concentrations did not exceed industrial soil RBC standards, which are the current use for the site.

Groundwater is not used in the vicinity of the site for drinking, process, or production purposes. The chief potable water supply in the region is the surface water reservoir system operated by the City of Norfolk. The system includes in-town lakes located near the Norfolk International Airport and other reservoirs (Lake Prince, Western Branch and Burnt Mills) located in Suffolk, Virginia. The in-town lakes are located over 5 miles from Fort Story while the Suffolk lakes are located over 20 miles from the facility. As stated in Section 3.1.5, several housing communities located within 1 mile of Fort Story are developing drinking water wells in the shallow aquifer;

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however, none of these communities are located downgradient of the site. Migration potential is minimal due to the very low vertical gradient present across the site. VOC concentrations have decreased substantially due to numerous natural subsurface mechanisms such as biodegradation, volatilization, and dispersion and implementation of the Groundwater Pilot Scale Study, which injected sodium permanganate into the former source area. Therefore, exposures to groundwater, under current conditions will not exceed regulatory standards since there are no current uses of the groundwater and that MCLs were not exceeded in the last groundwater monitoring event conducted in May 2007.

Future Land Use

Although construction or excavation activities could be conducted in the future, neither surface nor subsurface soil contaminant concentrations exceeded industrial screening criteria. Therefore, no significant exposures during these activities would be expected because these activities are typically very short term and contaminant concentrations were below screening criteria.

Based on master planning issues for Fort Story, which does not include base closure (most recent BRAC did not include Fort Story as a potential candidate), as well as its unique location and subsequent training environs, the facility is expected to remain government property. The potential for future development of the land as commercial, residential, or recreational properties is not expected as the installation will remain open and the area will continued to be identified as industrial usage; therefore, the future land use will be the same as the current land use. If land use conditions change in the future, possible exposure scenarios (e.g., residential exposure to soils and groundwater if residential development was planned) will be re-evaluated. This conclusion is a revision from the text provided in the baseline human health risk assessment presented in the Final RI Report for the site. Based on guidance provided by the U.S. Army Environmental Command (USAEC), unless residential development is expected or planned in the future for an installation, the residential land use scenario will not be evaluated for future land use conditions.

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2.7 SUMMARY OF SITE RISKS

Human Health Risk Assessment

Identification of Chemicals of Potential Concern (COPCs)

As shown in **Tables 2-8 through 2-12**, COPCs identified during the hazard identification of the LARC 60 site media because of their exceedences of EPA screening criteria (e.g., MCLs or RBCs) include the following:

Media	*COPC*
Surface and Subsurface Soils	Arsenic
Groundwater	cis 1,2-DCE, MIBK, toluene, vinyl chloride, 2-methylnaphthalene, naphthalene, antimony, arsenic, iron, and manganese
Surface Water	Iron and manganese

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Exposure Assessment

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Potential Receptors and Exposure Pathways Summary¶

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This section describes the complete exposure pathways by which the potential receptors may be exposed to the COPCs in the soil, surface water, and groundwater via a specific exposure route.

Because no contaminants in soils or sediment exceeded EPA RBCs for industrial soils, and because groundwater is not utilized at the site, no risk-based limits would be exceeded for the current situation.

In the original RI Report, the potential exposure pathways for future land use at the LARC 60 site included:

- Residential exposure (adults and children) to **contaminated groundwater** through ingestion of drinking water, dermal contact with and inhalation of volatilized chemicals while bathing or showering.
- Residential exposure (adults and children) to **contaminated soil** through ingestion of and dermal contact with chemicals.

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Unless residential development is expected or planned in the future for an installation, the residential land use scenario will not be evaluated for future land use conditions; therefore, there is no potential identified human health risk for the current or anticipated future land use at the site. It should also be noted that groundwater contaminant concentrations, based on the May 2007 monitoring event, are below the EPA drinking water standards.

Although initially identified as the only COPC in soil due to its exceedence of the residential soil RBC value, arsenic was detected in site soils at concentrations consistent with the background soils; therefore, the risk associated with it is not related to site-specific activities such as spills, leaks, or industrial activities; therefore, no land use issues (industrial or residential) as they relate to human health risk would be associated with site soils.

Ecological Risk Assessment (ERA)

Identification of COPCs

This section presents lists of chemicals detected in the site surface soil and sediment samples that are considered COPCs. Groundwater was not addressed in this assessment, as it does not have a complete exposure pathway at the site. The compounds identified as COPCs are considered to be those with the greatest potential significance to aquatic and wildlife receptors.

Soil

Table 2-13 presents a comparison of soils data to EPA screening criteria. Acetone was detected in one sample and lacked screening criteria; however, due to the low frequency and the low level at which it was detected, it was not considered to be of concern. Total TPH was detected in 19 of the 22 samples. These samples were taken from the former UST area, the wash rack, the Sandbox Area and the adjacent wooded area. However, no PAHs were measured above detection limits. Total TPH was not retained as a COPC, since the more toxic components of TPH were not detected.

Several metals were detected with high frequency at concentrations that exceeded EPA Region III BTAG screening criteria. Chromium, iron, and lead concentrations exceeded screening criteria. In addition, aluminum, arsenic, copper, and zinc lacked faunal screening criteria. Of these compounds, aluminum, arsenic, iron and vanadium concentrations fell within site specific and USGS regional background concentrations; therefore, these compounds were not considered to be potentially of concern. Chromium, lead, and zinc concentrations fell within regional background but exceeded measured site-specific concentrations; therefore, these compounds were retained as COPCs for surface soils. Copper concentrations exceeded both site-specific and regional background concentrations and were retained as a COPC.

Sediment

Table 2-14 presents a comparison of sediment data to EPA screening criteria. A total of 2 sediment samples were taken from the small drainage ditch adjacent to the site and analyzed for VOCs, SVOCs, TPH and metal concentrations. VOC and SVOCs were not detected in the samples. Total TPH was detected in both samples. Because PAHs were not detected in the samples, TPH was not considered to be of potential concern. No metals detected exceeded EPA Region III BTAG screening criteria. Several metals detected lacked screening criteria. No background values were available for sediment. All contaminants that lacked screening criteria were retained as COPCs.

Surface Water

Table 2-15 presents a comparison of surface water data to EPA screening criteria. Two surface water samples were taken from the adjacent drainage ditch. Acetone was detected in both samples at levels below screening criteria. SVOCs and TPHs were not detected in either sample. No metals were detected at levels that exceeded available screening criteria. Calcium, magnesium, manganese, potassium, and sodium do not have screening criteria. These constituents are naturally occurring in water and were found at low levels in the samples taken; therefore, they were not considered to be of concern. No COPCs were selected for surface water at the LARC 60 Site.

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COPC Summary

The COPCs for the LARC 60 site include the following:

- **Surface Soil** - chromium, copper, lead, and zinc
- **Sediment** - aluminum, barium, iron, manganese, and vanadium
- **Surface Water** - none

Exposure Assessment

The following summarizes the ecological setting, target receptors, and potential exposure pathways.

Ecological Setting and Species Summary

Following is a brief description of the habitat requirements and diet of the terrestrial endpoint species selected for the LARC 60 site. In addition, the reasons for selection of these species are discussed.

- **Herbaceous Vegetation.** Plants that occur in pine/oak woodland and disturbed areas of the northeastern United States are likely to occur at the Site. These plants include herbaceous species that serve as an important food source for songbirds, small mammals, and larger herbivores. The measurement endpoints for terrestrial vegetation are published phytotoxicity reference values for each contaminant.

- **Soil/Sediment Invertebrates.** Invertebrates that are common in sandy soils in Southeastern Virginia are likely to occur within and adjacent to the site. In addition, sediment invertebrates that favor intermittent streams and pools or damp soils are likely to occur within the drainage area adjacent to the site. These invertebrates are an important food source for ground gleaning birds and small mammals. The measurement

endpoints for soil/sediment invertebrates are published toxicity reference values for each contaminant.

- **White-footed Mouse**. This common small mammal occurs throughout Virginia and occupies home ranges from 0.054 to 0.072 hectares. It is found in a variety of habitats including interiors and edges of deciduous and coniferous forests, scrub areas, clearings, pastures, stream-side thickets, and buildings. The White-footed Mouse consumes arthropods, seeds, and other vegetation. It is active throughout the year and usually nests off the ground.

  The White-footed Mouse has been selected to represent the small mammal community at the LARC 60 site. As a receptor with an omnivorous diet, the mouse is representative of herbivorous and insectivorous small mammals present within the boundaries of the site. Due to the scarcity of vegetation on the site itself, larger herbivores such as rabbits are unlikely to make significant use of the area.

  Measurement endpoints for the White-footed Mouse are derived from rodent toxicity data taken from published dose-response studies that relate contaminant exposure or uptake to effects on individual organisms.

- **Northern Bobwhite (*Coilnus virginianus*).** Bobwhite Quail are ground-dwelling birds that occupy a number of habitats in Virginia. They are poor fliers, seldom leave the ground and do not migrate. Their range may encompass several hectares and they prefer grasslands, idle fields and pastures during breeding season while concentrating in wooded areas with an understory adjacent to open fields during winter seasons. Bobwhites forage in areas with open vegetation, some bare ground and light litter. Nearby dry powdery soils are important for dust bathing. Seeds from weeds, woody plants, insects and invertebrates and grasses comprise the majority of the bobwhite's diet throughout the year. In the winter, green vegetation can dominate the diet. Quail consume little grit.

  The Northern Bobwhite was selected to represent the ground-gleaning avian community at the site. Their habit of dustbathing makes them a more likely candidate for exposure to contaminants in the Sandbox Area, in addition to exposure realized through habits such as foraging and nesting.

  Measurement endpoints for the Northern Bobwhite are derived from avian toxicity data taken from published dose-response studies that relate contaminant exposure or uptake to effects on individual organisms.

- **Gray Fox (*Urocyon cinereoargenteus*).** Gray Foxes are present throughout the United States, except in the northwest and northern prairies. Foxes are secretive and nocturnal, and will often climb trees to evade predators. Gray foxes prey on small mammals but will also eat insects, fruits, acorns, birds, and eggs. The home range of this species varies from 57 and 855 hectares (USEPA, 1993). This species is similar in size and habits of the Red Fox (*Vulpes vulpes*).

  The Gray Fox has been selected to represent the terrestrial carnivore community at the Site. Although the Merlin and Red-tailed Hawk may also represent other potential endpoint species in the carnivore category, their home ranges are typically much larger than that of the fox, and their use of the LARC 60 site is likely to be restricted.

  Measurement endpoints for the fox are derived from mammalian toxicity data taken from published dose-response studies that relate contaminant exposure or uptake to effects on individual organisms.

Exposure Pathways

Several ecologically relevant migration pathways for contaminants exist at the site. Wildlife may have incidental contact with or ingestion of contaminants while foraging, nesting, or engaging in other activities in the site. Chemical contaminants can also adversely affect plants and animals in surrounding habitats via the food chain.

Upon their release, some site contaminants are persistent and may be transformed to more bioavailable forms and mobilized in the food chain. Mobilization of contaminants in the terrestrial food chain could occur through the following pathways:

- Root uptake from contaminated soil by herbaceous plants,
- Bioaccumulation from vegetation or animal prey at the base of the food chain by wildlife.
- Contact and absorption, incidental ingestion, and feeding on contaminated food by invertebrates, and
- Drinking of contaminated surface water by wildlife

Based on these pathways, the following general classes of ecological receptors potentially might be exposed to contaminants at the LARC 60 site.

- Terrestrial plants growing within and adjacent to the sites,
- Terrestrial invertebrates likely to occur in surface soils and benthic invertebrates occurring within the sediments,
- Birds that forage or nest within the areas,

- Small mammals that reside and/or feed in the vicinity of the areas, and
- Other higher trophic level wildlife species (e.g., carnivores) that feed within the vicinity of the sites.

Ecological Effects Assessment

Ecological Effects Summaries

Toxicity profiles summarizing the potential adverse ecological effects of each COPC were derived from the literature, and are included as Appendix K of the Final RI Report. The profiles provide discussions of the acute and chronic toxicity of the COPCs to plants and animals. Effects on growth, reproduction, and survival of terrestrial species are given, where available. Also included are significant fate and transport characteristics of the chemicals. These summaries, in addition to established criteria, were used to identify the critical effects of COPCs.

Toxicity Reference Values

Toxicity reference values (TRVs) were derived for plants, soil/sediment invertebrates and other wildlife as described below.

Terrestrial Plants and Invertebrates - The TRVs used to evaluate the toxicity of a given COPC to terrestrial plants and soil invertebrates were derived from the available literature. Values were applied to both soil and sediment since toxicity values for sediment were unavailable. Phytotoxic values represent the lowest values from toxicity studies conducted in the field or in greenhouse and growth chamber settings. Soil TRVs based on microbial heterotroph and earthworm toxicity represent data provided by toxicity studies in the field or in laboratory settings.

Wildlife - TRVs for mammals and birds chosen as receptor species were derived based on methodology presented by Opresko et al. This general method is based on USEPA methodology for deriving human toxicity values from animal data. In this method, experimentally derived No Observed Adverse Effect Levels (NOAELs) or Lowest Observed Adverse Effect Levels (LOAELs) are used to estimate NOAELs for wildlife by adjusting the dose according to differences in body size. NOAELs for laboratory species, obtained from the literature, were converted to receptor species NOAELs as follows:

$$NOAEL_r = NOAEL_t\ (bw_t / bw_r)$$

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Where: $NOAEL_r$ = receptor species NOAEL
$NOAEL_t$ = test species NOAEL
bw_r = receptor body weight

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bw_t = test species body weight

The test species and receptor species NOAELs for the LARC 60 site are provided for each of the COPCs in **Table 2-16.**

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Ecological Risk Characterization

Hazard Quotients

The levels of chromium in the soil and aluminum and vanadium in sediment were found to exceed phytotoxicity values. The levels of aluminum and iron in the sediment were found to exceed invertebrate toxicity values. Phytotoxicity values were not available for iron.

Results of the exposure calculations show that the levels of zinc resulted in an HQ of 1 for the Northern Bobwhite. The levels of aluminum resulted in HQs greater than 1 for the White-footed Mouse and the Gray Fox. These contaminants detected at the site may pose a risk to the species examined. The other contaminants are unlikely to pose a risk to the species examined. Avian and mammalian toxicity values were unavailable for iron. Therefore, the potential risk of this contaminant could not be estimated.

A summary of the exposure estimates and HQs for the LARC 60 site is presented in **Table 2-17.**

Summary of Risks

At the LARC 60 site, the potential risks of exposure to zinc for avian species and aluminum for small mammals and terrestrial carnivores were identified. The potential risk of exposure to chromium in the soil and aluminum and vanadium in sediment were identified for plants. Lastly, potential risks of exposure to aluminum and iron in the sediment were identified for sediment invertebrates. These risks of adverse effects were identified for the maximum exposure scenario.

Uncertainties

Areas of uncertainty for the LARC 60 site include the following:

- Uncertainty associated with environmental sampling is generally related to the limitations of the sampling program in terms of the number and distribution of samples, while uncertainty associated with the analysis of the samples is generally related to systematic or random errors.

- The principal uncertainties in the exposure assessment have to do with quantitative estimates of exposure parameters such as BAFs. These parameters typically are chemical, species, and site specific. Generally, the reasonable worst case was assumed to provide a conservative estimate.

- Another point of uncertainty lies in the assumption that each of the wildlife receptor species feeds only upon food items found in the study areas.

- The assumption that soil and sediment invertebrate uptake of compounds would be equal to published Earthworm Uptake Factors may also result in an over- or underestimation of potential risk.

- Uncertainty arises when using any published toxicity results as TRVs.

In general, the risk assessment is likely to overestimate rather than underestimate the risks of adverse ecological effects at the sites, because of the conservative nature of the assumptions used. Overall, a generally conservative approach was taken in the evaluation to minimize the possibility of actual risk being greater than that predicted. Conservative steps taken include:

- The selection of COPCs based on exceedence or lack of EPA Region III BTAG criteria and exceedence of site-specific and regional background data.

- The comparison of maximum chemical concentrations in site media with maximum background concentrations

- The use of maximum chemical concentrations, where appropriate.

- The use of average body weights and feeding rates and minimum home ranges for the endpoint species.

Ecological Significance

The LARC 60 site is a potential source of environmental contamination in soil and sediments. These potential effects are considered to have minimal ecological significance for the following reasons:

- In many cases, wildlife risks were identified for the maximum exposure case. The average concentrations are more representative of exposure for mobile species of wildlife, such as the White-footed Mouse.

- The LARC 60 site is currently disturbed by military activities occurring on the base. Therefore, the site can support only a few individuals, and the potential impacts to plant or animal populations as a whole are minimal.

- The ecosystems in the general vicinity of the site do not appear to be impacted or stressed due to chemical contamination.

- Apex predators and wildlife with large home ranges are not likely to be adversely affected due to the comparatively limited extent of contamination.

2.8 DOCUMENTATION OF SIGNIFICANT CHANGES

No significant changes have occurred since finalization of the Remedial Investigation Addendum Report that included the conclusions of the baseline risk assessment that provides the basis for No Further Action required at the LARC 60 site.