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FINAL

**SWMU 261/297
RCRA FACILITY INVESTIGATION REPORT**

MCB CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0041

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MCB Camp Lejeune

Jacksonville, North Carolina

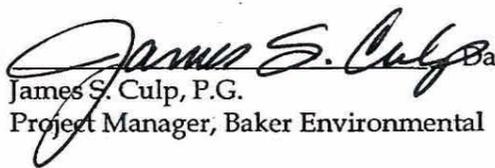
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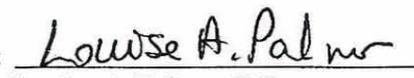
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ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Society for Testing and Materials
AT	Averaging Time
ATSDR	Agency for Toxic Substance and Disease Registry
Baker	Baker Environmental, Inc.
bgs	below the ground surface
BERA	Baseline ERA
BTAG	Biological Technical Assistant Group
CaCO ₃ /L	Calcium Carbonate per Liter
CDIs	Chronic Daily Intakes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
CNO	Chief of Naval Operations
COPCs	Chemicals of Potential Concern
CRDL	Contract Required Detection Limit
CRQL	Contract Required Quantitation Limit
CSFs	Cancer Slope Factors
CSI	Confirmatory Sampling Investigation
CT	Central Tendency
CTO	Contract Task Order
DADs	Dermally-Absorbed Doses
DoN	Department of the Navy
DOT	United States Department of Transportation
Eco-SSL	Ecological Soil Screening Level
EF	Exposure Frequency
EnSafe	Environmental Safety and Designs, Inc.
ERA	Ecological Risk Assessment
ET	Exposure Time
ft/d	feet per day
gpm	Gallons Per Minute
gpd	Gallons Per Day
GPS	Global Positioning System
HA	Health Advisories
HEAST	Health Effects Assessment Summary Table
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
HSWA	Hazardous and Solid Waste Amendments

ACRONYMS AND ABBREVIATIONS

(Continued)

ID	Inside Diameter
ILCR	Incremental Lifetime Cancer Risk
IDW	Investigation Derived Waste
IEUBK	Integrated Exposure Uptake Biokinetic
ILM	Inorganic Low Medium
IMAC	Interim Maximum Allowable Concentrations
IR	Installation Restoration
IRIS	Integrated Risk Information System
J	Estimated Result
2L Standards	North Carolina Water Quality Standards for Groundwater
MCAS	Marine Corps Air Station
MCB	Marine Corps Base
MCLGs	Maximum Contaminant Levels Goals
MDL	Maximum Detection Limit
mg/kg	Milligram per Kilogram
MHSPE	Ministry of Housing, Spatial Planning and Environment
msl	Mean Sea Level
NAWQC	National Ambient Water Quality Criteria
NCAC	North Carolina Administrative Code
NC DENR	North Carolina Department of Environment and Natural Resources
NCEA	National Center for Environmental Assessment
NCWQS	North Carolina Water Quality Standards
NPL	National Priorities List
NTUs	Nephelometric Turbidity Units
OEPA	Ohio Environmental Protection Agency
OSWER	Office of Solid Waste and Emergency Response
PAHs	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PEF	Particulate Emission Factor
PRGs	Preliminary Remediation Goals
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RAC	Remedial Action Contractor
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recover Act
RfC	Reference Concentration
RfDs	Reference Doses
RFA	RCRA Facility Assessment

ACRONYMS AND ABBREVIATIONS

(Continued)

RFI	RCRA Facility Investigation
RME	Reasonable Maximum Exposure
RPD	Relative Percent Difference
SAs	Surface Areas
SAF	Skin Adherence Factor
SLERA	Screening Level Ecological Risk Assessment
SOW	Statement of Work
SQL	Sample Quantitation Level
SSSVs	Surface Soil Screening Values
STGCs	Soil-to-Groundwater Concentrations
S.U.	Standard Units
SVOCs	Semi-Volatile Organic Compounds
SW	Solid Waste
SWMUs	Solid Waste Management Units
SWSVs	Surface Water Screening Values
TAL	Target Analyte List
TCE	Trichloroethene
TCL	Target Compound List
TSD	Treatment, Storage, and Disposal (Facility)
the Base	Marine Corps Base Camp Lejeune
the SWMU	Solid Waste Management Units 261 and 297
TICs	Tentatively Identified Compounds
U	Not Detected
UCL	Upper Confidence Limit
µg/L	Micrograms per Liter
USGS	United States Geological Survey
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds
VKT	Vehicle Kilometers Traveled
WQPs	Water Quality Parameters

7.0 ECOLOGICAL RISK ASSESSMENT

The overall purpose of an ecological risk assessment (ERA) is to evaluate the likelihood that adverse ecological effects would occur or are occurring as a result of exposure to one or more physical or chemical stressors. The assessment evaluates the potential effects of chemicals on terrestrial and aquatic receptors (e.g., flora and fauna) and their habitats, including the consideration of protected species and sensitive or critical habitats, and identifies particular chemical stressors that may cause adverse effects (ecological COPCs).

Because no risk assessment guidance has been developed specifically for the RCRA program, guidance designed for Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) sites was followed. The following guidance documents were consulted during the risk assessment process:

- Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. USEPA 1997a.
- Supplemental Guidance to RAGS: Region IV Bulletins, Ecological Risk Assessment. USEPA 2001. Originally published November 1995. Website version last updated November 30, 2001.
<<http://www.epa.gov/region4/waste/ots/ecolbul.htm>>
- Amended Guidance on Ecological Risk Assessment at Military Bases: Process Considerations, Timing of Activities, and Inclusion of Stakeholders. USEPA Region IV, Memorandum 4WD-OTS, 2000.
- Navy Policy for Conducting Ecological Risk Assessments. Chief of Naval Operations (CNO) 1999.
- Guidelines for Performing Screening Level Ecological Risk Assessments Within the North Carolina Division of Waste Management, NCDENR Division of Waste Management. October 2003b.

The ERA process under CERCLA consists of eight steps (USEPA 1997a):

1. Preliminary Problem Formulation and Ecological Effects Evaluation
2. Preliminary Exposure Estimate and Risk Calculation
3. Baseline Risk Assessment Problem Formulation
4. Study Design and Data Quality Objectives
5. Field Verification of Sampling Design
6. Site Investigation and Analysis of Exposure and Effects
7. Risk Characterization
8. Risk Management

The Navy Policy for Conducting ERAs (CNO 1999) clarifies and interprets the USEPA process and organizes the eight steps into three tiers. Under both Navy and EPA policy, if the results of Step 1 and Step 2 (Navy Tier 1) indicate that, based on a set of conservative exposure assumptions, there are chemicals present in environmental media that may present a risk to receptor species/communities, the ERA process proceeds to the baseline ERA. According to Superfund guidance (USEPA, 1997a), Step 3 represents the problem formulation phase of the baseline ERA and includes a refinement of conservative exposure assumptions. Under Navy policy, the baseline ERA is defined as Tier 2, and the refinement of conservative exposure assumptions is identified as Step 3a. Step 3a precedes the baseline risk assessment problem formulation (Step 3b). In Step 3a, the conservative exposure assumptions applied in Tier 1 are refined and risk estimates are recalculated using the same conceptual site model. The evaluation of risks in Step 3a may also include consideration of background data, chemical bioavailability, and the frequency of detection. If the re-evaluation of the conservative exposure assumptions supports an acceptable risk determination, the site may exit the ERA process.

This document presents a Screening Level Ecological Risk Assessment (SLERA), which includes Step 1 and Step 2 of the eight-step process, and a refinement of conservative exposure assumptions (Step 3a).

Step 1: Preliminary Problem Formulation and Ecological Effects Evaluation

This step is designed to help answer the question “Is there an ecology here to protect?”

- Ecological Setting
- Fate and Transport Mechanisms
- Potentially Complete Exposure Pathways

Step 2: Preliminary Exposure Estimate and Risk Calculation

This step is designed to help answer the question “Are risks to ecological receptors present at the site?”

- Data Collection and Evaluation
- Abiotic Screen
- Uncertainty and Data Gaps
- Scientific/Management Decision Point
- SLERA Summary

Step 3A: Refining the List of COPCs

- Refinement of Exposure and Effects Level Estimates
- Additional Considerations
- Uncertainty Associated with Step 3A
- Step 3A Summary

It should be noted that Step 3A is only conducted if it is determined that potential ecological effects are possible based on the results of Steps 1 and 2. The conclusion of the SLERA and Step 3A (if applicable) will be one of the following (NCDENR 2003b):

- There is adequate information to conclude that the ecological risks are negligible
- The site has inadequate data to complete the risk characterization. Data gaps need to be filled prior to completion of the screening process.
- The information indicates a potential for adverse ecological effects and a more thorough assessment is warranted.

The following sections describe the general technical approach and results of the risk evaluation at SWMU 261/297.

7.1 Step 1 – Preliminary Problem Formulation and Ecological Effects Evaluation

Screening-level problem formulation concerns the development of a preliminary conceptual model for the site that includes a description of the ecological setting including discussion of contaminants known or suspected to exist at the site and potential contaminant fate and transport mechanisms, and the identification of potentially complete exposure pathways (USEPA 1997a). Information gathered as part of Step 1 of the SLERA is used to answer the question: “Is there an ecology here to protect?” (NCDENR 2003b).

7.1.1 Ecological Setting

An understanding of the ecological setting of the site is an important component of the SLERA. A discussion of the ecological setting generally includes a description of SWMU operations, the regional ecological setting, and the SWMU-specific ecological setting. A detailed description of the Base, including the history and mission of the Base, a summary of hazardous wastes generated, and detailed information regarding the regional ecological setting, including topography and surface features, surface water hydrology, geology, hydrogeology, land use and demographics, climatology, water supply, ecological characteristics, wetlands, and threatened and endangered species information is provided in Section 2.0 of the Phase II – SWMU Confirmatory Sampling Report (Baker 2002b). Information on the site-specific ecological setting follows.

The ecological setting of SWMU 261/297 was evaluated via examination of historical information and a site visit conducted by an ecologist on March 31, 2004. During the site visit, which lasted approximately one hour, the Checklist for Ecological Assessments/Sampling (Appendix A, NCDENR 2003b) was completed. This checklist, including photographs of the site taken during the site visit, is presented as Appendix N.

SWMU 261/297 is comprised of two adjacent areas. SWMU 261 was a 550-gallon, steel UST that was in operation since 1970 and SWMU 297 was the associated steel oil/water separator. Both SWMUs contained oil, grease, and water debris and have since been removed from service. A detailed history of the SWMUs is provided in Section 1.0. An aerial view of the study area taken subsequent to the removal of the UST and oil/water separator is provided as Figure 7-1.

The area immediately surrounding the former SWMU location is covered with a maintained lawn of grasses and low-lying herbaceous species. The area to the north is industrialized. To the south of the SWMU the ground slopes downhill into a wooded area. The woods are bisected by an approximate 30-foot wide treeless corridor, along which an above ground pipe runs northwest to southeast (Photos 1 and 2, Appendix N).

A drainage ditch south of the SWMU accepted discharge from SWMU 297 and currently drains rainwater (Photos 3 and 4, Appendix N). This ditch leads into a wooded area (Photos 5 through 8, Appendix N) dominated by loblolly pine (*Pinus taeda*) intermixed with hardwood species (e.g., *Magnolia* sp.). Ground vegetation in this wooded area was sparse as a result of a dense layer of pine needles. No birds, mammals, reptiles, or amphibians were observed during the site visit; however the habitat is suitable for a variety of woodland creatures.

The drainage ditch continues through the wooded area and ends at an unnamed tributary to Cogdels Creek, which is located approximately 120 feet south of the SWMU (Photos 9 and 10, Appendix N). During the March 2004 site visit, which occurred during dry conditions following heavy rains the preceding night and morning, the stream was very turbid and fast flowing and was 4 to 6 feet in width. The stream bottom was sandy. No aquatic plants or insects were observed within the water column. The stream flows east-southeast to Cogdels Creek (a tributary of the New River), which is located approximately 1,000 feet east of the SWMU.

Based on groundwater contours (see Section 3.3.2), groundwater flow direction in the surficial aquifer is to the east-southeast. There is the potential for discharge of groundwater to the unnamed tributary to Cogdel's Creek (located approximately 120 feet south of the SWMU) and to Cogdels Creek (located approximately 1,000 feet east of the SWMU).

No protected species have been reported or observed at the SWMU. The SWMU is not located within any areas identified as ecologically protected or of significant natural value. No endangered species were noted during the site visit nor were endangered species referenced at the site during the endangered species survey (LeBlond et al., 1994).

7.1.2 Fate and Transport Mechanisms

A transport pathway describes the mechanisms whereby chemicals may be transported from a source of contamination to ecologically relevant media. Transport pathways for SWMU 261/297 are illustrated in the preliminary ecological conceptual model (Figure 7-2). As depicted in the preliminary ecological conceptual model, the primary mechanisms for chemical transport from potential source areas are believed to include the following:

- Overland transport of chemicals with surface soil *via* surface runoff to downgradient surface soil and aquatic habitat.
- Leaching/desorption of chemicals from surface soil or subsurface soil to groundwater and subsequent discharge to surface water bodies.
- Uptake by biota from soil and trophic transfer to upper trophic level receptors.
- Volatile emissions from surface soils and erosion releasing fugitive dusts to the atmosphere.

Although a potentially complete and significant pathway, as per USEPA Region IV Guidance (USEPA, 2000b) the transfer of chemicals to upper trophic level ecological receptors via food chain uptake is beyond the scope of the SLERA and therefore is not evaluated in this report.

7.1.3 Potentially Complete Exposure Pathways

An exposure pathway links a source of contamination with one or more receptors through exposure via one or more media. Exposure, and thus potential risk, can only occur if each of the following components exists:

- A source and mechanism of chemical release into the environment
- An environmental transport medium

- A point of potential contact between an ecological receptor and the medium
- A feasible exposure route at the contact point

An exposure route describes the specific mechanism(s) by which a receptor is exposed to a chemical present in an environmental medium. The most common exposure routes are direct uptake, dermal contact, ingestion, and inhalation. Although the SWMU is not located in the immediate vicinity of an aquatic habitat, potential exposure to aquatic as well as terrestrial receptors is discussed in the following paragraphs because of the potential for the SWMU to impact a downgradient aquatic habitat via groundwater discharge or surface runoff.

Terrestrial plants may be exposed to chemicals present in surface soils through their root surfaces during water and nutrient uptake. Unrooted, floating aquatic plants, rooted submerged aquatic plants, and algae may be exposed to chemicals directly from the water or (for rooted plants) from sediments. Terrestrial and aquatic invertebrates may be exposed to chemicals in soil, sediment, or surface water through dermal adsorption and ingestion. Much of the toxicological data available for terrestrial and aquatic invertebrates are based on *in situ* studies that represent both dermal and ingestion pathways; therefore, both pathways are considered together in the risk evaluation.

Upper trophic level receptors may be exposed to chemicals through: (1) the inhalation of gaseous chemicals or chemicals adhered to particulate matter; (2) the incidental ingestion of contaminated abiotic media (e.g., soil or sediment) during feeding or cleaning activities; (3) the ingestion of contaminated water; (4) the ingestion of contaminated plant and/or animal tissues for chemicals that have entered food webs; and/or (5) dermal contact with contaminated abiotic media. These exposure routes (with the exception of the inhalation route) are depicted on Figure 7-2. Their relative importance depends in part on the chemical being evaluated. For chemicals having the potential to bioaccumulate (e.g., polychlorinated biphenyls [PCBs]), the greatest exposure to wildlife is likely to be from the ingestion of prey. For chemicals having a limited potential to bioaccumulate (e.g., aluminum), the exposure of wildlife to chemicals is likely to be greatest through the direct ingestion of abiotic media, such as soil or sediment.

For upper trophic level receptors, certain potential exposure pathways and/or routes (e.g., dermal contact and inhalation), although potentially complete, are considered insignificant relative to other pathways (e.g., ingestion) due to low potential for exposure. The relative insignificance of the dermal exposure pathway is supported by the low potential exposure frequency and duration, and the protection offered by feathers, fur, and scales to avian, mammalian, and reptilian receptors as outlined in Suter II et al. (2000) and USEPA (2000c). Literature reviews indicate that dermal exposures to wildlife from classes of chemicals known or suspected to be of concern via dermal adsorption (VOCs, organophosphate pesticides, and petroleum compounds) are often overestimated in laboratory studies (where feathers/fur are removed) and do not represent realistic exposure scenarios (USEPA, 2000c). Moreover, in developing soil screening levels for 24 important compounds identified from National Priorities List (NPL) sites and Biological Technical Assistant Group (BTAG) recommendations, USEPA calculated that the contribution of dermal exposures to the total dose received by terrestrial receptors to be 0.5 percent or less and therefore omitted the dermal pathway from in their exposure estimates (USEPA, 2000c).

Inhalation of gaseous chemicals and chemicals adhered to particulate matter (e.g., soil) is also considered insignificant relative to ingestion pathways. As described above for dermal exposures, excluding the inhalation pathway from the risk evaluation is consistent with Suter II et al. (2000) and USEPA (1997b and 2000c), which recognize the relatively small contribution the inhalation pathway contributes to exposure estimates. For example, USEPA (2000c) estimates the expected contribution of exposure to dust particles and VOCs via inhalation to be 0.01 percent and 0.5 percent or less, respectively relative to ingestion. When present, vegetative groundcover and litter layers further minimize suspension of dust and the potential for inhalation exposures to chemicals adhered to particulate matter.

As noted above, the evaluation of potential risks to upper trophic level receptors is beyond the scope of the SLERA; however, should the site proceed to Step 3A of the ERA process, the bioaccumulative potential of chemicals will be considered qualitatively when determining the need for additional evaluation.

A discussion of potential complete exposure pathways for ecological receptors at the SWMU is presented below. Specific pathways addressed by the SLERA are also identified.

Groundwater Exposure Pathway. The potential release sources for the groundwater exposure pathway are surface and subsurface soils that may have been contaminated as a result of prior spills or leaks from the UST or underground piping associated with the oil water separator, or from discharge from the oil/water separator. Release mechanisms are leaching/desorption of chemicals to subsurface soil and vertical migration with infiltrating precipitation to groundwater (or leaching/desorption directly to groundwater).

Although groundwater is not inhabited by ecological receptors, receptors may potentially be exposed to chemicals in groundwater if the chemicals migrate to surface water and/ or sediment. Based on groundwater contours (see Section 3.3.2), groundwater flow direction in the surficial aquifer is to the east-southeast. There is the potential for discharge of groundwater to the unnamed tributary to Cogdel's Creek (located approximately 120 feet south of the SWMU) and to Cogdels Creek (located approximately 1,000 feet east of the SWMU).

The evaluation of potential exposures resulting from the migration of chemicals with groundwater to off-site aquatic habitats is addressed in the evaluation of the surface water and sediment exposure pathway below.

Surface Water and Sediment Exposure Pathway. The potential release source for the surface water and sediment exposure pathway is contaminated groundwater migrating from the site and contaminated soils migrating to off-site aquatic habitat via surface runoff via the drainage ditch. Historically, discharge from the former oil/water separator (which would be released into the drainage ditch leading to the unnamed tributary to Cogdel's Creek) may have also served as a release source for the surface water and sediment exposure pathway.

Aquatic life (e.g., fish and invertebrates) may be exposed to chemicals that have potentially migrated to off-site aquatic habitats through incidental ingestion, direct contact, and ingestion of plant and/or animal tissues for chemicals that have entered the food web (i.e., food chain transfer). Aquatic vegetation within these areas may be exposed to chemicals directly from the water (direct contact) or through root uptake from the substrate. Mammals and birds using the aquatic habitat as a potential food and/or drinking water source may be exposed to chemicals in surface water and sediment through ingestion, direct contact, and food chain transfer.

Other receptors that may forage within aquatic areas include reptiles and amphibians. The potential exposure routes for reptiles and amphibians are ingestion of surface water and sediment, direct contact with surface water and sediment, and food chain transfer. It is noted that for all potential receptors, exposures from food chain transfer will be limited to those chemicals that bioaccumulate in lower trophic level organisms or biomagnify through successive trophic levels.

It should be noted that there is no direct evidence that groundwater from the site is migrating to a surface water body. However, because there is potential for discharge of groundwater to the unnamed tributary to Cogdel's Creek and to Cogdel's Creek, as a conservative measure, the surface water and sediment exposure pathway for aquatic receptors was evaluated by comparing groundwater analytical data to surface water screening values for freshwater. This evaluation assumes discharge of groundwater to suitable aquatic habitat with no dilution or natural attenuation. Surface water and sediment data were not collected from the unnamed tributary because a direct connection between the source of contamination at the site and this habitat has not been established at this point.

Subsurface and Surface Soil Exposure Pathway. The release source for the subsurface and surface soil exposure pathway is the material that may have spilled or leaked from the UST or underground piping associated with the oil water separator. Chemicals may remain in site soils or migrate via surface runoff and fugitive dust emissions. The potential for contaminant migration via fugitive dust emissions is addressed in the air exposure pathway.

Soil invertebrates, such as earthworms, may be exposed to chemicals in surface soil through direct contact and ingestion. Terrestrial plants may be exposed to chemicals in surface soil through root uptake. Terrestrial birds may be exposed to chemicals in surface soil through incidental ingestion and food chain transfer. Mammals, amphibians, and reptiles may be exposed to chemicals in surface soil through incidental ingestion and food chain transfer. For all potential terrestrial receptors, exposure from food chain transfer will be limited to those chemicals that bioaccumulate in lower trophic level organisms or biomagnify through successive trophic levels.

Subsurface soil is not considered a complete exposure pathway for terrestrial receptors for the following reasons (Suter II 1995):

- The mass of most root systems is within the surface soil
- Most soil heterotrophic activity is within the surface organic layer
- Soil invertebrates occur on the surface or within the oxidized root zone

Surface soil is considered a complete exposure pathway for terrestrial receptors. The surface soil exposure pathway was evaluated by comparing contaminant concentrations in the surface soil to soil screening values.

Air Exposure Pathway. Contaminated surface soil may serve as a release source for the air exposure pathway (fugitive dust emissions from wind erosion). In addition to this release mechanism, volatilization of chemicals from surface soil may occur. Terrestrial mammals, birds, amphibians, and reptiles may be exposed to chemicals in fugitive dust emissions or chemicals that may have volatilized from the SWMU through inhalation. As discussed above, the area above and around the former UST and oil water separator is covered by a maintained lawn. This lawn minimizes fugitive dust emissions to ambient air and would also limit the area over which volatilization of chemicals could potentially occur. Burrowing mammals may be exposed to volatile emissions in subterranean passageways; no data on VOCs in shallow subsurface soils were available at this site. However, VOCs in surface soils at the SWMU were detected infrequently, with concentrations exceeding screening values limited to one location (SWMU261-SS01; Table 7-3). Available subsurface soil data were collected from 12-14 feet bgs. With the exception of the common laboratory contaminant acetone, no VOCs were detected in these subsurface soils. Furthermore, as discussed previously, the inhalation exposure pathway is considered insignificant relative to the ingestion pathway. For these reasons, the air exposure pathway is considered insignificant and is not evaluated in this risk assessment.

7.1.4 Conclusions of Step 1

Step 1 of the SLERA posed the question "Is there an ecology here to protect?" Based on information regarding the ecological setting of the site, fate and transport mechanisms, and potentially complete exposure pathways, which are discussed in the preceding sections, there is an ecology at the site to protect. Terrestrial habitat on site consists of a manicured lawn that leads into an off-site wooded habitat. This habitat may have been impacted by historical site activities.

Potential migration of contaminated groundwater and surface soils to off-site aquatic habitats (e.g., unnamed tributary to Cogdel's Creek and Cogdel's Creek) is also a concern. An evaluation of the potential for ecological effects to occur in each of these habitats is presented in the following section.

7.2 Step 2 - Screening-Level Preliminary Exposure Estimate and Risk Calculation

Step 2 of the ERA process consists of the preliminary exposure estimate and risk calculation. The following sections describe the data available for the preliminary exposure estimate, and the methods and results of the abiotic screen.

7.2.1 Data Used in the SLERA

Data available for the SLERA at SWMU 261/297 include surface soil, subsurface soil, and groundwater data collected for the Phase I CSI (Baker 2001a), Phase II CSI (Baker 2002b), and the current RFI field investigation. These investigations were conducted in series with specific goals for each investigation. The Phase I investigation was conducted to determine if activities associated with the SWMU had possibly impacted the environment surrounding the SWMU. Therefore, the samples collected as part of this investigation were located as near the SWMU as physically possible or in areas where evidence of possible environmental impact had been observed. If a specific group of contaminants were not detected in the samples (e.g. volatiles), then they were eliminated as contaminants of concern for that particular SWMU. As such, subsequent investigations did not include any group of contaminants that had been eliminated as a potential contaminant of concern.

As part of the Phase I CSI conducted in September 1997, surface (0-2 feet bgs) and subsurface (12-14 feet bgs) soil samples were collected from each of four soil borings advanced around the perimeter of the SWMU. In addition, a surface soil sample was collected from the nearby drainage ditch approximately 15 feet from the SWMU. The soil samples were analyzed for VOCs, SVOCs, and RCRA metals. Analyses of BTEX constituents were included in both VOC and SVOC analyses, with VOC data having lower detection limits and therefore less uncertainty than SVOC data.

As part of the Phase II CSI conducted in March and April 2002, surface soil samples (0-1 foot bgs) were collected from four temporary well borings and from two locations along the drainage ditch south of the site, subsurface soil (13-15 feet bgs) was sampled from one temporary well boring, and groundwater was sampled from four temporary wells. The soil and groundwater samples were analyzed for RCRA metals. VOC and SVOC analyses were not included in the Phase II CSI because VOCs and SVOCs detected during Phase I were detected at concentrations less than background criteria and/or NC DENR soil to groundwater screening criteria and USEPA Region IX residential PRGs (Baker 2001a). Because detected VOCs and SVOCs did not exceed these comparison criteria in the samples collected closest to the SWMU, the COPC list was reduced to include only RCRA metals based on the Phase I results.

The RFI field investigation included the collection of two surface soil samples (0-1 foot bgs) and three groundwater samples from groundwater monitoring wells, and aquifer properties testing. The soil and groundwater samples were analyzed for RCRA metals (total fraction in groundwater). Groundwater sample SWMU261-MW02 was analyzed for both total and dissolved RCRA metals due to high turbidity. Soil samples were additionally analyzed for pH. Groundwater samples were additionally analyzed in the field for pH, specific conductance, dissolved oxygen, temperature, and turbidity.

A subset of the available data was used for this SLERA. All surface soil samples collected from 0-1 feet bgs were included in the ecological data set. Soils from depths greater than 1-foot bgs are generally not included in a SLERA because they are not representative of the most biologically active soil zone. However, the five surface soil samples collected from 0-2 feet bgs during the Phase I CSI were included in the ecological data set because they were collected from the area immediately surrounding the former oil/water separator and from the drainage way (a potential migration pathway) in areas not represented by the 0-1 foot surface soil data. It is noted that the use of the 0-2 foot bgs surface soil samples adds uncertainty to the risk evaluation. In addition to not being representative of the most biologically active soil zone, the inclusion of soils from 1-2 feet bgs in these samples may dilute the concentration of any contaminants that may be present in the top foot of soil. This uncertainty is addressed in Section 7.2.3. No subsurface soil data were included in ecological data set. All available groundwater data were included in the ecological data set. Surface soil and groundwater data used for the ecological risk assessment are the same as those used for the HHRA. These data are summarized on Table 7-1 and are presented in full in Appendix J.

Duplicate samples were included in the data set by the following means: In instances where the original and duplicate sample were both detected or both non-detected the values were averaged for the risk assessment. In instances when the original and duplicate samples contained one detection and one non-detection, the detected value was averaged with one-half of the detection limit of the non-detected value and the sample was considered a detection.

7.2.2 Abiotic Screen

The screening-level exposure estimate and risk calculation provides a highly conservative evaluation of potential ecological risks at a site. Although upper trophic level receptors (e.g., terrestrial mammals, piscivorous birds) may be identified as potential receptors at the site, the SLERA is limited to a comparison of analytical data to media-specific screening values. Screening values used in the SLERA are those provided in the NCDENR SLERA Guidance (2003b) and are consistent with ecological screening values established by USEPA Region IV (USEPA 2001). The sections that follow describe the various criteria and toxicological benchmarks used as screening values (toxicological thresholds) for chemicals analyzed in groundwater and surface soil. USEPA Region IV chemical-specific surface water and soil screening values are summarized on Table 7-2. The screening values represent conservative exposure thresholds above which adverse ecological effects may occur.

7.2.2.1 Media-Specific Screening Values

Surface Water Screening Values

Two sets of surface water screening values (SWSVs) were used in the SLERA, Region IV SWSVs and North Carolina State Surface Water Quality Standards for Aquatic Life. Surface water was not sampled at this site; however, fresh surface water screening values were used to screen groundwater contaminant concentrations. Both USEPA Region IV freshwater screening values and North Carolina Surface Water Quality Standards for Aquatic Life were obtained from the North Carolina guidelines for performing SLERAs (NCDENR 2003b). North Carolina standards were originally published in the North Carolina Administrative Code (NCAC) Section 15A NCAC 2B (NCDENR 2003a).

The chronic freshwater SWSVs for cadmium and lead as well as the chronic value for trivalent chromium, are expressed as a function of water hardness. As a conservative measure, chromium in site groundwater was assumed to be hexavalent chromium, the more toxic form of the element. Therefore the screening value for hexavalent chromium, which is not hardness based, was used in the risk assessment. Screening values for cadmium, copper, lead, nickel, and zinc are ideally calculated based on site-specific hardness values. Hardness is usually calculated for each groundwater sample using the following equation (Franson 1992):

$$\text{Hardness} = 2.497 * [\text{Calcium}](\text{mg/L}) + 4.118 * [\text{Magnesium}](\text{mg/L})$$

However, because calcium and magnesium are not included in the RCRA metals analysis, these inorganic constituents were not analyzed in the groundwater samples used in the SLERA and site-specific hardness could not be calculated. A default hardness of 50 mg calcium carbonate per liter (CaCO_3/L) (NCDENR 2003b) was used to calculate SWSVs for total recoverable metals as follows (NCDENR 2003b, USEPA 2002):

- Cadmium: $\text{SWSV} = e^{(0.7409 * \ln(\text{hardness value}) - 4.719)}$
- Lead: $\text{SWSV} = e^{(1.273 * \ln(\text{hardness value}) - 4.705)}$

The use of the default value results in conservative screening values for these chemicals. It should be noted that the equation for cadmium provided by NCDENR (2003b) is a National Ambient Water Quality Criterion (NAWQC). This equation has been updated to reflect the most recent NAWQC (USEPA 2002).

In the SLERA, only total recoverable metals data for groundwater were considered. This is done as a conservative measure. Groundwater does not represent an exposure point for ecological receptors. The dissolved fraction of metals in groundwater is more likely to migrate through the aquifer than the total fraction; therefore, the use of total groundwater data is likely to overestimate potential risks to receptors in surface water bodies into which the groundwater may discharge. Dissolved groundwater data were not available at this SWMU with one exception. Both dissolved and total groundwater data was available from SWMU261-MW02 (a filtered groundwater sample was collected due to the high turbidity in this well). The uncertainty that use of total recoverable metals data adds to the risk assessment is addressed in Section 7.2.3.

The SWSV selected for pentachlorophenol is expressed as a function of pH. A default pH value of 7.8 standard units (S.U.) was used to adjust the chronic criterion for this organic chemical (USEPA 2002).

Soil Screening Values

Surface soil screening values (SSSVs) used in this evaluation were obtained from the NCDENR Guidelines for Performing SLERAs (NCDENR 2003b). The recommended soil screening values presented by NCDENR are consistent with values recommended by USEPA Region IV in the Ecological Risk Assessment Bulletins (USEPA 2001). The original sources for these values include the following: Beyer (1990), Efroymson et al. (1997a), Efroymson et al. (1997b), Canadian Council of Ministers of the Environment (1997), the Dutch Ministry of Housing, Spatial Planning and Environment (1994), and Crommentuijn et al. (1997).

7.2.2.2 Hazard Quotient Calculation

An HQ was calculated for each chemical by dividing the maximum exposure concentration of the chemical by the ecological screening value for that chemical:

$$\text{Hazard Quotient} = \frac{\text{Maximum Exposure Concentration}}{\text{Screening Value}}$$

The maximum exposure concentration is estimated as the maximum detected concentration of the chemical or, in cases where the chemical was not detected in a given media, the maximum sample detection limit (MDL)(NCDENR 2003b). HQs exceeding 1.0 indicate the potential for risk since the estimated exposure exceeds the estimated effects concentration. However, screening values and exposure estimates are derived using intentionally conservative assumptions such that HQs greater than one do not necessarily indicate that risks are present or impacts are occurring. Rather, they identify chemical-pathway-receptor combinations requiring further evaluation. Following the same reasoning, HQs that are equal to or less than one indicate that risks are very unlikely, enabling a conclusion of no unacceptable risk to be reached with high confidence.

Chemicals were identified as COPCs if they fell in to one or more of the following categories (NCDENR 2003b):

- Category 1 – Chemicals whose maximum detection exceeds the USEPA Region IV media specific ecological screening value (HQ> 1.0; chemical detected).
- Category 2 – Chemicals that were not detected in any samples for a given media, but for which the MDL exceeded the USEPA Region IV media specific ecological screening value (HQ>1.0; chemical not detected).
- Category 3 – Chemicals that have no USEPA Region IV ecological screening value but were detected above the laboratory sample quantitation level (SQL) (No screening value; chemical detected).
- Category 4 – Chemicals that were not detected above the laboratory SQL and have no USEPA Region IV ecological screening value (No screening value; chemical not detected).
- Category 5 – Chemicals for which the maximum detection or MDL exceeds the North Carolina Surface Water Quality Standards (for aqueous samples only).

Any tentatively identified compounds (TICs) or unknown chemicals present at the site would have been identified as preliminary COPCs and included as Category 3 contaminants; however, no such chemicals were present at the SWMU. Chemicals that do not fall in to one or more of the contaminant categories were not identified as COPCs. It should be noted that chemicals could be classified into more than one category only if one of those categories was Category 5.

7.2.2.3 Results of the Abiotic Screen

The results of the abiotic screen for surface soil and groundwater are presented in the sections that follow. Chemicals identified as ecological COPCs based on the abiotic screen proceed to Step 3A of the ERA (Section 7.3).

Surface Soil

Five surface soil samples collected from 0-2 feet bgs and eight surface soil samples collected from 0-1 feet bgs were evaluated in the SLERA. As discussed in Section 7.2.1, five of these samples were analyzed for VOCs and SVOCs and 13 were analyzed for RCRA metals. Table 7-3 presents HQ calculations for surface soil. Seventy-six chemicals were identified as ecological COPCs in surface soils. One VOC (total xylenes) and four metals (cadmium, chromium, lead, and mercury) were identified as Category 1 COPCs because maximum detected concentrations exceeded soil screening values. The screening HQ for the Category 1 VOC was 4.20, while HQs for Category 1 metals ranged from 1.90 (mercury) to 164.50 (chromium), indicating the potential for unacceptable ecological risks. Figure 7-3 presents analytical data of Category 1 COPCs and indicates detected concentrations that exceeded USEPA Region IV soil screening values.

Seven VOCs, 19 SVOCs, and one metal were not detected but were identified as Category 2 COPCs because their MDL exceeded soil screening values. HQs for Category 2 COPCs ranged from 1.15 (for 2,4-dinitrophenol) to 11,500 (for pentachlorophenol).

Five VOCs (1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 4-methyl-2-pentanone and bromomethane) and four SVOCs (bis[2-ethylhexyl]phthalate, fluoranthene, phenanthrene, and pyrene) were identified as Category 3 COPCs because they were detected at the site but lacked soil screening values with which to evaluate potential risks.

Finally, five VOCs and 31 SVOCs were identified as Category 4 COPCs because they were not detected and are lacking soil screening values.

Groundwater

Groundwater data used in the SLERA included four samples collected from temporary monitoring wells in April 2002 and analyzed for RCRA metals; and three groundwater monitoring well samples collected in March/April 2004 and analyzed for RCRA metals. All monitoring wells at the SWMU were screened in the surficial aquifer. Groundwater data were

compared to fresh surface water screening values. Table 7-4 presents HQ calculations for groundwater. Each of the eight RCRA metals were identified as ecological COPCs in groundwater. Five metals (cadmium, lead, mercury, selenium, and silver) were identified as Category 1 COPCs because maximum detected concentrations exceeded fresh surface water screening values. All five Category 1 COPCs were also classified in Contaminant Category 5 because maximum detected concentrations exceeded NCWQS for freshwater aquatic life. HQs (calculated with USPEA Region IV screening values) for Category 1 inorganic contaminants ranged from 4.74 (selenium) to 911.48 (lead). Figure 7-4 presents analytical data of Category 1 COPCs and indicates detected concentrations that exceed USEPA Region IV screening values or NCWQS for freshwater aquatic life.

No chemicals were classified as COPCs in Category 2.

Barium and chromium (total) were identified as Category 3 COPCs because they were detected in groundwater but lacked freshwater SWSVs with which to evaluate potential risks. Chromium was also identified as a Category 5 COPC because detected concentrations exceeded NCWQS for aquatic life.

There were no RCRA metals classified as Category 4 COPCs. Arsenic was identified as a Category 5 COPC because its maximum detected concentration exceeded NCWQS for aquatic life. Arsenic was not identified as a COPC in any other category.

7.2.3 Uncertainties Associated with the SLERA

The procedures used in this evaluation to assess risks to ecological receptors, as in all such assessments, are subject to uncertainties because of the limitations of the available data and the need to make certain assumptions and extrapolations based on incomplete information. Uncertainties associated with the SLERA for SWMU 261/297 and their effects on risk conclusions are presented and discussed below.

Limitations of Available Data Set

- Surface soil samples collected in 1997 were obtained from 0-2 feet bgs. This is a deeper sampling depth than is typically included in the SLERA; however, these samples were

included in the ecological data set because they were collected from the area immediately surrounding the former oil/water separator and above ground storage tank, and from the drainage ditch (a potential migration pathway) in areas not represented by the 0-1 foot surface soil data. Surface samples from 0-1 feet bgs are preferred for use in an ERA because this depth represents the most biologically active soil zone. In addition to not being representative of the most biologically active soil zone, the inclusion of soils from 1-2 feet bgs in the 1997 samples may dilute the concentration of any contaminants that may be present in the top foot of soil (e.g., those deposited directly on to soils or transported to downgradient soils via surface runoff), or alternatively may elevate apparent surface concentrations of those chemicals that may be more prevalent at depths greater than 1 foot (e.g., those that have leaked into soils from underground piping). In the case of surface soil samples collected in 1997 that were within the drainage way (SWMU261-SS01) contamination is likely to have been deposited on the ground surface directly or via surface runoff. In the case of samples collected in the vicinity of the former oil water separator (SWMU261-IS01, SWMU261-IS02, SWMU297-IS01, and SWMU297-IS02), contamination may have been deposited on the ground surface and/or contaminants may have leaked from underground piping associated with the oil water separator.

Additional uncertainty is introduced into the risk assessment by the use of the 1997 surface soil samples because these samples were not validated by an independent third-party data validator. Therefore, there is some uncertainty regarding the quality of these data. However, as described above, due to the location of these samples and their representation of important source and migration pathways at the site, the inclusion of these samples in the data set was considered a more conservative approach that would be most protective of the environment.

- Surface soil samples collected in 2002 and 2004 were not analyzed for VOCs or SVOCs. VOC and SVOC analyses were excluded from the Phase II CSI and RFI sampling plan because VOCs and SVOCs detected in surface soil during Phase I were detected at concentrations less than AOC background, Base background, NC DENR soil to groundwater screening criteria, and USEPA Region IX residential PRGs (Baker 2001a).

Because these chemicals were not detected at levels of concern in Phase I of the SWMU investigation they were not considered to be of concern at the SWMU and were not included in analyses for subsequent investigations. The exclusion of VOCs and SVOCs from requested analyses in subsequent phases of investigation at this SWMU is in agreement with the phased nature of the investigation (see Section 7.2.1). However, the lack of VOC data in surface soil samples collected within the drainage way downgradient of SWMU261-SS01 represents a data gap for the ecological evaluation and adds uncertainty to the risk assessment because concentrations of total xylenes in SWMU261-SS01 were in excess of USEPA Region IV soil screening values. The extent of migration of this VOC down the drainage way at ecologically significant concentrations is unknown. Therefore, there is also uncertainty regarding the potential adverse impacts of total xylenes to the unnamed tributary to Cogdels Creek located at the outfall of this drainage way.

- Groundwater data was used to evaluate potential risks to off-site aquatic habitat that may be impacted by groundwater discharge from the SWMU. The evaluation of the groundwater migration pathway is included as a conservative approach aimed at preventing the removal of chemicals from further consideration when those chemicals may be contributing unacceptable risks to the environment. There is no direct evidence that groundwater from the site reaches a surface water body, however, there is some indication that lead is migrating with groundwater outside the study area at concentrations exceeding its surface water screening value (Figure 7-4). The use of total metals data and no dilution factors for the evaluation of metals in groundwater adds further uncertainty to the risk assessment and is likely to overestimate potential risks because dissolved metals are more likely to migrate with groundwater than total metals, and because dilution of groundwater occurs upon discharge to surface water. These uncertainties are addressed further in Step 3a (Section 7.3.5).

Identification of Ecological COPCs

- There is uncertainty regarding potential risk that may be contributed by chemicals that were identified as COPCs but were not detected in site media (Category 2 and Category 4 COPCs). Method detection limits indicate the maximum concentration above which it

can be stated with certainty that a given chemical is not present in site media. There is some potential for non-detected chemicals to be present at the site at concentrations below the method detection limit; however, generally each chemical is as likely to be absent from the site or present at levels so low as to not pose unacceptable risk to ecological receptors. Therefore, the identification of such chemicals as COPCs is a conservative measure designed to be highly protective, but is likely to overestimate the potential for adverse effects.

- There is also uncertainty regarding the potential risk that may be contributed by chemicals that lack soil or surface water screening values (Category 3 and Category 4 COPCs). Because toxicological data regarding the potential effects of such chemicals on ecological receptors is lacking, it is not possible to quantitatively evaluate risks to ecological receptors. The identification of such chemicals as COPCs is a highly conservative approach aimed at preventing the elimination of compounds that could have harmful impacts on the environment from further consideration. Although this approach is conservative, the absence of toxicological data on these chemicals adds uncertainty to the conclusions of the risk assessment and may lead to an underestimation or overestimation of potential ecological impacts contributed by the SWMU. This uncertainty is reduced in Step 3a of the baseline ERA though the introduction of additional available toxicological data from the literature for those chemicals lacking Region IV ecological screening values.
- Some compounds detected in environmental media are known to be common laboratory contaminants. These include acetone, 2-butanone, methylene chloride, toluene, and the phthalate esters (USEPA 1989). While validation of the data removes uncertainty involving laboratory contamination, there is the possibility that detections of such compounds in site media reflect laboratory conditions and not site conditions. These chemicals were identified as ecological COPCs if they could be classified in to Category 1, 2, 3, 4, or 5 even though their presence may be unrelated to the site.

Exposure Point Concentrations

- As is typical in a SLERA, a finite number of samples of abiotic media are used to develop the exposure estimates. The maximum measured concentration provides a conservative estimate for immobile biota or those with a limited home range. The most realistic exposure estimates for mobile species with relatively large home ranges and for species populations (even those that are immobile or have limited home ranges) are those based on the mean chemical concentrations in each medium to which these receptors are exposed. This is reflected in the wildlife dietary exposure models contained in the Wildlife Exposure Factors Handbook (USEPA 1993), which specify the use of average media concentrations. The use of mean concentrations to estimate exposure in a refinement (Step 3a of the baseline ERA) is more likely to provide a more accurate picture of potential risks at the site.
- A second source of uncertainty related to exposure point concentrations applies to the evaluation of groundwater data. In the SLERA, maximum total recoverable metal concentrations in groundwater were used as exposure point concentrations in the screening level risk calculation assuming discharge to surface waters. Because the dissolved fraction of metals in groundwater is more likely to migrate through the aquifer than the total fraction, the use of total recoverable metals data may overestimate potential risks to receptors in surface water bodies into which the groundwater may discharge. This is especially the case when high turbidity was an issue during groundwater collection (e.g., data from temporary wells SWMU261-TW01 and SWMU261-TW02). As indicated previously, dissolved groundwater data was limited at this SWMU. The SLERA also assumes no dilution or natural attenuation of groundwater contaminants upon discharge to surface water. This is a conservative assumption likely to overestimate potential risks by a factor of 10 or more (Buchman 1999).

Media-specific Screening Values

- Potential adverse impacts to terrestrial flora and fauna were evaluated by comparing the detected compound concentrations to surface soil screening values. Screening values may not take into account soil type, which may have a great influence on the toxicity of

the chemicals. For example, soil with high organic carbon content will tend to absorb many of the organic compounds, thus making them less bioavailable to terrestrial receptors. Some screening values can be developed based on both field and growth chamber studies; therefore, the reported toxic concentrations are not always equivalent to actual field conditions. In addition, some screening values may be calculated based on a low number of studies or may have only examined toxicities to a limited diversity of invertebrate species.

- Screening values for some chemicals are based on background soil concentrations and not on toxicological studies. The use of these values may overestimate risks at the site.
- Surface water screening levels are established to be protective of *most* of the potential ecological receptors. However, some species will not be protected by the values because of their increased sensitivity to the chemicals. For example, the Ambient Water Quality Criteria developed by the USEPA, in theory, only protect 95 percent of the exposed species. Therefore, there may be some sensitive species present that may not be protected with these criteria. In addition, most of the values are established using laboratory tests, where the concentrations of certain water quality parameters (pH, total organic carbon) that may influence toxicity are most likely at different concentrations than in surface waters that may be influenced by the study area.
- The species used to develop the screening values may not be present at the site, or have the potential to exist at the site. Depending on the sensitivity of the tested species relative to that of the species at the site, use of the toxicity values may overestimate or underestimate risk.
- Groundwater data were used to evaluate potential risks to aquatic receptors in off-site aquatic habitats via a comparison of data to fresh surface water screening values. Because there is no clear indication that groundwater is in fact discharging to an aquatic habitat off-site, the inclusion of this evaluation in the risk assessment is a conservative feature. Evaluation of surface water and sediment data would provide a more realistic evaluation of potential risks to an aquatic habitat; however, no such data were collected

due to the distance from the nearest downgradient water body from the site (approximately 120 feet to the unnamed tributary to Cogdels Creek) and because no direct connection between the source of contamination at the site and this off-site aquatic habitat has been established.

Chemical Mixtures

- Information on the ecotoxicological effects of chemical interactions is generally lacking, which required (as is standard for ecological risk assessments) that the chemicals be evaluated on a compound-by-compound basis during the comparison to screening values. This could result in an underestimation of risk (if there are additive or synergistic effects among chemicals) or an overestimation of risks (if there are antagonistic effects among chemicals).

Bioaccumulative Chemicals

- Many of the chemicals identified as ecological COPCS at the SWMU have been identified as important bioaccumulative chemicals by the USEPA (2000a). There is some potential that bioaccumulative chemicals may pose unacceptable risks to upper trophic level receptors even if no unacceptable risk is posed to primary receptors. Because ecological screening values are typically based on toxicological studies of primary receptors (e.g., terrestrial plants and invertebrates), the abiotic screen alone may underestimate the number of COPCs at the SWMU. An evaluation of risks to upper trophic level receptors is beyond the scope of the SLERA. The bioaccumulative potential of individual chemicals identified as COPCs in the SLERA is considered qualitatively in Step 3A of the BERA when determining the need for further evaluation.

Limits of Contamination

- As indicated above, the extent of total xylene contamination above ecological screening values within surface soils of the drainage way downgradient of the site is unknown. In agreement with the phased nature of the investigation, VOC analysis was not included in the Phase II CSI or RFI sampling events because concentrations of VOCs detected in

Phase I of the SWMU investigation were less than the comparison criteria against which they were evaluated. However, concentrations of xylene at SWMU261-SS01 were in excess of ecological screening values, and there is some potential that this chemical may have migrated to the downgradient wooded habitat via surface runoff during precipitation events.

- Concentrations of lead in the farthest downgradient monitoring well (261-MW02) were in excess of fresh surface water screening values indicating that lead may be migrating off site at ecologically significant concentrations.

7.3 Step 3A – Refinement of the List of Chemicals of Potential Concern

The SLERA for SWMU 261/297 indicated that, based on a set of conservative exposure assumptions, there are multiple chemicals that may present a risk to ecological receptors at or in the vicinity of the site. Therefore, the SWMU was carried in to Step 3a of the ERA process. In Step 3a, the ecological COPCs identified in Step 2 are further evaluated to determine which chemicals, if any, can be removed from further ecological consideration. The Step 3A evaluation examines multiple factors that improve the realism of the risk evaluation while remaining protective of the environment. These factors include consideration of population-level effects, use of alternative screening values, an evaluation of background data, consideration of the frequency and distribution of detections, consideration of bioavailability, dilution, and natural attenuation, and any chemical or site-specific considerations that may be relevant. These factors were used to weigh the evidence of potential risk for each COPC identified for each media to assess whether the COPC should be carried in to Step 3b of the BERA. The specific assumptions and methods that were modified for Step 3a are identified below, along with justification for each modification. If re-evaluation of the conservative exposure assumptions supports an acceptable risk determination then the site may exit the ecological risk assessment process (USEPA 1997a, CNO 1999).

7.3.1 Refinement of Exposure and Effects Level Estimates

During Steps 1 and 2, maximum concentrations of detected chemicals were used as conservative estimates of receptor exposure to calculate HQs. Because many of the receptors evaluated are

relatively immobile or have a limited home range, individuals are more likely to be impacted by locations of maximum concentration; however, average contaminant concentrations are more appropriate for evaluating impacts to *populations* of soil invertebrates, sediment invertebrates, and aquatic receptors. Arithmetic means were calculated for all compounds identified as COPCs in the SLERA. For COPCs detected in less than 100 percent of the samples collected, arithmetic means were calculated using one half the detection limit of non-detected samples. These means were used to estimate the exposure of ecological receptors to site contaminants. If the arithmetic mean for a given chemical was greater than the maximum detected concentration, the maximum detected concentration was used as the exposure estimate.

Effects levels used in Steps 1 and 2 were USEPA Region IV media screening values. In Step 3A, screening values were introduced, when available, for chemicals that did not have screening values established by USEPA Region IV. All screening values used in Step 3A are provided on Table 7-5. Screening values that were introduced for Step 3a are shaded on the table. Introduced screening values for soils included those established by NCDENR for chemical classes (e.g., the screening value for total chlorobenzenes is applied to individual chlorobenzenes). USEPA Region V soil ecological screening values for RCRA hazardous constituents (USEPA 2003) were also introduced in Step 3a when available. Introduced screening values for fresh surface water included (in order of preference), those established by NCDENR for chemical classes, USEPA Region V fresh surface water screening values for RCRA hazardous constituents (USEPA 2003c), and USEPA Region III BTAG screening values for fresh surface waters (USEPA 2004).

A mean HQ was calculated for each COPC using the refined estimates of exposure and effects. Because chemicals with mean HQs less than one are unlikely to pose unacceptable risks to populations of ecological receptors, such chemicals were not considered to be risk-driving COPCs and were not recommended for further ecological evaluation. However, if maximum HQs indicated risk levels of particular concern, the spatial distribution of exceedences was further evaluated to identify any potential hot spots of contamination that may be driving unacceptable risk. Only if no hot spots were identified was a mean HQ less than one used as a sole criteria for eliminating a COPC from further consideration.

Results of the refinement of exposure assumptions are summarized on Table 7-6 for surface soil and Table 7-7 for groundwater. Those COPCs that were removed from further consideration because mean HQs were less than one are indicated on the tables by the comment “Mean HQ < 1.0.”

7.3.2 Comparison to Background Data

Inorganics in surface soils and groundwater that were selected as COPCs based on the SLERA were compared to background data. Surface and subsurface soil background data were obtained from the Area of Concern Background Study (Baker, 2001b). SWMU-specific background concentrations were established using protocol outlined in Ohio Environmental Protection Agency’s (OEPA’s) Closure Plan Review Guidance for RCRA Facilities (OEPA, 1999). NC DENR agreed that SWMUs could be grouped together into AOCs based on geographical location, geology, and type of SWMU, and that background concentrations for metals could be established for each of these AOCs. These background data are to be evaluated in comparison to levels of inorganic constituents detected at individual SWMUs to assess whether the presence of such constituents is naturally occurring or may be attributed to activities (past and/or present) within the AOCs. SWMU 261/297 was included within AOC 7, which is located on the eastern side of the Base. Therefore, surface and subsurface soil data from the SWMU were compared to the AOC 7 background data set.

Groundwater background data were obtained from the Base Background Groundwater Investigation (Baker, 2002a). Background groundwater data were collected from locations throughout the Base away from identified sites in relatively undisturbed areas not near any known sources of contamination. In the Base Background Groundwater Investigation, groundwater data were divided into two categories, including upper (shallow) and lower (deep) portions of the surficial aquifer. Groundwater samples at the SWMU were collected from the shallow portions of the surficial aquifer (less than 25 feet bgs); therefore, they were compared to the background data set for the upper surficial aquifer.

In accordance with USEPA Region IV Human Health Risk Assessment Bulletins, Supplement to RAGS, maximum site concentrations were compared to two times the base background mean (USEPA 2001). The comparison is useful for determining whether or not the presence of chemicals at the site should be considered site related or may be considered naturally occurring.

Inorganic constituents with background concentrations (two times the mean) that exceed maximum site concentrations are not considered risk-driving COPCs and are not recommended for further evaluation. Organic compounds were not analyzed as part of the AOC Background Study or Groundwater Base Background Groundwater Investigation.

Tables 7-6 and 7-7 present background data and results of comparisons to maximum soil and groundwater concentrations detected at the SWMU, respectively. Those COPCs that were removed from further consideration because maximum site concentrations were less than twice the mean background concentration are indicated on the tables by the comment "< Background."

7.3.3 Frequency and Distribution of Detections

As addressed in Section 7.2.3, chemicals not detected in any environmental samples are unlikely to be present in sufficient volume to contribute significant risks to receptors at a site, especially at the population level. Those COPCs that were not detected were removed from further consideration and are indicated on Tables 7-6 (for surface soil) and 7-7 (for groundwater) by the comment "Not Detected." The magnitude and frequency with which sample quantitation limits exceeded screening values and the likelihood for a chemical to be site-related, even if not detected (based on site history and presence of chemical precursors or daughter products at the site), were considered prior to removing a chemical from further consideration based on detection frequency. It should be noted that the exclusion of non-detected chemicals from further evaluation is considered reasonable and appropriate as this approach follows that outlined in the National Contingency Plan (NCP) (40 CFR 300 Appendix A), which does not establish a release when the sample measurement is less than the contract required detection limit as determined by an EPA-certified laboratory.

It should be noted that COPCs detected infrequently may also be removed from further consideration after evaluation of a variety of factors including the distribution of detections, the magnitude of potential risks, and the site history and presence or absence of chemical precursors in any site media. When appropriate, a discussion of such COPCs will be included in the text.

7.3.4 Considerations of Bioaccumulative Potential

The USEPA has identified certain chemicals as “important bioaccumulative chemicals” (USEPA 2000a). Bioaccumulative chemicals may pose unacceptable risks to upper trophic level receptors even if no unacceptable risk is posed to primary receptors. Although an evaluation of risks to upper trophic level receptors is not included in the SLERA, consideration of the bioaccumulative potential of each COPC identified in Steps 1 and 2 will be made before determining the need for additional evaluation of a particular chemical. Those chemicals identified as important bioaccumulative chemicals by the USEPA are indicated in the third column from the right on Tables 7-6 and 7-7.

7.3.5 Groundwater Considerations

In the SLERA, only total recoverable metals data for groundwater were considered. The dissolved fraction of metals in groundwater is more likely to migrate through the aquifer to surface water; therefore, the comparison of total metals data in groundwater to surface water screening values is a conservative approach. In the refined risk evaluation, dissolved data may be considered if available, as this data may provide a more realistic estimate of the concentration of metals that could migrate to off-site aquatic habitat. At SWMU 261/297 dissolved groundwater data were not available for evaluation.

In addition, the risk evaluation for groundwater assumes discharge to a surface water body with no natural attenuation or dilution. Buchman (1999) recommends the use of a dilution factor of 10 to account for the dilution expected during migration and upon discharge of groundwater to surface water in the absence of site-specific dilution factors. Under this scenario, mean HQs for barium and selenium (Table 7-7) would be less than one and this inorganic would not be recommended for further evaluation. Refined HQs for all remaining ecological COPCs with the exception of lead would be less than six if dilution were accounted for. Considerations of dilution were not used as a sole criteria for removing a COPC from further consideration.

7.3.6 Additional Considerations

Additional factors that were considered when determining the need for further evaluation of an ecological COPC include but were not limited to the following:

- For chemicals lacking screening values, comparison to range of available screening values for chemicals in the same chemical class.
- For chemicals with screening values not based on toxicological studies, consideration of toxicological-based screening values from the scientific literature.

Chemical specific considerations for surface soil and groundwater COPCs are addressed in the following sections.

7.3.6.1 Surface Soil COPCs

The VOC bromomethane was identified as a Category 3 COPC in Step 2 of the SLERA because it was detected in surface soils and lacked a soil screening value. Bromomethane was detected in one of five surface soil samples (SWMU261-IS02-00) at a concentration (3.3J $\mu\text{g}/\text{kg}$) at the low end of the range of available screening values for VOCs (1 [for trichloroethene {TCE}] to 1,000,000 [for carbon tetrachloride; Table 7-2]). While no screening value is available for bromomethane (CH_3Br), a screening value of 100 $\mu\text{g}/\text{kg}$ is available for bromodichloromethane (CHBrCl_2) and dibromochloromethane (CHBr_2Cl). The sole detected concentration of bromomethane was less than these screening values. Based on these considerations, bromomethane is unlikely to pose unacceptable population-level ecological risks at the SWMU and is not recommended for further evaluation.

The SVOC bis(2-ethylhexyl)phthalate was also identified as a Category 3 COPC in the SLERA. Bis(2-ethylhexyl)phthalate was detected in five of five samples with a maximum detected concentration of 500J $\mu\text{g}/\text{kg}$. The Step 3a screening value for this chemical is the value for total phthalates listed in NCDENR 2003 (100 $\mu\text{g}/\text{kg}$); the maximum detected concentration of bis(2-ethylhexyl)phthalate (500J $\mu\text{g}/\text{kg}$) exceeded this value. The original source of the 100 $\mu\text{g}/\text{kg}$ screening value is a Dutch soil screening benchmark (MHSPE, 1994). This screening value

represents background concentrations, and is not based on toxicological data; therefore, it may not be representative of effects-based concentrations. For this reason, an additional search for toxicity-based benchmarks was conducted. USEPA Region V (USEPA, 2003) has developed screening values for RCRA hazardous materials, including a value of 925 ug/kg for bis(2-ethyl)hexylphthalate. This screening value is based on toxicity to the masked shrew (*Sorex cinerus*) (USEPA 2003). All detections at the SWMU were less than the Region V benchmark. A search of the primary literature on the toxicological effects of bis(2-ethylhexyl)phthalate to soil flora and fauna yielded a single study. Neuhauser et al. (1985) investigated the toxic effect of bis(2-ethylhexyl)phthalate on *Lactuca sativa* (lettuce) growth in a natural soil (1.4 percent TOC). After 14-days of exposure, lettuce growth (biomass) was not affected by the single concentration tested (1,000,000 ug/kg). Application of a conservative safety factor of 100 yields an estimated chronic NOAEL equal to 10,000 ug/kg. Given each of the detected concentrations of bis(2-ethylhexyl)phthalate in SWMU surface soil is less than the toxicologically based USEPA Region V screening value and the NOAEL estimated from data reported by Neuhauser et al. (1985), bis(2-ethylhexyl)phthalate is not identified as a potential ecological risk driver, and no additional evaluation is recommended.

Chromium was detected in all 13 surface soil samples at concentrations exceeding its soil screening value (0.4 mg/kg; derived from an earthworm study on hexavalent chromium [Efroymsen et al., 1997b]). The maximum HQ for chromium was 164.50 and the mean HQ was 38.96. Chromium detections on site ranged from 5.5J to 65.8 mg/kg, while detections in AOC 7 background samples ranged from 1.4 to 28.7 mg/kg. In addition to the USEPA Region IV screening value for chromium, the Federal USEPA has established ecological soil screening levels (Eco-SSLs) for this metal (USEPA 2005). An Eco-SSL of 26 mg/kg (Cr III) was established for avian receptors, while Eco-SSLs of 34 mg/kg (Cr III) and 81 mg/kg (Cr VI) were established for mammalian receptors. Two detections of chromium on site exceeded the lowest of these Eco-SSLs (65.8 mg/kg at SWMU261-SS01-00, located immediately under the above ground pipeline, and 28.7J mg/kg at SWMU261-SS03-00, located in a depositional area at the northern edge of the woodline [Figure 7-3]). The mean site concentration (15.58 mg/kg) was less than these values, indicating acceptable population-level risk. Insufficient data were available for the USEPA to establish Eco-SSLs for terrestrial plants or invertebrates; however, USEPA 2005 does provide data from two invertebrate toxicity studies that they consider eligible for Eco-SSL derivation (a minimum of three studies are required to establish an Eco-SSL). In the first study, Van Gestel et al, (1992) identified a MATC of 57 mg/kg for effects on reproduction of the

earthworm *Eisenia andrei* in soils with a pH of 6.7. In 1993, the same researchers studied reproductive effects of chromium on *E. andrei* in a soil with a pH of 6.0 and again identified a MATC of 57 mg/kg (Van Gestel et al., 1993). Only the maximum detected concentration exceeded these toxicity-based values. Again, a comparison to the mean site concentration indicated acceptable population-level risk. Based on comparisons to toxicological data and Eco-SSLs provided by USEPA (2005), chromium concentrations at SWMU261 are not indicated to pose unacceptable risk to populations of ecological receptors that may use the site. Chromium is not identified as an ecological risk-driver, and no further evaluation is recommended.

7.3.6.2 Groundwater COPCs

Barium was identified as a groundwater COPC in Category 3 because it was detected in groundwater but lacked a USEPA Region IV freshwater screening value. Barium was detected in each of seven groundwater samples at concentrations ranging from 8.6J to 2,360J ug/L. USEPA Region V (USEPA, 2003) has established a screening value of 220 ug/L for barium in freshwater. Two of the detected concentrations (2,360J ug/L in SWMU261-GW01 and 532 ug/L in SWMU261-GW02, both from the Phase II investigation) exceeded the Region V screening value. The turbidity of the samples from these wells was elevated due to a high percentage of silt encountered during drilling and installation of the temporary wells. This elevated turbidity may have caused artificially high metals concentrations (Baker 2002b). All other groundwater samples at the SWMU, including the farthest downgradient samples, had barium concentrations less than the toxicity-based screening value provided by USEPA Region V, indicating that potential adverse effects to off-site aquatic receptors from barium in groundwater is unlikely. Barium is not identified as a risk driving COPC in groundwater and no further evaluation is recommended.

Cadmium was identified as a groundwater COPC in Category 1 and Category 5. Cadmium was detected in two of seven groundwater samples and had a maximum HQ (calculated with the USEPA Region IV freshwater screening value) of 58.05 and a mean HQ of 12.86. The two detections of cadmium were from groundwater samples SWMU261-GW01 and SWMU261-GW02; the turbidity of which was elevated due to a high percentage of silt encountered during drilling and installation of the temporary wells. Cadmium was not detected above method detection limits in any other groundwater sample collected from the SWMU, including 261-MW02, the farthest downgradient sample. There is no indication that cadmium in groundwater is

migrating from the study area. Therefore, cadmium is not identified as a risk driving COPC in groundwater and no further evaluation is recommended.

Chromium was identified as a COPC in Category 3 and Category 5. Chromium was detected in six of seven groundwater samples at concentrations ranging from 1.4J to 1210 µg/L. Although the USEPA Region IV has not established a screening value for total chromium, screening values are available for trivalent and hexavalent chromium. The minimum of these two values (11 ug/L) was used as a surrogate screening value for total chromium in Step 3a. Based on the 11 ug/L screening value, the maximum HQ for chromium would be 110 and the mean HQ 20.26. Maximum detected concentrations of chromium were found in samples SWMU261-GW01 (1210 µg/L) and SWMU261-GW02 (313 µg/L)(Figure 7-4). As noted in the preceding paragraphs, these samples had elevated turbidity, which may have resulted in artificially high metals concentrations. The third highest chromium concentration was 17.8 µg/L, which was detected in SWMU261-GW03. Concentrations of chromium in the farthest downgradient monitoring well were 15.3 µg/L, indicating that chromium may be migrating outside of the study area at concentrations in excess of the USEPA Region IV freshwater screening value (11 µg/L), but less than the NCWQS for freshwater aquatic life (50 µg/L). As indicated in Section 7.3.5, when groundwater migrates and discharges to a surface water body, dilution of groundwater contaminants occurs. In the absence of site-specific dilution factors, Buchmann (1999) recommends the use of a dilution factor of 10 to account for this dilution. When data from the turbid monitoring wells is excluded from the data set, the maximum detected concentration of chromium is 17.8 µg/L. This concentration is less than twice the USEPA Region IV surface water screening value. When dilution is accounted for, this groundwater concentration would not result in a surface water concentration in excess of the surface water screening value; therefore, the potential for adverse ecological impacts from chromium in groundwater to off-site aquatic receptors is considered negligible. No further evaluation of chromium in groundwater is recommended.

Lead was identified as a COPC in Category 1 and Category 5. Lead was detected in four of seven groundwater samples at concentrations ranging from 4.4 to 1200 J µg/L. The maximum HQ was 911 and the mean HQ was 158.88 (calculated with USEPA Region IV screening values). The maximum concentrations of lead detected in groundwater were found in sample SWMU261-GW01 (1200 J µg/L) and SWMU261-GW02 (249 J µg/L). Again, these samples had elevated turbidities, which may have caused the high lead concentrations. If these turbid wells were

excluded from the data set, the maximum HQ would be mean 6.14 and the mean HQ would be 2.30. Assuming a dilution factor of 10 (Buchman 1999), both of these HQs would be less than 1.0, indicating acceptable risk to off-site aquatic receptors. The concentration of lead in the farthest downgradient monitoring well (SWMU261-MW02) was 4.4 µg/L, which exceeds the USEPA Region IV SWSV (1.32 µg/L) but is less than the NCWQS for freshwater aquatic life (25 µg/L). High turbidity was also encountered when sampling this well; therefore, filtered water samples were collected. Lead was not detected in the filtered groundwater sample. Because it is the dissolved fraction of metals that is most likely to migrate with groundwater, this suggests that lead is not migrating from the study area at ecologically significant concentrations. Based upon these considerations, lead in groundwater at SWMU 261/297 is not recommended for further evaluation for the protection of the environment.

Mercury was identified as a COPC in Category 1 and Category 5. Mercury was detected in three of seven groundwater samples at concentrations ranging from 0.02J to 3.6 J µg/L. The maximum HQ was 300 and the mean HQ was 57.50 (calculated with USEPA Region IV screening values). The only two detections of mercury that exceeded screening criteria were in groundwater samples collected from SWMU261-GW01 (3.6 µg/L) and SWMU261-GW02 (1.1 µg/L), which were the samples with elevated turbidities collected during the Phase I investigation. The only other well mercury was detected in was SWMU261-MW02, the farthest downgradient well, which also had elevated turbidity (as discussed above). The total mercury concentration in SWMU261-MW02 was 0.02J mg/L, which is less than both the USEPA Region IV screening value and NCWQS screening values (both 0.012 µg/L). Mercury was not detected in the filtered sample collected from SWMU261-MW02. Based upon these considerations, mercury in groundwater at SWMU 261/297 does not pose unacceptable risks to off-site aquatic receptors and no further evaluation is recommended for the protection of the environment.

Selenium was identified as both a Category 1 and Category 5 COPC because the maximum detected concentration 23.7 µg/L exceeded both the USEPA Region IV SWSV and the NCWQS (both 5 µg/L). The maximum HQ for selenium was 4.74 and the mean HQ was 1.13, indicating a small potential for adverse ecological impacts. As noted in Section 7.3.5, if dilution is accounted for, potential ecological risk from selenium in groundwater would be negligible. Selenium was detected in two of the seven groundwater samples (SWMU261-GW01 and SWMU261-GW02). Both of these samples were collected from temporary monitoring wells located closest to the SWMU. Again, the elevated turbidity of these samples may have artificially elevated the metals

concentrations measured for groundwater. Selenium was not detected in the farthest downgradient well (261-MW02); therefore, there is no indication that selenium is migrating off-site. Based on the low potential for ecological impact, no further evaluation of selenium in groundwater is recommended.

7.4 Risk Characterization

The risk characterization integrates the results of the SLERA and Step 3A. The likelihood of adverse effects occurring as a result of exposure to a stressor is evaluated. The ecological significance of the risks characterized at the site is discussed considering the types and magnitudes of the effects and their spatial and temporal patterns. Ecologically significant risks are defined as those potential adverse risks or impacts to ecological integrity that affect populations, communities, and ecosystems, rather than individuals (i.e. measured impacts to individuals does not necessarily indicate impacts to the ecosystem).

7.4.1 Surface Soil

Of the 76 chemicals identified as ecological COPCs in surface soil based on Steps 1 and 2 of the SLERA, cadmium and lead are indicated to pose unacceptable risk to ecological receptors at the SWMU and are recommended for further action or evaluation based on the results of Step 3A. Cadmium was detected in six of 13 surface soil samples. Four of the detected concentrations exceeded the 1.6 mg/kg screening value and two times the mean background concentration (0.63 mg/kg). The maximum detected concentration (from SWMU261-SS01) was 31.6 mg/kg, resulting in a maximum HQ of 19.75. This detection represents a hot spot of cadmium contamination at the site. If the soils in this area were removed from the site, the mean site cadmium concentration would be 1.57 mg/kg, which is less than the USEPA Region IV soil screening value. With this hot spot in place, the mean site concentration is 3.88 mg/kg, resulting in a mean HQ of 2.42. The remaining detections of cadmium in excess of screening values were collected from sample location SWMU261-SS03 (11.9J mg/kg, also a "hot spot"), located within the drainage way at the edge of the wooded area, location SWMU261-SS04 (1.9J mg/kg), located farther down the drainage way within the wooded area, and from location SWMU297-IS01-00 (1.7 mg/kg), located adjacent to the location of the former UST and oil/water separator (Figure 7-3). The cadmium concentration in the farthest downgradient sample collected from the drainage way within the wooded area (SWMU261-

SS05) was less than soil screening value. The USEPA has published Ecological Soil Screening Level (Eco-SSL) Guidance for Cadmium (USEPA 2003a), which recommends a soil screening value of 32 mg/kg for plants and 140 mg/kg for soil invertebrates. Both the maximum and mean concentrations of chromium at the SWMU are below these values, indicating that unacceptable risks to lower trophic level receptors are unlikely. Cadmium was identified as an important bioaccumulative chemical by the USEPA (2000a). The USEPA Eco-SSL Guidance suggests an avian Eco-SSL of 1.0 mg/kg and a mammalian Eco-SSL of 0.38 mg/kg. Based on this information, cadmium is identified as a potential risk-driving COPC in surface soils. Cadmium is unlikely to pose unacceptable risks to lower trophic level flora and fauna, but may pose unacceptable risks to upper trophic level mammals and birds. Risk to upper trophic level receptors is driven by soils in the vicinity of samples SWMU261-SS01 and SWMU261-SS03. The removal of soils in these areas would eliminate unacceptable risk from cadmium to ecological receptors at the SWMU.

Lead was detected in 11 of 13 surface soil samples. Four of the detected concentrations were in excess of the soil screening value (50 mg/kg). The maximum detected concentration (604 mg/kg; maximum HQ = 12.08) again was located at SWMU261-SS01. A concentration of 587J mg/kg was detected at sample location SWMU261-SS03. These locations, both of which represent depositional areas within the drainage way, are considered hot spots of lead contamination. Lead detections at SWMU261-SS02 and SWMU261-SS04-00 exceeded the soil screening value by less than a factor of two. Lead detections on site ranged from 4.1 to 604 mg/kg, while detections in AOC 7 background samples ranged from 1.6 to 24.7J mg/kg. The mean concentration of lead in the study area was 112.2 mg/kg, resulting in a mean HQ of 2.24, which indicates some potential for adverse impacts to populations of ecological receptors. If the hot spots are excluded from the mean calculation, the site average falls to 25.0 mg/kg, which is less than that Region IV screening value and indicative of acceptable population-level risk. The Federal USEPA has published Eco-SSL Guidance for Lead (USEPA 2003b) that provides a soil invertebrate screening value of 1,700 mg/kg and a plant screening value of 110 mg/kg. Both the maximum and mean SWMU concentrations were less than the invertebrate screening value indicating that risks to terrestrial fauna are within acceptable levels, and only the two lead hot spots had concentrations exceeding the plant screening value. Lead was identified as an important bioaccumulative chemical by the USEPA (USEPA 2000a). The Eco-SSL Guidance for lead recommends an avian screening value of 16 mg/kg and a mammalian screening value of 59 mg/kg. The avian screening value was exceeded at three of 13 locations, while the mammalian screening value was exceeded

at five of 13 locations. Based upon the above considerations, lead is identified as risk driving ecological COPC in surface soils and may cause adverse effects to terrestrial flora and upper trophic level receptors. This risk is driven by two hot spots of lead contamination at locations SWMU261-SS01 and SWMU261-SS03. If these hot spots were removed from the site, the potential risk from lead to populations of ecological receptors would be within acceptable levels.

7.4.2 Groundwater

Groundwater in the surficial aquifer was evaluated for the potential to cause adverse effects to ecological receptors assuming that the groundwater discharges in to a surface water body. The nearest downgradient/sidegradient surface water body is the unnamed tributary to Codgel's Creek, which is located approximately 120 feet south of the SWMU. It is noted that there is no direct evidence that groundwater from the surficial aquifer is currently discharging to this creek; however, the groundwater assessment was conducted as a conservative measure. Groundwater samples were analyzed for RCRA metals. Each of the eight RCRA metals were identified as groundwater ecological COPCs in the SLERA. Based on additional considerations addressed in Step 3A of the BERA, none are estimated to pose unacceptable risks to ecological receptors. Additional ecological evaluation of groundwater at SWMU 261/297 is not recommended.

7.5 Uncertainties Associated with Step 3A of the BERA

Many of the uncertainties identified in Section 7.2.3 also apply to the refined screening level risk calculation. Additionally, many uncertainties present in the screening level risk calculation are reduced or eliminated with the Step 3a evaluation. In addition to the uncertainties listed in Section 7.2.3, the following is identified as an uncertainty of Step 3A of the BERA at SWMU 261/297.

Screening Values

- In the case of chromium, to be conservative, screening values were estimated from the chromium VI form of the element. Chromium III, which is orders of magnitude less toxic than chromium VI, is most likely to be the predominant form in the environment.

Background Comparison

- The AOC 7 background soil samples were collected from 0 to 1 foot bgs. Surface soil samples collected at SWMU 261/297 during the Phase I investigation were collected from 0 to 2 feet bgs, while surface soil samples collected from subsequent investigations were collected from 0 to 1 foot bgs. As discussed in Section 7.2.3, the inclusion of soils in from the 1 to 2 foot depth interval in Phase I samples adds uncertainty to surface soil evaluation because contaminant concentrations in the upper foot of these samples may be diluted by soils from 1 to 2 foot interval, or, if contamination is greater in the subsurface soils, data may indicate contaminant concentrations that are greater than those present in the biologically active surface zone. Because background data includes only those soils from 0 to 1 foot bgs, the comparison of these soils to site samples may not accurately indicate if site concentrations reflect background conditions or not. For example, if site concentrations are artificially elevated due to naturally occurring increased concentrations of some metals within the 1 to 2 foot bgs depth interval, comparison of site data to background data collected only from 0 to 1 foot bgs will not indicate that site conditions are at background levels. It should be noted that maximum detected concentrations of the potentially risk-driving COPCs cadmium, chromium, and lead were detected in sample SWMU261-SS01, which was collected from 0 to 2 feet bgs.

7.6 Summary

Based on the results of the SLERA and Step 3A of the BERA, terrestrial receptors that may forage or live in the vicinity of the SWMU 261/297 study area may be at risk from the metals cadmium and lead in surface soils.

Based on a comparison to USEPA Eco-SSLs (USEPA 2003a), cadmium is unlikely to pose unacceptable risks to lower trophic level flora and fauna, but may pose unacceptable risks to upper trophic level mammals and birds. Risk to upper trophic level receptors is driven by soils in the vicinity of samples SWMU261-SS01 and SWMU261-SS03. The removal of soils in these areas would eliminate unacceptable risk from cadmium to ecological receptors at the SWMU.

Based on a comparison to USEPA Eco-SSLs (USEPA 2003a), lead is unlikely to pose unacceptable risks to terrestrial invertebrates, but may pose unacceptable risks to terrestrial flora and upper trophic level mammals and birds. As for cadmium, ecological risks from lead are driven by soils in the vicinity of samples SWMU261-SS01 and SWMU261-SS03. The removal of soils in these areas would eliminate unacceptable risk from lead to ecological receptors at the SWMU.

Based on the results of the SLERA and Step 3A of the BERA, potential aquatic receptors in off-site habitats are not estimated to be at unacceptable levels of risk from groundwater contamination associated with SWMU 261/297. No further ecological evaluation of groundwater is recommended.

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TABLE 7-1
SUMMARY OF ANALYTICAL DATA USED IN THE SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT
SWMU 261/297
RCRA FACILITY INVESTIGATION (CTO-0041)
MCB CAMP LEJEUNE, NORTH CAROLINA

Media	Sample ID	Date Sampled	Sample Interval or Well Depth (Feet below ground surface)	Analysis					Comments
				TCL VOCs (OLMO 4.2)	TCL SVOCs (OLMO 4.2)	RCRA Metals (ILMO 4.1)	pH (9045 C)	Field parameters ⁽¹⁾	
Surface Soil	SWMU261-IS01-00	9/13/1997	0 - 2	X	X	X			
	SWMU261-IS02-00	9/13/1997	0 - 2	X	X	X			
	SWMU261-SS01-00	9/17/1997	0 - 2	X	X	X			
	SWMU297-IS01-00	9/13/1997	0 - 2	X	X	X			
	SWMU297-IS02-00	9/13/1997	0 - 2	X	X	X			
	SWMU261-SS02-00	3/26/2002	0 - 1			X			
	SWMU261-SS03-00	3/26/2002	0 - 1			X			
	SWMU261-TW01-00	3/26/2002	0 - 1			X			
	SWMU261-TW02-00	3/26/2002	0 - 1			X			
	SWMU261-TW03-00	3/26/2002	0 - 1			X			
	SWMU261-TW04-00	3/26/2002	0 - 1			X			
	SWMU261-SS04	3/21/2004	0 - 1			X	X		
	SWMU261-SS05	3/21/2004	0 - 1			X	X		
Groundwater	SWMU261-GW01	4/9/2002	20			X			Temporary Well
	SWMU261-GW02	4/8/2002	12			X			Temporary Well
	SWMU261-GW03	4/8/2002	12			X			Temporary Well
	SWMU261-GW04	4/8/2002	12			X			Temporary Well
	SWMU261-MW01	4/2/2004	20			X		X	Groundwater Monitoring Well
	SWMU261-MW02	3/5/2004	15			X		X	Groundwater Monitoring Well; total and dissolved data available
	SWMU261-MW03	4/2/2004	16			X		X	Groundwater Monitoring Well

Notes:

⁽¹⁾ pH, specific conductance, dissolved oxygen, temperature, and turbidity

TABLE 7-2
ECOLOGICAL SCREENING VALUES
SWMU 261/297
RCRA FACILITY INVESTIGATION (CTO-0041)
MCB CAMP LEJUENE, NORTH CAROLINA

Analyte	USEPA Region IV Recommended Surface Soil Screening Values	
	(ug/kg) or (mg/kg) ^(1,2)	Comment
Volatile Organics:		
1,1,1-Trichloroethane	100	value for aliphatic chlorinated hydrocarbons
1,1,2,2-Tetrachloroethane	100	value for aliphatic chlorinated hydrocarbons
1,1,2-Trichloroethane	100	value for aliphatic chlorinated hydrocarbons
1,1-Dichloroethane	100	value for aliphatic chlorinated hydrocarbons
1,1-Dichloroethene	100	value for aliphatic chlorinated hydrocarbons
1,2-Dichloroethane	400	
1,2-Dichloroethene (Total)	100	value for aliphatic chlorinated hydrocarbons
1,2-Dichloropropane	700,000	
2-Butanone	NA	
2-Hexanone	NA	
4-Methyl-2-Pentanone	NA	
Acetone	NA	
Benzene	50	
Bromodichloromethane	100	value for aliphatic chlorinated hydrocarbons
Bromoform	NA	
Bromomethane	NA	
Carbon Disulfide	NA	
Carbon Tetrachloride	1,000,000	
Chlorobenzene	50	
Chloroethane	100	value for aliphatic chlorinated hydrocarbons
Chloroform	1	
Chloromethane	100	value for aliphatic chlorinated hydrocarbons
cis-1,3-Dichloropropene	100	value for aliphatic chlorinated hydrocarbons
Dibromochloromethane	100	value for aliphatic chlorinated hydrocarbons
Ethylbenzene	50	
Methylene Chloride	2000	
Styrene	100	
Tetrachloroethene	10	
Toluene	50	
trans-1,3-Dichloropropene	100	value for aliphatic chlorinated hydrocarbons
Trichloroethene (TCE)	1	
Vinyl Chloride	10	
Xylene (Total)	50	
Semivolatile Organics:		
1,2,4-Trichlorobenzene	NA	
1,2-Dichlorobenzene	NA	
1,3-Dichlorobenzene	NA	
1,4-Dichlorobenzene	NA	
2,2'-Oxybis (1-Chloropropane)	100	value for aliphatic chlorinated hydrocarbons
2,4,5-Trichlorophenol	4,000	
2,4,6-Trichlorophenol	10,000	
2,4-Dichlorophenol	3	value for total dichlorophenols
2,4-Dimethylphenol	500	value for cresols
2,4-Dinitrophenol	20,000	
2,4-Dinitrotoluene	NA	
2,6-Dinitrotoluene	NA	
2-Chloronaphthalene	1000	value for chloronaphthalene
2-Chlorophenol	NA	
2-Methylnaphthalene	NA	
2-Methylphenol	500	value for cresols

TABLE 7-2
ECOLOGICAL SCREENING VALUES
SWMU 261/297
RCRA FACILITY INVESTIGATION (CTO-0041)
MCB CAMP LEJUENE, NORTH CAROLINA

Analyte	USEPA Region IV Recommended Surface Soil Screening Values	
	(ug/kg) or (mg/kg) ^(1,2)	Comment
Semivolatile Organics (Cont.):		
2-Nitroaniline	NA	
2-Nitrophenol	7,000	value for 4-nitrophenol
3,3'-Dichlorobenzidine	100	value for total polycyclic chlorinated hydrocarbons
3-Nitroaniline	NA	
4,6-Dinitro-2-Methylphenol	NA	
4-Bromophenyl-Phenylether	NA	
4-Chloro-3-Methylphenol	NA	
4-Chloroaniline	NA	
4-Chlorophenyl-Phenylether	10	value for chlorophenols
4-Methylphenol	500	value for cresols
4-Nitroaniline	NA	
4-Nitrophenol	7,000	
Acenaphthene	NA	
Acenaphthylene	NA	
Anthracene	NA	
Benzo(a)anthracene	NA	
Benzo(a)pyrene	NA	
Benzo(b)fluoranthene	NA	
Benzo(g,h,i)perylene	NA	
Benzo(k)fluoranthene	NA	
bis(2-Chloroethyl)ether	100	value for aliphatic chlorinated hydrocarbons
bis(2-Chloroethoxy)methane	100	value for aliphatic chlorinated hydrocarbons
bis(2-Ethylhexyl)phthalate	NA	see value for total phthalates
Butylbenzylphthalate	NA	see value for total phthalates
Carbazole	NA	
Chrysene	NA	
Dibenzo(a,h)anthracene	NA	
Dibenzofuran	NA	
Diethylphthalate	100,000	
Dimethylphthalate	200,000	
Di-n-butylphthalate	200,000	
Di-n-octylphthalate	NA	
Fluoranthene	NA	
Fluorene	NA	
Hexachlorobenzene	2.5	
Hexachlorobutadiene	100	value for aliphatic chlorinated hydrocarbons
Hexachlorocyclopentadiene	10,000	
Hexachloroethane	100	value for aliphatic chlorinated hydrocarbons
Indeno(1,2,3-cd)pyrene	NA	
Isophorone	NA	
Naphthalene	NA	
Nitrobenzene	40,000	
n-Nitroso-di-n-propylamine	NA	
n-Nitrosodiphenylamine	20,000	
Pentachlorophenol	2	
Phenanthrene	NA	
Phenol	50	
Pyrene	NA	
PAHs (total)	1000	
Phthalates (total)	100	

TABLE 7-2
 ECOLOGICAL SCREENING VALUES
 SWMU 261/297
 RCRA FACILITY INVESTIGATION (CTO-0041)
 MCB CAMP LEJUENE, NORTH CAROLINA

Analyte	USEPA Region IV Recommended Surface Soil Screening Values	
	(ug/kg) or (mg/kg) ^(1,2)	Comment
Total Inorganics:		
Arsenic	10	
Barium	165	
Cadmium	1.6	
Chromium (Total)	0.4	
Chromium III	0.4	Value for Chromium (total)
Chromium VI	0.4	Value for Chromium (total)
Lead	50	
Mercury	0.1	
Selenium	0.81	
Silver	2	

Notes:

NA = Not Applicable/ Not Established

⁽¹⁾ Soil screening values are in microgram per kilogram (ug/kg) for organic compounds and in milligram per kilogram (mg/kg) for inorganic constituents.

⁽²⁾ Values obtained from *Guidelines for Performing Screening Level Ecological Risk Assessments Within the North Carolina Division of Waste Management* (NCDENR 2003)

TABLE 7-2
 ECOLOGICAL SCREENING VALUES
 SWMU 261/297
 RCRA FACILITY INVESTIGATION (CTO-0041)
 MCB CAMP LEJUENE, NORTH CAROLINA

Analyte	USEPA Region IV Recommended Freshwater Screening Values ⁽¹⁾	
	(ug/L)	Comment
Volatile Organics:		
1,1,1-Trichloroethane	528	
1,1,2,2-Tetrachloroethane	240	
1,1,2-Trichloroethane	940	
1,1-Dichloroethane	NA	
1,1-Dichloroethene	303	
1,2-Dichloroethane	2000	
1,2-Dichloroethene (Total)	1350	value for 1,2-dichloroethene(trans)
1,2-Dichloropropane	525	
2-Butanone	NA	
2-Hexanone	NA	
4-Methyl-2-Pentanone	NA	
Acetone	NA	
Benzene	53	
Bromodichloromethane	NA	
Bromoform	293	
Bromomethane	110	
Carbon Disulfide	NA	
Carbon Tetrachloride	352	
Chlorobenzene	195	
Chloroethane	NA	
Chloroform	289	
Chloromethane	5500	
cis-1,3-Dichloropropene	24.4	
Dibromochloromethane	NA	
Ethylbenzene	453	
Methylene Chloride	1930	
Styrene	NA	
Tetrachloroethene	84	
Toluene	175	
trans-1,3-Dichloropropene	24.4	Cis and Trans isomers
Trichloroethene (TCE)	NA	
Vinyl Chloride	NA	
Xylene (Total)	NA	
Semivolatile Organics:		
1,2,4-Trichlorobenzene	44.9	
1,2-Dichlorobenzene	15.8	
1,3-Dichlorobenzene	50.2	
1,4-Dichlorobenzene	11.2	
2,2'-Oxybis (1-Chloropropane)	NA	
2,4,5-Trichlorophenol	NA	
2,4,6-Trichlorophenol	3.2	
2,4-Dichlorophenol	36.5	
2,4-Dimethylphenol	21.2	
2,4-Dinitrophenol	6.2	
2,4-Dinitrotoluene	310	
2,6-Dinitrotoluene	NA	
2-Chloronaphthalene	NA	
2-Chlorophenol	43.8	
2-Methylnaphthalene	NA	
2-Methylphenol	NA	

TABLE 7-2
ECOLOGICAL SCREENING VALUES
SWMU 261/297
RCRA FACILITY INVESTIGATION (CTO-0041)
MCB CAMP LEJUENE, NORTH CAROLINA

Analyte	USEPA Region IV Recommended Freshwater Screening Values ⁽¹⁾	
	(ug/L)	Comment
Semivolatile Organics (Cont.):		
2-Nitroaniline	NA	
2-Nitrophenol	3500	
3,3'-Dichlorobenzidine	NA	
3-Nitroaniline	NA	
4,6-Dinitro-2-Methylphenol	2.3	
4-Bromophenyl-Phenylether	12.2	
4-Chloro-3-Methylphenol	0.3	
4-Chloroaniline	NA	
4-Chlorophenyl-Phenylether	NA	
4-Methylphenol	NA	
4-Nitroaniline	NA	
4-Nitrophenol	82.8	
Acenaphthene	17	
Acenaphthylene	NA	
Anthracene	NA	
Benzo(a)anthracene	NA	
Benzo(a)pyrene	NA	
Benzo(b)fluoranthene	NA	
Benzo(g,h,i)perylene	NA	
Benzo(k)fluoranthene	NA	
bis(2-Chloroethyl)ether	2380	
bis(2-Chloroethoxy)methane	NA	
bis(2-Ethylhexyl)phthalate	0.299	
Butylbenzylphthalate	22	
Carbazole	NA	
Chrysene	NA	
Dibenzo(a,h)anthracene	NA	
Dibenzofuran	NA	
Diethylphthalate	521	
Dimethylphthalate	330	
Di-n-butylphthalate	9.4	
Di-n-octylphthalate	0.3	value for bis(2-ethylhexyl)phthalate
Fluoranthene	39.8	
Fluorene	NA	
Hexachlorobenzene	NA	
Hexachlorobutadiene	0.93	
Hexachlorocyclopentadiene	0.07	
Hexachloroethane	9.8	
Indeno(1,2,3-cd)pyrene	NA	
Isophorone	1170	
Naphthalene	62	
Nitrobenzene	270	
n-Nitroso-di-n-propylamine	NA	
n-Nitrosodiphenylamine	58.5	
Pentachlorophenol	12.8	pH = 7.8 S.U.
Phenanthrene	NA	
Phenol	256	
Pyrene	NA	
PAHs (total)	17	Value for acenaphthene
Phthalates (total)	NA	

**TABLE 7-2
 ECOLOGICAL SCREENING VALUES
 SWMU 261/297
 RCRA FACILITY INVESTIGATION (CTO-0041)
 MCB CAMP LEJUENE, NORTH CAROLINA**

Analyte	USEPA Region IV Recommended Freshwater Screening Values ⁽¹⁾	
	(ug/L)	Comment
Total Inorganics:		
Arsenic	190	Trivalent (+3) form
Barium	NA	
Cadmium	0.16	Hardness = 50 mg CaCO ₃ /L (default) ⁽²⁾
Chromium (Total)	NA	
Chromium III	117.32	Hardness = 50 mg CaCO ₃ /L (default)
Chromium VI	11	
Lead	1.32	Hardness = 50 mg CaCO ₃ /L (default)
Mercury	0.012	
Selenium	5	
Silver	0.012	

Notes:

NA = Not Applicable/ Not Established

USEPA = United States Environmental Protection Agency

⁽¹⁾ Values obtained from *Guidelines for Performing Screening Level Ecological Risk Assessments within the North Carolina Division of Waste Management* (NCDENR 2003)

⁽²⁾ USEPA Region IV hardness based calculation updated to reflect current ambient water quality criteria (USEPA 2002).

TABLE 7-2
 ECOLOGICAL SCREENING VALUES
 SWMU 261/297
 RCRA FACILITY INVESTIGATION (CTO-0041)
 MCB CAMP LEJUENE, NORTH CAROLINA

Analyte	North Carolina Surface Water Quality Standard for Aquatic Life - Fresh Water ⁽¹⁾	
	(ug/L)	Comment
Volatile Organics:		
1,1,1-Trichloroethane	NA	
1,1,2,2-Tetrachloroethane	NA	
1,1,2-Trichloroethane	NA	
1,1-Dichloroethane	NA	
1,1-Dichloroethene	NA	
1,2-Dichloroethane	NA	
1,2-Dichloroethene (Total)	NA	
1,2-Dichloropropane	NA	
2-Butanone	NA	
2-Hexanone	NA	
4-Methyl-2-Pentanone	NA	
Acetone	NA	
Benzene	NA	
Bromodichloromethane	NA	
Bromoform	NA	
Bromomethane	NA	
Carbon Disulfide	NA	
Carbon Tetrachloride	0.4	
Chlorobenzene	NA	
Chloroethane	NA	
Chloroform	NA	
Chloromethane	NA	
cis-1,3-Dichloropropene	NA	
Dibromochloromethane	NA	
Ethylbenzene	NA	
Methylene Chloride	NA	
Styrene	NA	
Tetrachloroethene	NA	
Toluene	0.36	
trans-1,3-Dichloropropene	NA	
Trichloroethene (TCE)	NA	
Vinyl Chloride	NA	
Xylene (Total)	NA	
Semivolatile Organics:	NA	
1,2,4-Trichlorobenzene	NA	
1,2-Dichlorobenzene	NA	
1,3-Dichlorobenzene	NA	
1,4-Dichlorobenzene	NA	
2,2'-Oxybis (1-Chloropropane)	NA	
2,4,5-Trichlorophenol	NA	
2,4,6-Trichlorophenol	NA	
2,4-Dichlorophenol	NA	
2,4-Dimethylphenol	NA	
2,4-Dinitrophenol	NA	
2,4-Dinitrotoluene	NA	
2,6-Dinitrotoluene	NA	
2-Chloronaphthalene	NA	
2-Chlorophenol	NA	
2-Methylnaphthalene	NA	
2-Methylphenol	NA	

TABLE 7-2
ECOLOGICAL SCREENING VALUES
SWMU 261/297
RCRA FACILITY INVESTIGATION (CTO-0041)
MCB CAMP LEJUENE, NORTH CAROLINA

Analyte	North Carolina	
	Surface Water Quality Standard for Aquatic Life - Fresh Water ⁽¹⁾	
	(ug/L)	Comment
Semivolatile Organics (Cont.):		
2-Nitroaniline	NA	
2-Nitrophenol	NA	
3,3'-Dichlorobenzidine	NA	
3-Nitroaniline	NA	
4,6-Dinitro-2-Methylphenol	NA	
4-Bromophenyl-Phenylether	NA	
4-Chloro-3-Methylphenol	NA	
4-Chloroaniline	NA	
4-Chlorophenyl-Phenylether	NA	
4-Methylphenol	NA	
4-Nitroaniline	NA	
4-Nitrophenol	NA	
Acenaphthene	NA	
Acenaphthylene	NA	
Anthracene	NA	
Benzo(a)anthracene	NA	
Benzo(a)pyrene	NA	
Benzo(b)fluoranthene	NA	
Benzo(g,h,i)perylene	NA	
Benzo(k)fluoranthene	NA	
bis(2-Chloroethyl)ether	NA	
bis(2-Chloroethoxy)methane	NA	
bis(2-Ethylhexyl)phthalate	NA	
Butylbenzylphthalate	NA	
Carbazole	NA	
Chrysene	NA	
Dibenzo(a,h)anthracene	NA	
Dibenzofuran	NA	
Diethylphthalate	NA	
Dimethylphthalate	NA	
Di-n-butylphthalate	NA	
Di-n-octylphthalate	NA	
Fluoranthene	NA	
Fluorene	NA	
Hexachlorobenzene	NA	
Hexachlorobutadiene	NA	
Hexachlorocyclopentadiene	NA	
Hexachloroethane	NA	
Indeno(1,2,3-cd)pyrene	NA	
Isophorone	NA	
Naphthalene	NA	
Nitrobenzene	NA	
n-Nitroso-di-n-propylamine	NA	
n-Nitrosodiphenylamine	NA	
Pentachlorophenol	NA	
Phenanthrene	NA	
Phenol	NA	
Pyrene	NA	
PAHs (total)	NA	
Phthalates (total)	NA	

TABLE 7-2
 ECOLOGICAL SCREENING VALUES
 SWMU 261/297
 RCRA FACILITY INVESTIGATION (CTO-0041)
 MCB CAMP LEJUENE, NORTH CAROLINA

Analyte	North Carolina Surface Water Quality Standard for Aquatic Life - Fresh Water ⁽¹⁾	
	(ug/L)	Comment
Total Inorganics:		
Arsenic	50	
Barium	NA	
Cadmium	0.4	
Chromium (Total)	50	
Chromium III	NA	
Chromium VI	NA	
Lead	25	
Mercury	0.012	
Selenium	5	
Silver	0.06	

Notes:

NA = Not Applicable/ Not Established

⁽¹⁾ Values obtained from *Guidelines for Performing Screening Level Ecological Risk Assessments Within the North Carolina Division of Waste Management* (NCDENR 2003).
 Original reference: North Carolina Water Quality Standards (North Carolina Administrative Code, Title 15A, Subchapter 2L) October 25, 1995. Last updated 1 April 2003.

TABLE 7-3
SELECTION OF ECOLOGICAL COPCs IN SURFACE SOIL
SWMU 261/297
RCRA FACILITY INVESTIGATION (CTO-0041)
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	Contaminant Frequency/Range					EPA Region IV ESV	Maximum Hazard Quotient	Soil COPC?	Contaminant Category
	Frequency of Detection	Range of Positive Detections	Location of Maximum Concentration	Range of Detection Limits	Concentration Used For Screening ⁽¹⁾				
Volatiles (ug/kg)									
1,1,1-Trichloroethane (TCA)	0/5	NA	NA	5.4U - 73U	73.00	100	0.73	No	
1,1,2,2-Tetrachloroethane	0/5	NA	NA	5.4U - 73U	73.00	100	0.73	No	
1,1,2-Trichloroethane	1/5	1.4J - 1.4J	SWMU261-IS02-00	5.4U - 73U	1.40	100	0.01	No	
1,1-Dichloroethane	0/5	NA	NA	5.4U - 73U	73.00	100	0.73	No	
1,1-Dichloroethene	0/5	NA	NA	5.4U - 73U	73.00	100	0.73	No	
1,2-Dichlorobenzene (o-) (1)	1/5	180 - 180	SWMU261-SS01-00	1.1U - 1.2U	180.00	NA	NA	Yes	3
1,2-Dichloroethane	0/5	NA	NA	5.4U - 73U	73.00	400	0.18	No	
1,2-Dichloroethene (total)	1/5	2.2J - 2.2J	SWMU261-IS02-00	5.4U - 73U	2.20	100	0.02	No	
1,2-Dichloropropane	0/5	NA	NA	5.4U - 73U	73.00	700000	<0.01	No	
1,3-Dichlorobenzene (m-) (1)	1/5	220 - 220	SWMU261-SS01-00	1.1U - 1.2U	220.00	NA	NA	Yes	3
1,3-Dichloropropene (cis)	0/5	NA	NA	5.4U - 73U	73.00	100	0.73	No	
1,3-Dichloropropene (trans)	0/5	NA	NA	5.4U - 73U	73.00	100	0.73	No	
1,4-Dichlorobenzene (p-) (1)	2/5	1.8 - 210	SWMU261-SS01-00	1.1U	210.00	NA	NA	Yes	3
2-Butanone (MEK)	0/5	NA	NA	22U - 290U	290.00	NA	NA	Yes	4
2-Hexanone (MBK)	0/5	NA	NA	22U - 290U	290.00	NA	NA	Yes	4
4-Methyl-2-pentanone (MIBK)	1/5	4.4J - 4.4J	SWMU261-IS02-00	22U - 290U	4.40	NA	NA	Yes	3
Acetone	0/5	NA	NA	22U - 290U	290.00	NA	NA	Yes	4
Benzene (1)	0/5	NA	NA	1.1U - 73U	73.00	50	1.46	Yes	2
Bromodichloromethane	0/5	NA	NA	5.4U - 73U	73.00	100	0.73	No	
Bromoform	0/5	NA	NA	5.4U - 73U	73.00	NA	NA	Yes	4
Bromomethane	1/5	3.3J - 3.3J	SWMU261-IS02-00	11U - 150U	3.30	NA	NA	Yes	3
Carbon Disulfide	0/5	NA	NA	5.4U - 73U	73.00	NA	NA	Yes	4
Carbon Tetrachloride	0/5	NA	NA	5.4U - 73U	73.00	1000000	<0.01	No	
Chlorobenzene (1)	0/5	NA	NA	1.1U - 73U	73.00	50	1.46	Yes	2
Chloroethane	1/5	2.9J - 2.9J	SWMU261-IS02-00	11U - 150U	2.90	100	0.03	No	
Chloroform	0/5	NA	NA	5.4U - 73U	73.00	1	73.00	Yes	2
Chloromethane	0/5	NA	NA	11U - 150U	150.00	100	1.50	Yes	2
Dibromochloromethane	0/5	NA	NA	5.4U - 73U	73.00	100	0.73	No	
Ethylbenzene (1)	0/5	NA	NA	1.1U - 73U	73.00	50	1.46	Yes	2
Methylene Chloride	1/5	3.1J - 3.1J	SWMU261-IS02-00	5.4U - 73U	3.10	2000	<0.01	No	
Styrene (Ethenylbenzene)	0/5	NA	NA	5.4U - 73U	73.00	100	0.73	No	
Tetrachloroethene (PCE)	1/5	2.1J - 2.1J	SWMU261-IS02-00	5.4U - 73U	2.10	10	0.21	No	
Toluene (1)(2)	1/5	1.4J - 1.4J	SWMU261-IS02-00	1.1U - 73U	1.40	50	0.03	No	
Trichloroethene (TCE)	0/5	NA	NA	5.4U - 73U	73.00	1	73.00	Yes	2
Vinyl Chloride	0/5	NA	NA	11U - 150U	150.00	10	15.00	Yes	2
Xylenes, total (1)(2)	3/5	1.2 - 210	SWMU261-SS01-00	1.1U	210.00	50	4.20	Yes	1

TABLE 7-3
SELECTION OF ECOLOGICAL COPCS IN SURFACE SOIL
SWMU 261/297
RCRA FACILITY INVESTIGATION (CTO-0041)
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	Contaminant Frequency/Range					EPA Region IV ESV	Maximum Hazard Quotient	Soil COPC?	Contaminant Category
	Frequency of Detection	Range of Positive Detections	Location of Maximum Concentration	Range of Detection Limits	Concentration Used For Screening ⁽¹⁾				
Semivolatiles (ug/kg)									
1,2,4-Trichlorobenzene	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
2,2'-Oxybis[1-chloropropane]	0/5	NA	NA	360U - 4800U	4800.00	100	48.00	Yes	2
2,4,5-Trichlorophenol	0/5	NA	NA	360U - 4800U	4800.00	4000	1.20	Yes	2
2,4,6-Trichlorophenol	0/5	NA	NA	360U - 4800U	4800.00	10000	0.48	No	
2,4-Dichlorophenol	0/5	NA	NA	360U - 4800U	4800.00	3	1600.00	Yes	2
2,4-Dimethylphenol	0/5	NA	NA	360U - 4800U	4800.00	500	9.60	Yes	2
2,4-Dinitrophenol	0/5	NA	NA	1700U - 23000U	23000.00	20000	1.15	Yes	2
2,4-Dinitrotoluene	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
2,6-Dinitrotoluene	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
2-Chloronaphthalene	0/5	NA	NA	360U - 4800U	4800.00	1000	4.80	Yes	2
2-Chlorophenol	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
2-Methylnaphthalene	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
2-Methylphenol (o-Cresol)	0/5	NA	NA	360U - 4800U	4800.00	500	9.60	Yes	2
2-Nitroaniline	0/5	NA	NA	1700U - 23000U	23000.00	NA	NA	Yes	4
2-Nitrophenol	0/5	NA	NA	360U - 4800U	4800.00	7000	0.69	No	
3,3'-Dichlorobenzidine	0/5	NA	NA	1700U - 23000U	23000.00	100	230.00	Yes	2
3-Nitroaniline	0/5	NA	NA	1700U - 23000U	23000.00	NA	NA	Yes	4
4,6-Dinitro-2-methylphenol	0/5	NA	NA	1700U - 23000U	23000.00	NA	NA	Yes	4
4-Bromophenyl-phenylether	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
4-Chloro-3-methylphenol	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
4-Chloroaniline	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
4-Chlorophenyl-phenylether	0/5	NA	NA	360U - 4800U	4800.00	10	480.00	Yes	2
4-Methylphenol (p-Cresol)	0/5	NA	NA	360U - 4800U	4800.00	500	9.60	Yes	2
4-Nitroaniline	0/5	NA	NA	1700U - 23000U	23000.00	NA	NA	Yes	4
4-Nitrophenol	0/5	NA	NA	1700U - 23000U	23000.00	7000	3.29	Yes	2
Acenaphthene	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Acenaphthylene	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Anthracene	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Benzo(a)anthracene	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Benzo(a)pyrene	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Benzo(b)fluoranthene	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Benzo(g,h,i)perylene	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Benzo(k)fluoranthene	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Bis(2-chloroethoxy)methane	0/5	NA	NA	360U - 4800U	4800.00	100	48.00	Yes	2
Bis(2-chloroethyl)ether	0/5	NA	NA	360U - 4800U	4800.00	100	48.00	Yes	2

TABLE 7-3
SELECTION OF ECOLOGICAL COPCs IN SURFACE SOIL
SWMU 261/297
RCRA FACILITY INVESTIGATION (CTO-0041)
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	Contaminant Frequency/Range					EPA Region IV ESV	Maximum Hazard Quotient	Soil COPC?	Contaminant Category
	Frequency of Detection	Range of Positive Detections	Location of Maximum Concentration	Range of Detection Limits	Concentration Used For Screening ⁽¹⁾				
Semivolatiles (ug/kg)(Cont.)									
Bis(2-ethylhexyl) Phthalate (BEHP)	5/5	76J - 500J	SWMU261-SS01-00,SWMU297-IS01-00	NA	500.00	NA	NA	Yes	3
Butyl Benzyl Phthalate	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Carbazole	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Chrysene	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Dibenz(a,h)anthracene	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Dibenzofuran	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Diethyl Phthalate (DEP)	0/5	NA	NA	360U - 4800U	4800.00	100000	0.05	No	
Dimethyl Phthalate	0/5	NA	NA	360U - 4800U	4800.00	200000	0.02	No	
Di-n-butyl Phthalate (DBP)	0/5	NA	NA	360U - 4800U	4800.00	200000	0.02	No	
Di-n-octyl Phthalate	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Fluoranthene	1/5	79J - 79J	SWMU297-IS01-00	360U - 4800U	79.00	NA	NA	Yes	3
Fluorene	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Hexachlorobenzene	0/5	NA	NA	360U - 4800U	4800.00	2.5	1920.00	Yes	2
Hexachlorobutadiene	0/5	NA	NA	360U - 4800U	4800.00	100	48.00	Yes	2
Hexachlorocyclopentadiene	0/5	NA	NA	1700U - 23000U	23000.00	10000	2.30	Yes	2
Hexachloroethane	0/5	NA	NA	360U - 4800U	4800.00	100	48.00	Yes	2
Indeno(1,2,3-cd)pyrene	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Isophorone	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Naphthalene	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Nitrobenzene	0/5	NA	NA	360U - 4800U	4800.00	40000	0.12	No	
Nitrosodi-n-propylamine, n-	0/5	NA	NA	360U - 4800U	4800.00	NA	NA	Yes	4
Nitrosodiphenylamine, n-	0/5	NA	NA	360U - 4800U	4800.00	20000	0.24	No	
Pentachlorophenol	0/5	NA	NA	1700U - 23000U	23000.00	2	11500.00	Yes	2
Phenanthrene	1/5	71J - 71J	SWMU297-IS01-00	360U - 4800U	71.00	NA	NA	Yes	3
Phenol	0/5	NA	NA	360U - 4800U	4800.00	50	96.00	Yes	2
Pyrene	1/5	45J - 45J	SWMU297-IS01-00	360U - 4800U	45.00	NA	NA	Yes	3
Metals (mg/kg)									
Arsenic	6/13	0.39J - 1.9J	SWMU261-TW01-00	0.3U - 1.9U	1.90	10	0.19	No	
Barium	9/13	9.2J - 140	SWMU261-SS01-00	21.8U - 23.1U	140.00	165	0.85	No	
Cadmium	6/13	0.84J - 31.6	SWMU261-SS01-00	0.03U - 0.56U	31.60	1.6	19.75	Yes	1
Chromium	13/13	5.5J - 65.8	SWMU261-SS01-00	NA	65.80	0.4	164.50	Yes	1
Lead	11/13	4.1 - 604	SWMU261-SS01-00	5.7U - 7.2U	604.00	50	12.08	Yes	1
Mercury	8/13	0.03J - 0.19J	SWMU261-SS03-00	0.036U - 0.048U	0.19	0.1	1.90	Yes	1
Selenium	0/13	NA	NA	0.48U - 1.6UJ	1.60	0.81	1.98	Yes	2
Silver	0/13	NA	NA	0.1U - 1.5U	1.50	2	0.75	No	

TABLE 7-3
 SELECTION OF ECOLOGICAL COPCs IN SURFACE SOIL
 SWMU 261/297
 RCRA FACILITY INVESTIGATION (CTO-0041)
 MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	Contaminant Frequency/Range					EPA Region IV ESV	Maximum Hazard Quotient	Soil COPC?	Contaminant Category
	Frequency of Detection	Range of Positive Detections	Location of Maximum Concentration	Range of Detection Limits	Concentration Used For Screening ⁽¹⁾				

Notes:

⁽¹⁾ Maximum concentration. If contaminant was not detected, equals the maximum detection limit.

D = Value is the result of a dilution

U = Chemical was not detected above the method detection limit

J = Estimated Value

NJ = Presumptive evidence for the presence of the material at an estimated value.

COPC = Contaminant of Potential Concern

EPA = Ecological Protection Agency

ESV = Ecological Screening Value

Hazard Quotient = Contaminant Concentration/ ESV

MDL = Maximum detection limit

mg/kg = miligram per kilogram

NA = Not Available

SQL = Sample quantitation limit

ug/kg = microgram per kilogram

Contaminant Categories

- 1 Contaminant was found in concentrations exceeding its screening value.
- 2 Contaminant was not found in concentrations exceeding the SQL; however, the MDL exceed its screening value.
- 3 Contaminant was found in concentrations exceeding its SQL; however, there is no current screening value for the contaminant.
- 4 Contaminant was not found in concentrations exceeding the SQL and there is no current screening value for the contaminant.

TABLE 7-4
SELECTION OF ECOLOGICAL COPCs IN GROUNDWATER
SWMU 261/297
RCRA FACILITY INVESTIGATION (CTO-0041)
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	Contaminant Frequency/Range					EPA Region IV Freshwater CSV	Maximum Hazard Quotient	North Carolina Fresh Surface Water Quality Standard	Exceeds NCWQS?	Groundwater COPC?	Contaminant Category
	Frequency of Detection	Range of Positive Detections	Location of Maximum Concentration	Range of Detection Limits	Concentration Used For Screening ⁽¹⁾						
Metals (ug/L)											
Arsenic	4/7	3J - 67.1	SWMU261-GW01	2UJ - 3.03U	67.10	190	0.35	50	Yes	Yes	5
Barium	7/7	8.6J - 2360J	SWMU261-GW01	NA	2360.00	NA	NA	NA	NA	Yes	3
Cadmium	2/7	4.4J - 9.4J	SWMU261-GW01	0.25U - 0.4U	9.40	0.1619	58.05	0.4	Yes	Yes	1, 5
Chromium	6/7	1.4J - 1210	SWMU261-GW01	0.8U	1210.00	NA	NA	50	Yes	Yes	3, 5
Lead	4/7	4.4 - 1200J	SWMU261-GW01	1.7U - 2U	1200.00	1.3165	911.48	25	Yes	Yes	1, 5
Mercury	3/7	0.02J - 3.6	SWMU261-GW01	0.01U - 0.1U	3.60	0.012	300.00	0.012	Yes	Yes	1, 5
Selenium	2/7	7.7 - 23.7	SWMU261-GW01	2.1U - 4.6U	23.70	5	4.74	5	Yes	Yes	1, 5
Silver	1/7	0.745J - 0.745J	SWMU261-MW01	0.5U - 1.16U	0.75	0.012	62.08	0.06	Yes	Yes	1, 5

Notes:

⁽¹⁾ Maximum concentration. If contaminant was not detected, equals the maximum detection limit.

COPC = Contaminant of Potential Concern

CSV = Chronic Screening Value

EPA = Ecological Protection Agency

Hazard Quotient = Contaminant Concentration/ CSV

J = Estimated Value

MDL = Maximum detection limit

mg/L = milligram per liter

NA = Not Available

NCWQS = North Carolinal Water Quality Standard

SQL = Sample quantitation limit

U = Chemical was not detected above the method detection limit

ug/L = microgram per liter

UJ = Chemical was not detected above the method detection limit; method detection limit is an estimated value.

Contaminant Categories

- 1 Contaminant was found in concentrations exceeding its screening value.
- 2 Contaminant was not found in concentrations exceeding the SQL; however, the MDL exceed its screening value.
- 3 Contaminant was found in concentrations exceeding its SQL; however, there is no current screening value for the contaminant.
- 4 Contaminant was not found in concentrations exceeding the SQL and there is no current screening value for the contaminant.
- 5 Contaminant's SQL (if not detected) or maximum concentration exceeds the NCWQS.

TABLE 7-5
MEDIA-SPECIFIC SCREENING VALUES FOR STEP 3A
SWMU 269/297
RCRA FACILITY INVESTIGATION (CTO-0041)
MCB CAMP LEJUENE, NORTH CAROLINA

Analyte	Step 3A Soil Screening Values		
	(ug/kg) or (mg/kg) ⁽¹⁾	Reference ⁽²⁾	Comment
Volatile Organics:			
1,1,1-Trichloroethane	100		value for aliphatic chlorinated hydrocarbons
1,1,2,2-Tetrachloroethane	100		value for aliphatic chlorinated hydrocarbons
1,1,2-Trichloroethane	100		value for aliphatic chlorinated hydrocarbons
1,1-Dichloroethane	100		value for aliphatic chlorinated hydrocarbons
1,1-Dichloroethene	100		value for aliphatic chlorinated hydrocarbons
1,2-Dichloroethane	400		
1,2-Dichloroethene (Total)	100		value for aliphatic chlorinated hydrocarbons
1,2-Dichloropropane	700,000		
2-Butanone	89,600	USEPA, 2003	
2-Hexanone	12,600	USEPA, 2003	
4-Methyl-2-Pentanone	443,000	USEPA, 2003	
Acetone	2,500	USEPA, 2003	
Benzene	50		
Bromodichloromethane	100		value for aliphatic chlorinated hydrocarbons
Bromoform	15,900	USEPA, 2003	
Bromomethane	NA		
Carbon Disulfide	94.1	USEPA, 2003	
Carbon Tetrachloride	1,000,000		
Chlorobenzene	50		
Chloroethane	100		value for aliphatic chlorinated hydrocarbons
Chloroform	1		
Chloromethane	100		value for aliphatic chlorinated hydrocarbons
cis-1,3-Dichloropropene	100		value for aliphatic chlorinated hydrocarbons
Dibromomethane	100		value for aliphatic chlorinated hydrocarbons
Ethylbenzene	50		
Methylene Chloride	2000		
Styrene	100		
Tetrachloroethene	10		
Toluene	50		
trans-1,3-Dichloropropene	100		value for aliphatic chlorinated hydrocarbons
Trichloroethene (TCE)	1		
Vinyl Chloride	10		
Xylene (Total)	50		
Semivolatile Organics:			
1,2,4-Trichlorobenzene	50	NCDENR 2003	value for total chlorobenzenes
1,2-Dichlorobenzene	50	NCDENR 2003	value for total chlorobenzenes
1,3-Dichlorobenzene	50	NCDENR 2003	value for total chlorobenzenes
1,4-Dichlorobenzene	50	NCDENR 2003	value for total chlorobenzenes
2,2'-Oxybis (1-Chloropropane)	100		value for aliphatic chlorinated hydrocarbons
2,4,5-Trichlorophenol	4,000		
2,4,6-Trichlorophenol	10,000		
2,4-Dichlorophenol	3		value for total dichlorophenols
2,4-Dimethylphenol	500		value for cresols
2,4-Dinitrophenol	20,000		
2,4-Dinitrotoluene	1,280	USEPA, 2003	
2,6-Dinitrotoluene	32.8	USEPA, 2003	
2-Chloronaphthalene	1000		value for chloronaphthalene
2-Chlorophenol	2.5	NCDENR 2003	value for total monochlorophenols

TABLE 7-5
 MEDIA-SPECIFIC SCREENING VALUES FOR STEP 3A
 SWMU 269/297
 RCRA FACILITY INVESTIGATION (CTO-0041)
 MCB CAMP LEJUENE, NORTH CAROLINA

Analyte	Step 3A Soil Screening Values		
	(ug/kg) or (mg/kg) ⁽¹⁾	Reference ⁽²⁾	Comment
Semivolatile Organics (Cont.):			
2-Methylnaphthalene	3,240	USEPA, 2003	
2-Methylphenol	500		value for cresols
2-Nitroaniline	74,100	USEPA, 2003	
2-Nitrophenol	7,000		value for 4-nitrophenol
3,3'-Dichlorobenzidine	100		value for total polycyclic chlorinated hydrocarbons
3-Nitroaniline	NA		
4,6-Dinitro-2-Methylphenol	NA		
4-Bromophenyl-Phenylether	NA		
4-Chloro-3-Methylphenol	2.5	NCDENR 2003	value for total monochlorophenols
4-Chloroaniline	1,100	USEPA, 2003	
4-Chlorophenyl-Phenylether	10		value for chlorophenols
4-Methylphenol	500		value for cresols
4-Nitroaniline	NA		
4-Nitrophenol	7,000		
Acenaphthene	1,000	NCDENR 2003	value for total PAHs
Acenaphthylene	1,000	NCDENR 2003	value for total PAHs
Anthracene	1,000	NCDENR 2003	value for total PAHs
Benzo(a)anthracene	1,000	NCDENR 2003	value for total PAHs
Benzo(a)pyrene	1,000	NCDENR 2003	value for total PAHs
Benzo(b)fluoranthene	1,000	NCDENR 2003	value for total PAHs
Benzo(g,h,i)perylene	1,000	NCDENR 2003	value for total PAHs
Benzo(k)fluoranthene	1,000	NCDENR 2003	value for total PAHs
bis(2-Chloroethyl)ether	100		value for aliphatic chlorinated hydrocarbons
bis(2-Chloroethoxy)methane	100		value for aliphatic chlorinated hydrocarbons
bis(2-Ethylhexyl)phthalate	100	NCDENR 2003	value for total phthalates
Butylbenzylphthalate	100	NCDENR 2003	value for total phthalates
Carbazole	NA		
Chrysene	1,000	NCDENR 2003	value for total PAHs
Dibenzo(a,h)anthracene	1,000	NCDENR 2003	value for total PAHs
Dibenzofuran	NA		
Diethylphthalate	100,000		
Dimethylphthalate	200,000		
Di-n-butylphthalate	200,000		
Di-n-octylphthalate	100	NCDENR 2003	value for total phthalates
Fluoranthene	1,000	NCDENR 2003	value for total PAHs
Fluorene	1,000	NCDENR 2003	value for total PAHs
Hexachlorobenzene	2.5		
Hexachlorobutadiene	100		value for aliphatic chlorinated hydrocarbons
Hexachlorocyclopentadiene	10,000		
Hexachloroethane	100		value for aliphatic chlorinated hydrocarbons
Indeno(1,2,3-cd)pyrene	1,000	NCDENR 2003	value for total PAHs
Isophorone	139,000	USEPA, 2003	
Naphthalene	1,000	NCDENR 2003	value for total PAHs
Nitrobenzene	40,000		
n-Nitroso-di-n-propylamine	544	USEPA, 2003	
n-Nitrosodiphenylamine	20,000		
Pentachlorophenol	2		
Phenanthrene	1,000	NCDENR 2003	value for total PAHs

**TABLE 7-5
 MEDIA-SPECIFIC SCREENING VALUES FOR STEP 3A
 SWMU 269/297
 RCRA FACILITY INVESTIGATION (CTO-0041)
 MCB CAMP LEJUENE, NORTH CAROLINA**

Analyte	Step 3A Soil Screening Values		
	(ug/kg) or (mg/kg) ⁽¹⁾	Reference ⁽²⁾	Comment
Semivolatile Organics (Cont.):			
Phenol	50		
Pyrene	1,000	NCDENR 2003	value for total PAHs
PAHs (total)	1000		
Phthalates (total)	100		
Total Inorganics:			
Arsenic	10		18 Eco-SSL terrestrial plants (USEPA 2003)
Barium	165		330 Eco-SSL soil invertebrates (USEPA 2003)
Cadmium	1.6		0.36 Eco-SSL mammalian wildlife (USEPA 2003)
Chromium (Total)	0.4		26 Eco-SSL avian wildlife (USEPA 2003)
Chromium III	0.4		Value for Chromium (total)
Chromium VI	0.4		Value for Chromium (total)
Lead	50		16 Eco-SSL avian wildlife (USEPA 2003)
Mercury	0.1		
Selenium	0.81		
Silver	2		

Notes:

NA = Not Applicable/ Not Established

NCDENR = North Carolina Department of Environment and Natural Resources

USEPA = United States Environmental Protection Agency

⁽¹⁾ Soil screening values are in microgram per kilogram (ug/kg) for organic compounds and in milligram per kilogram (mg/kg) for inorganic constituents.

⁽²⁾ Non-shaded values are USEPA Region IV screening values obtained from *Guidelines for Performing Screening Level Ecological Risk Assessments within the North Carolina Division of Waste Management* (NCDENR 2003)

Shading indicates a screening value not included in Step 2 evaluation.

TABLE 7-5
MEDIA-SPECIFIC SCREENING VALUES FOR STEP 3A
SWMU 269/297
RCRA FACILITY INVESTIGATION (CTO-0041)
MCB CAMP LEJUENE, NORTH CAROLINA

Analyte	Step 3A Surface Water Screening Values - Freshwater		
	(ug/L)	Reference ⁽¹⁾	Comment
Volatile Organics:			
1,1,1-Trichloroethane	528		
1,1,2,2-Tetrachloroethane	240		
1,1,2-Trichloroethane	940		
1,1-Dichloroethane	47	USEPA, 2003	
1,1-Dichloroethene	303		
1,2-Dichloroethane	2000		
1,2-Dichloroethene (Total)	1350	NCDENR, 2003	value for 1,2-dichloroethene(trans)
1,2-Dichloropropane	525		
2-Butanone	2,200	USEPA, 2003	
2-Hexanone	99	USEPA, 2003	
4-Methyl-2-Pentanone	170	USEPA, 2003	
Acetone	1,700	USEPA, 2003	
Benzene	53		
Bromodichloromethane	4,320	USEPA, 2003	
Bromoform	293		
Bromomethane	110		
Carbon Disulfide	15	USEPA, 2003	
Carbon Tetrachloride	352		
Chlorobenzene	195		
Chloroethane	NA		
Chloroform	289		
Chloromethane	5500		
cis-1,3-Dichloropropene	24.4		
Dibromomethane	NA		
Ethylbenzene	453		
Methylene Chloride	1930		
Styrene	32,000	USEPA, 2003	
Tetrachloroethene	84		
Toluene	175		
trans-1,3-Dichloropropene	24.4		Cis and Trans isomers
Trichloroethene (TCE)	47	USEPA, 2003	
Vinyl Chloride	930	USEPA, 2003	
Xylene (Total)	27	USEPA, 2003	
Semivolatile Organics:			
1,2,4-Trichlorobenzene	44.9		
1,2-Dichlorobenzene	15.8		
1,3-Dichlorobenzene	50.2		
1,4-Dichlorobenzene	11.2		
2,2'-Oxybis (1-Chloropropane)	NA		
2,4,5-Trichlorophenol	NA		
2,4,6-Trichlorophenol	3.2		
2,4-Dichlorophenol	36.5		
2,4-Dimethylphenol	21.2		
2,4-Dinitrophenol	6.2		
2,4-Dinitrotoluene	310		
2,6-Dinitrotoluene	81	USEPA, 2003	
2-Chloronaphthalene	0.396	USEPA, 2003	
2-Chlorophenol	43.8		

TABLE 7-5
MEDIA-SPECIFIC SCREENING VALUES FOR STEP 3A
SWMU 269/297
RCRA FACILITY INVESTIGATION (CTO-0041)
MCB CAMP LEJUENE, NORTH CAROLINA

Analyte	Step 3A Surface Water Screening Values - Freshwater		
	(ug/L)	Reference ⁽¹⁾	Comment
Semivolatile Organics (Cont.):			
2-Methylnaphthalene	330	USEPA, 2003	
2-Methylphenol	67	USEPA, 2003	
2-Nitroaniline	NA		
2-Nitrophenol	3500		
3,3'-Dichlorobenzidine	4.5	USEPA, 2003	
3-Nitroaniline	NA		
4,6-Dinitro-2-Methylphenol	2.3		
4-Bromophenyl-Phenylether	12.2		
4-Chloro-3-Methylphenol	0.3		
4-Chloroaniline	232	USEPA, 2003	
4-Chlorophenyl-Phenylether	NA		
4-Methylphenol	25	USEPA, 2003	
4-Nitroaniline	NA		
4-Nitrophenol	82.8		
Acenaphthene	17		
Acenaphthylene	4,840	USEPA, 2003	
Anthracene	0.035	USEPA, 2003	
Benzo(a)anthracene	0.025	USEPA, 2003	
Benzo(a)pyrene	0.014	USEPA, 2003	
Benzo(b)fluoranthene	9.07	USEPA, 2003	
Benzo(g,h,i)perylene	7.64	USEPA, 2003	
Benzo(k)fluoranthene	NA		
bis(2-Chloroethyl)ether	2380		
bis(2-Chloroethoxy)methane	NA		
bis(2-Ethylhexyl)phthalate	0.30		
Butylbenzylphthalate	22		
Carbazole	NA		
Chrysene	NA		
Dibenzo(a,h)anthracene	4	USEPA, 2003	
Dibenzofuran	3.7	USEPA Region III, 2004	
Diethylphthalate	521		
Dimethylphthalate	330		
Di-n-butylphthalate	9.4		
Di-n-octylphthalate	0.3		value for bis(2-ethylhexyl)phthalate
Fluoranthene	39.8		
Fluorene	19	USEPA, 2003	
Hexachlorobenzene	0.0003	USEPA, 2003	
Hexachlorobutadiene	0.93		
Hexachlorocyclopentadiene	0.07		
Hexachloroethane	9.8		
Indeno(1,2,3-cd)pyrene	4.31	USEPA, 2003	
Isophorone	1170		
Naphthalene	62		
Nitrobenzene	270		
n-Nitroso-di-n-propylamine	NA		
n-Nitrosodiphenylamine	58.5		
Pentachlorophenol	12.8		pH = 7.8 S.U.
Phenanthrene	3.6	USEPA, 2003	

**TABLE 7-5
 MEDIA-SPECIFIC SCREENING VALUES FOR STEP 3A
 SWMU 269/297
 RCRA FACILITY INVESTIGATION (CTO-0041)
 MCB CAMP LEJUENE, NORTH CAROLINA**

Analyte	Step 3A Surface Water Screening Values - Freshwater		
	(ug/L)	Reference ⁽¹⁾	Comment
Semivolatile Organics (Cont.):			
Phenol	256		
Pyrene	0.3	USEPA, 2003	
PAHs (total)	17		Value for acenaphthene
Phthalates (total)	NA		
Total Inorganics:			
Arsenic	190		Trivalent (+3) form
Barium	220	USEPA, 2003	
Cadmium	0.16	NCDENR 2003, USEPA 2002	Hardness = 50 mg CaCO ₃ /L (default) ⁽²⁾
Chromium (Total)	11	NCDENR, 2003	Value for Chromium VI
Chromium III	117.32		Hardness = 50 mg CaCO ₃ /L (default)
Chromium VI	11		
Lead	1.32		Hardness = 50 mg CaCO ₃ /L (default)
Mercury	0.012		
Selenium	5		
Silver	0.012		

Notes:

NA = Not Applicable/ Not Established

NCDENR = North Carolina Department of Environment and Natural Resources

USEPA = United States Environmental Protection Agency

⁽¹⁾ Non-shaded values are USEPA Region IV screening values obtained from *Guidelines for Performing Screening Level Ecological Risk Assessments within the North Carolina Division of Waste Management* (NCDENR 2003)

⁽²⁾ USEPA Region IV hardness based calculation updated to reflect current ambient water quality criteria (USEPA 2002).

Shading indicates a screening value not included in NCDENR 2003.

TABLE 7-6
 REFINED ASSESSMENT OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SURFACE SOIL
 SWMU 261/297
 RCRA FACILITY INVESTIGATION (CTO-0143)
 MCB CAMP LEJEUNE, NORTH CAROLINA

Ecological Contaminant of Potential Concern based on Steps 1 and 2	Contaminant Category ⁽¹⁾	Refined Risk Screening			Background Comparison			Frequency of Detection		Important Bioaccumulative Chemical? ⁽⁵⁾	Further Evaluation Recommended based on Step 3A?	Comments
		Arithmetic Mean (Half Non-Detects)	Refined Surface Soil Screening Value (SSSV) ⁽⁴⁾	Mean HQ ⁽³⁾	Maximum Site Concentration	2 X Mean Background ⁽⁴⁾ Concentration	Maximum Site Concentration Less than 2X Background?	Frequency of Detection	Contaminant Detected?			
Volatiles (ug/kg)												
1,2-Dichlorobenzene (o-) (1)	3	36.45	50	0.73	180	NA	NA	1/5	Yes	Yes	No	Mean HQ < 1.0
1,3-Dichlorobenzene (m-) (1)	3	44.45	50	0.89	220	NA	NA	1/5	Yes	Yes	No	Mean HQ < 1.0
1,4-Dichlorobenzene (p-) (1)	3	42.69	50	0.85	210	NA	NA	2/5	Yes	Yes	No	Mean HQ < 1.0
2-Butanone (MEK)	4	38.00	89600	<0.01	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
2-Hexanone (MBK)	4	38.00	12600	<0.01	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
4-Methyl-2-pentanone (MIBK)	3	36.68	443000	<0.01	4 J	NA	NA	1/5	Yes	No	No	Mean HQ < 1.0
Acetone	4	38.00	2500	0.02	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
Benzene (1)	2	7.75	50	0.16	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
Bromoform	4	9.53	15900	<0.01	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
Bromomethane	3	19.06	NA	NA	3 J	NA	NA	1/5	Yes	No	No	See text
Carbon Disulfide	4	9.53	94.1	0.10	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
Chlorobenzene (1)	2	7.75	50	0.16	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
Chloroform	2	9.53	1	9.53	ND	NA	NA	0/5	No	No	No	Not Detected
Chloromethane	2	19.50	100	0.20	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
Ethylbenzene (1)	2	7.75	50	0.16	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
Trichloroethene (TCE)	2	9.53	1	9.53	ND	NA	NA	0/5	No	No	No	Not Detected
Vinyl Chloride	2	19.50	10	1.95	ND	NA	NA	0/5	No	No	No	Not Detected
Xylenes, total (1)(2)	1	42.98	50	0.86	210	NA	NA	3/5	Yes	No	No	Mean HQ < 1.0
Semivolatiles (ug/kg)												
1,2,4-Trichlorobenzene	4	627.00	50	12.54	ND	NA	NA	0/5	No	Yes	No	Not Detected
1,2-Dichlorobenzene (o-)	4	627.00	50	12.54	ND	NA	NA	1/5	No	Yes	No	Not Detected
1,3-Dichlorobenzene (m-)	4	627.00	50	12.54	ND	NA	NA	1/5	No	Yes	No	Not Detected
1,4-Dichlorobenzene (p-)	4	627.00	50	12.54	ND	NA	NA	2/5	No	Yes	No	Not Detected
2,2'-Oxybis[1-chloropropane]	2	627.00	100	6.27	ND	NA	NA	0/5	No	No	No	Not Detected
2,4,5-Trichlorophenol	2	627.00	4000	0.16	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
2,4-Dichlorophenol	2	627.00	3	209.00	ND	NA	NA	0/5	No	No	No	Not Detected
2,4-Dimethylphenol	2	627.00	500	1.25	ND	NA	NA	0/5	No	No	No	Not Detected
2,4-Dinitrophenol	2	3000.00	20000	0.15	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
2,4-Dinitrotoluene	4	627.00	1280	0.49	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
2,6-Dinitrotoluene	4	627.00	32.8	19.12	ND	NA	NA	0/5	No	No	No	Not Detected
2-Chloronaphthalene	2	627.00	1000	0.63	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
2-Chlorophenol	4	627.00	2.5	250.80	ND	NA	NA	0/5	No	No	No	Not Detected
2-Methylnaphthalene	4	627.00	3240	0.19	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
2-Methylphenol (o-Cresol)	2	627.00	500	1.25	ND	NA	NA	0/5	No	No	No	Not Detected
2-Nitroaniline	4	3000.00	74100	0.04	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
3,3'-Dichlorobenzidine	2	3000.00	100	30.00	ND	NA	NA	0/5	No	No	No	Not Detected

TABLE 7-6
 REFINED ASSESSMENT OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SURFACE SOIL
 SWMU 261/297
 RCRA FACILITY INVESTIGATION (CTO-0143)
 MCB CAMP LEJEUNE, NORTH CAROLINA

Ecological Contaminant of Potential Concern based on Steps 1 and 2	Contaminant Category ⁽¹⁾	Refined Risk Screening			Background Comparison			Frequency of Detection		Important Bioaccumulative Chemical? ⁽²⁾	Further Evaluation Recommended based on Step 3A?	Comments
		Arithmetic Mean (Half Non-Detects)	Refined Surface Soil Screening Value (SSSV) ⁽²⁾	Mean HQ ⁽³⁾	Maximum Site Concentration	2 X Mean Background ⁽⁴⁾	Maximum Site Concentration Less than 2X Background?	Frequency of Detection	Contaminant Detected?			
Semivolatiles (ug/kg)(Cont.)												
3-Nitroaniline	4	3000.00	NA	NA	ND	NA	NA	0/5	No	No	No	Not Detected
4,6-Dinitro-2-methylphenol	4	3000.00	NA	NA	ND	NA	NA	0/5	No	No	No	Not Detected
4-Bromophenyl-phenylether	4	627.00	NA	NA	ND	NA	NA	0/5	No	Yes	No	Not Detected
4-Chloro-3-methylphenol	4	627.00	2.5	250.80	ND	NA	NA	0/5	No	No	No	Not Detected
4-Chloroaniline	4	627.00	1100	0.57	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
4-Chlorophenyl-phenylether	2	627.00	10	62.70	ND	NA	NA	0/5	No	Yes	No	Not Detected
4-Methylphenol (p-Cresol)	2	627.00	500	1.25	ND	NA	NA	0/5	No	No	No	Not Detected
4-Nitroaniline	4	3000.00	NA	NA	ND	NA	NA	0/5	No	No	No	Not Detected
4-Nitrophenol	2	3000.00	7000	0.43	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
Acenaphthene	4	627.00	1000	0.63	ND	NA	NA	0/5	No	Yes	No	Mean HQ < 1.0
Acenaphthylene	4	627.00	1000	0.63	ND	NA	NA	0/5	No	Yes	No	Mean HQ < 1.0
Anthracene	4	627.00	1000	0.63	ND	NA	NA	0/5	No	Yes	No	Mean HQ < 1.0
Benzo(a)anthracene	4	627.00	1000	0.63	ND	NA	NA	0/5	No	Yes	No	Mean HQ < 1.0
Benzo(a)pyrene	4	627.00	1000	0.63	ND	NA	NA	0/5	No	Yes	No	Mean HQ < 1.0
Benzo(b)fluoranthene	4	627.00	1000	0.63	ND	NA	NA	0/5	No	Yes	No	Mean HQ < 1.0
Benzo(g,h,i)perylene	4	627.00	1000	0.63	ND	NA	NA	0/5	No	Yes	No	Mean HQ < 1.0
Benzo(k)fluoranthene	4	627.00	1000	0.63	ND	NA	NA	0/5	No	Yes	No	Mean HQ < 1.0
Bis(2-chloroethoxy)methane	2	627.00	100	6.27	ND	NA	NA	0/5	No	No	No	Not Detected
Bis(2-chloroethyl)ether	2	627.00	100	6.27	ND	NA	NA	0/5	No	No	No	Not Detected
Bis(2-ethylhexyl) Phthalate (BEHP)	3	253.00	100	2.53	500 J	NA	NA	5/5	Yes	No	No	See text
Butyl Benzyl Phthalate	4	627.00	100	6.27	ND	NA	NA	0/5	No	No	No	Not Detected
Carbazole	4	627.00	NA	NA	ND	NA	NA	0/5	No	No	No	Not Detected
Chrysene	4	627.00	1000	0.63	ND	NA	NA	0/5	No	Yes	No	Mean HQ < 1.0
Dibenz(a,h)anthracene	4	627.00	1000	0.63	ND	NA	NA	0/5	No	Yes	No	Mean HQ < 1.0
Dibenzofuran	4	627.00	NA	NA	ND	NA	NA	0/5	No	No	No	Not Detected
Di-n-octyl Phthalate	4	627.00	100	6.27	ND	NA	NA	0/5	No	No	No	Not Detected
Fluoranthene	3	604.80	1000	0.08	79 J	NA	NA	1/5	Yes	Yes	No	Mean HQ < 1.0
Fluorene	4	627.00	1000	0.63	ND	NA	NA	0/5	No	Yes	No	Mean HQ < 1.0
Hexachlorobenzene	2	627.00	2.5	250.80	ND	NA	NA	0/5	No	Yes	No	Not Detected
Hexachlorobutadiene	2	627.00	100	6.27	ND	NA	NA	0/5	No	Yes	No	Not Detected
Hexachlorocyclopentadiene	2	3000.00	10000	0.30	ND	NA	NA	0/5	No	Yes	No	Mean HQ < 1.0
Hexachloroethane	2	627.00	100	6.27	ND	NA	NA	0/5	No	Yes	No	Not Detected
Indeno(1,2,3-cd)pyrene	4	627.00	1000	0.63	ND	NA	NA	0/5	No	Yes	No	Mean HQ < 1.0
Isophorone	4	627.00	139000	<0.01	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
Naphthalene	4	627.00	1000	0.63	ND	NA	NA	0/5	No	No	No	Mean HQ < 1.0
Nitrosodi-n-propylamine, n-	4	627.00	544	1.15	ND	NA	NA	0/5	No	No	No	Not Detected
Pentachlorophenol	2	3000.00	2	1500.00	ND	NA	NA	0/5	No	Yes	No	Not Detected
Phenanthrene	3	603.20	1000	0.07	71 J	NA	NA	1/5	Yes	Yes	No	Mean HQ < 1.0

TABLE 7-6
REFINED ASSESSMENT OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SURFACE SOIL
SWMU 261/297
RCRA FACILITY INVESTIGATION (CTO-0143)
MCB CAMP LEJEUNE, NORTH CAROLINA

Ecological Contaminant of Potential Concern based on Steps 1 and 2	Contaminant Category ⁽¹⁾	Refined Risk Screening			Background Comparison			Frequency of Detection		Important Bioaccumulative Chemical? ⁽⁵⁾	Further Evaluation Recommended based on Step 3A?	Comments
		Arithmetic Mean (Half Non-Detects)	Refined Surface Soil Screening Value (SSSV) ⁽²⁾	Mean HQ ⁽³⁾	Maximum Site Concentration	2 X Mean Background ⁽⁴⁾ Concentration	Maximum Site Concentration Less than 2X Background?	Frequency of Detection	Contaminant Detected?			
Semivolatiles (ug/kg)(Cont.)												
Phenol	2	627.00	50	12.54	ND	NA	NA	0/5	No	No	No	Not Detected
Pyrene	3	598.00	1000	0.05	45 J	NA	NA	1/5	Yes	Yes	No	Mean HQ < 1.0
Metals (mg/kg)												
Cadmium	1	3.88	1.6	2.42	32	0.63	No	6/13	Yes	Yes	Yes	Mean HQ > 1.0
Chromium	1	15.58	0.4	38.96	66	14.49	No	13/13	Yes	Yes	No	See text
Lead	1	112.23	50	2.24	604	21.14	No	11/13	Yes	Yes	Yes	Mean HQ > 1.0
Mercury	1	0.04	0.1	0.44	0.19 J	0.06	No	8/13	Yes	Yes	No	Mean HQ < 1.0
Selenium	2	0.33	0.81	0.41	ND	1.19	No	0/13	No	Yes	No	Mean HQ < 1.0

Notes:

COPC = Ecological Contaminant of Potential Concern

HQ = Hazard Quotient

mg/kg = miligram per kilogram

ug/kg = microgram per kilogram

N = sample size

NA = Not Applicable

ND = Not Detected

NE = Not Established (for screening value)

⁽¹⁾ See Table 7-3 and text for definitions of contaminant categories.

⁽²⁾ References for alternative screening values are provided on Table 7-5.

⁽³⁾ The mean HQ represents the mean (half non-detect) concentration divided by the screening value. In cases where the mean exceeds the maximum the maximum value is used.

⁽⁴⁾ The background concentration presented is for AOC 7 surface soils (Final Area of Concern Background Study [Baker 2001]).

⁽⁵⁾ Compound is identified as an "important bioaccumulative chemical" in the USEPA document *Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment, Status and Needs* (EPA-823-R-00-001, February 2000).

TABLE 7-7
 REFINED ASSESSMENT OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN GROUNDWATER
 SWMU 261/297
 RCRA FACILITY INVESTIGATION (CTO-0143)
 MCB CAMP LEJEUNE, NORTH CAROLINA

Ecological Contaminant of Potential Concern based on Steps 1 and 2	Contaminant Category ⁽¹⁾	Refined Risk Screening					Background Comparison			Frequency of Detection		Important Bioaccumulative Chemical? ⁽⁵⁾	Further Evaluation Recommended based on Step 3A?	Comments
		Arithmetic Mean (Half Non-Detects)	Refined Surface Water Screening Value (SWSV) ⁽²⁾	North Carolina Fresh Surface Water Quality Standard	Refined SWSV Mean HQ ⁽⁴⁾	NCWQS Mean HQ ⁽⁴⁾	Maximum Site Concentration	2 X Mean Background ⁽⁴⁾	Maximum Site Concentration Less than 2X Mean Background?	Frequency of Detection	Contaminant Detected?			
Metals (ug/L)														
Arsenic	5	14.6736	190	50	0.08	0.29	67.10	5.77	No	4/7	Yes	Yes	No	Mean HQ < 1.0
Barium	3	429.1429	220	NA	1.95	NA	2360.00 J	86.24	No	7/7	Yes	No	No	See text
Cadmium	1, 5	2.0821	0.1619	0.4	12.86	5.21	9.40 J	0.36	No	2/7	Yes	Yes	No	See text
Chromium	3, 5	222.8143	11	50	20.26	4.46	1210.00	3.13	No	6/7	Yes	Yes	No	See text
Lead	1, 5	209.1714	1.32	25	158.88	8.37	1200.00 J	2.80	No	4/7	Yes	Yes	No	See text
Mercury	1, 5	0.69	0.012	0.012	57.50	57.50	3.60	0.10	No	3/7	Yes	Yes	No	See text
Selenium	1, 5	5.66	5	5	1.13	1.13	23.70	3.14	No	2/7	Yes	Yes	No	See text
Silver	1, 5	0.4107	0.012	0.06	34.23	6.85	0.75 J	0.77	Yes	1/7	Yes	Yes	No	< Background

Notes:

HQ = Hazard Quotient

COPC = Ecological Contaminant of Potential Concern

ug/L = microgram per liter

NA = Not Applicable

NE = Note Established

⁽¹⁾ See Table 7-3 and text for definitions of contaminant categories.

⁽²⁾ References for alternative screening values are provided on Table 7-5.

⁽³⁾ The mean HQ represents the mean (half non-detect) concentration divided by the screening value. In cases where the mean exceeds the maximum the maximum value is used.

⁽⁴⁾ The background concentration presented is for shallow portions of the surficial aquifer (Base Background Groundwater Investigation [Baker 2002]).

⁽⁵⁾ Compound is identified as an "important bioaccumulative chemical" in the USEPA document *Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment, Status and Needs* (EPA-823-R-00-001, February 2000).

8.0 CONCLUSIONS AND RECOMMENDATIONS

This section provides a discussion of conclusions that were rendered based on the data collected from the Phase I and II CSIs and the RFI. Recommendations for future actions are also discussed.

VOCs and SVOCs were detected infrequently and at low concentrations (below the regulatory-driven screening criteria) in soil. Metals (cadmium, chromium, lead, and mercury) were detected in soil at concentrations exceeding the regulatory-driven screening values, as well as the background screening values. The metals contamination appears to be limited to the nearby drainage ditch that accepted discharge from the SWMU. The highest concentrations were detected within the upper portions of the drainage way and extended approximately 35 to 45 feet downgradient. The concentrations decreased with increased distance from the SWMU.

A few metals (arsenic, barium, cadmium, chromium, lead, and mercury) were historically detected in groundwater samples from temporary wells at concentrations exceeding the regulatory-driven screening values, as well as the background screening values. However, it is important to note that the turbidity was elevated (greater than 1,100 NTUs) in the groundwater samples from these wells and may have caused artificially high metals concentrations in the samples. As a result, three "permanent" monitoring wells were installed and developed as part of this RFI. In general, similar metals were detected in groundwater samples from the permanent wells; however, the concentrations were below both the regulatory-driven screening values and background screening values, which suggests that the elevated concentrations detected in the temporary wells likely was attributable to turbidity and groundwater has not been impacted as a result of a release(s) from the SWMU.

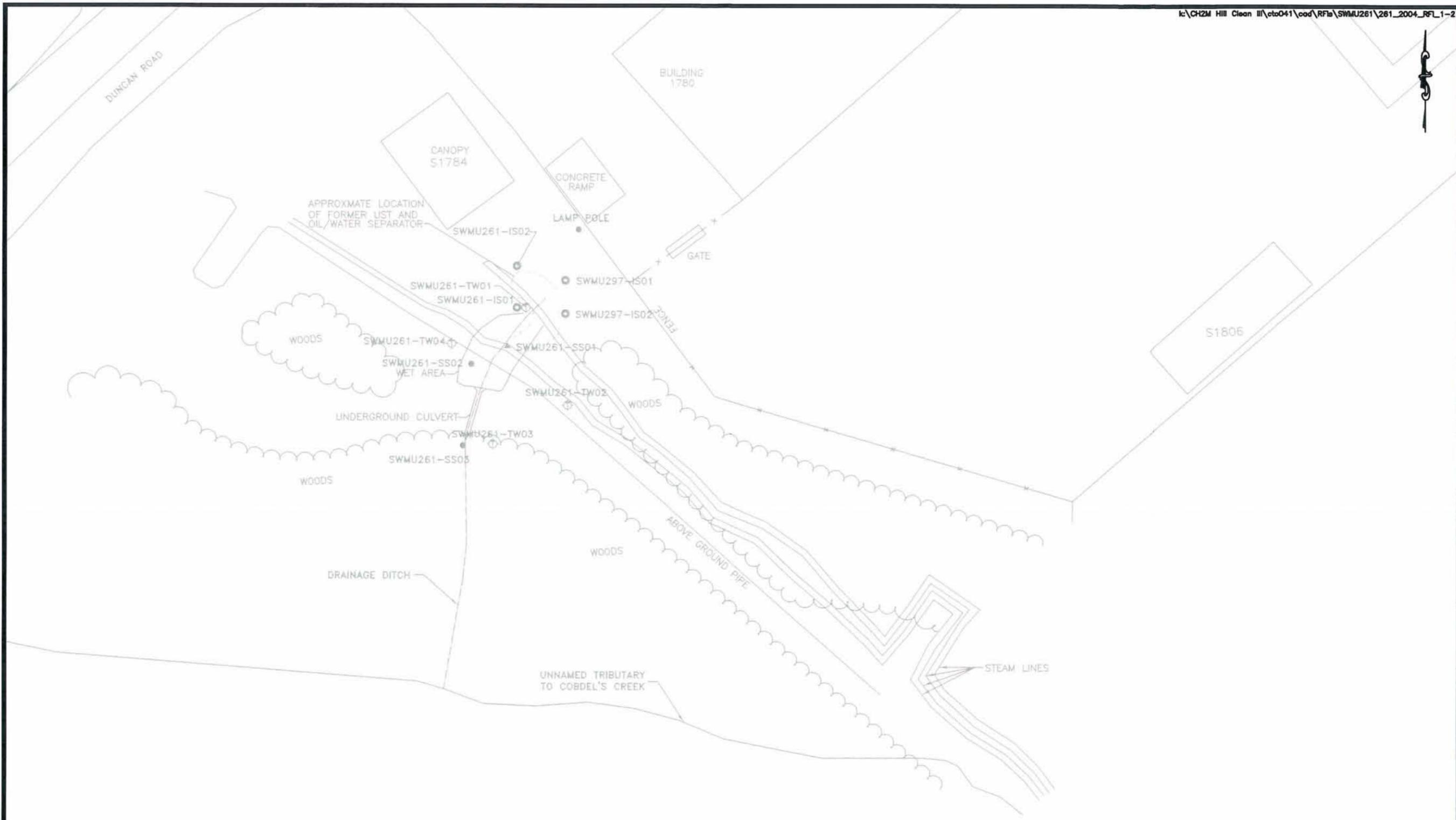
Based on the results of the HHRA, there were no unacceptable risks or adverse health hazards for adult and adolescent trespassers, current military Base personnel, or future construction workers upon exposure to environmental media at the SWMU. Lead in surface soil within the drainage way may pose unacceptable risks to future child residents. Arsenic, chromium, and mercury in shallow groundwater may also pose unacceptable risks to future adult and child residents. However, this risk was based on groundwater samples from temporary wells that exhibited elevated turbidity. Furthermore, shallow groundwater in the vicinity of the SWMU is not

currently used or planned to be used for potable water purposes and future uses as such will be prohibited.

Based on the results of the SLERA and Step 3A of the BERA, the metals cadmium and lead in surface soils may pose unacceptable risks to ecological receptors. Potential aquatic receptors in off-site habitats are not estimated to be at unacceptable levels of risk from groundwater contamination associated with the SWMU.

It should be noted that the highest concentrations of VOCs and metals that drove risk were detected within the drainage ditch that accepted discharge from the SWMU. If the soil data from this area were to be removed from the risk evaluations, risks to future child residents and ecological receptors would be below acceptable levels. As a result, Interim Measures are recommended to remove the impacted soils within the drainage ditch. Soil samples should be collected as part of the Interim Measures to confirm that the impacted soils have been removed. The confirmatory samples should be analyzed for RCRA metals as well as VOCs since VOC concentrations downgradient of sample 261-SS01 within the drainage ditch are unknown.

No future actions with respect to groundwater are recommended because constituents detected in samples from the monitoring wells were below the USEPA Region IX Tap Water PRGs, and risks to human health and ecological receptors are perceived to be acceptable when considering the conservative nature of the risk assessments (i.e., use of maximum detected concentrations from temporary wells with elevated turbidity) and the future intended use of shallow groundwater (i.e., groundwater in the vicinity of the SWMU is not currently used or planned to be used for potable water purposes and future uses as such will be prohibited).

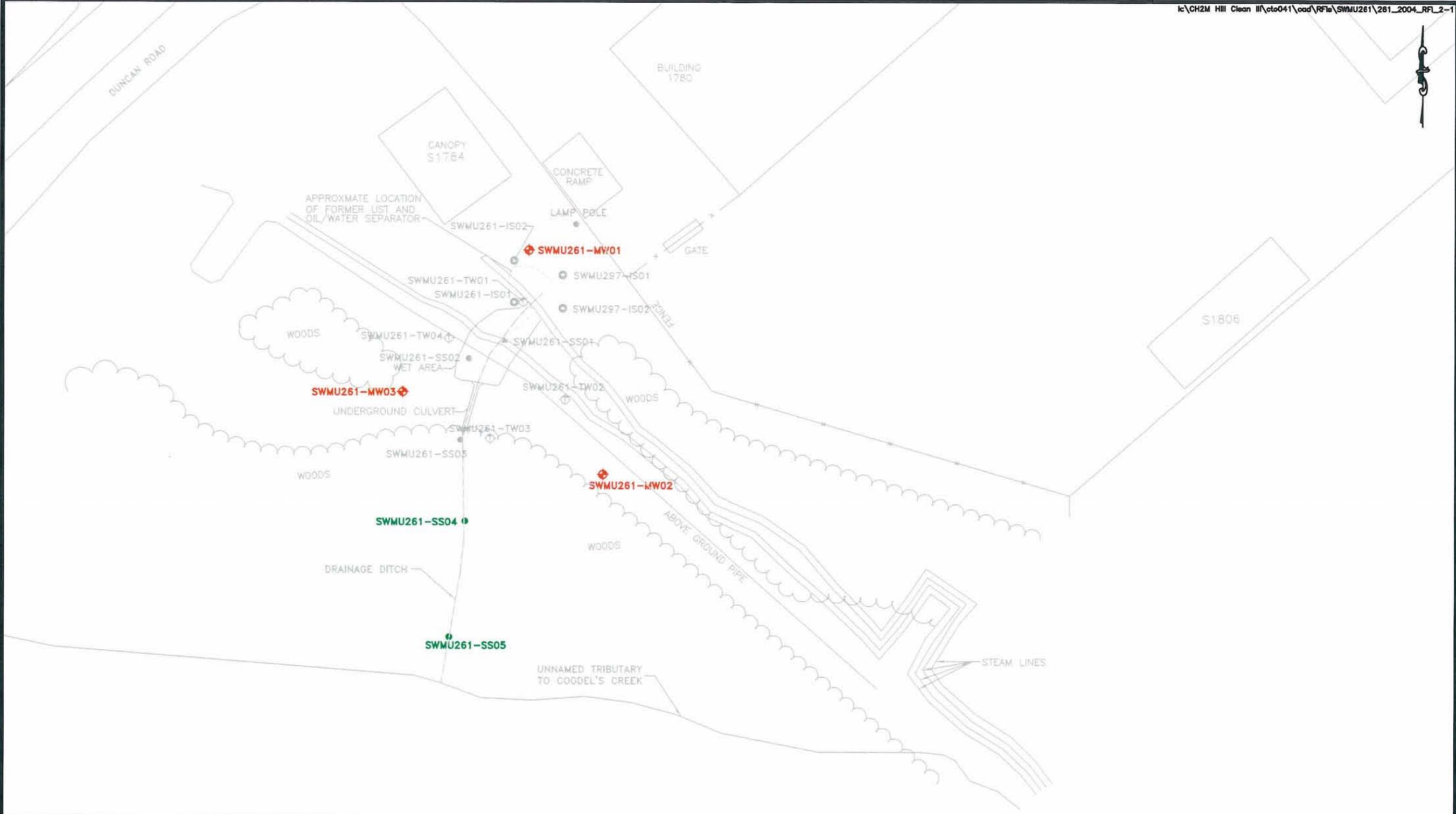


SOURCE: MCB CAMP LEJEUNE MARCH 2000

LEGEND

- ⊕ - PHASE II TEMPORARY WELL
- - PHASE II SURFACE SOIL SAMPLE
- - PHASE I SOIL BORING
- ▲ - PHASE I SURFACE SOIL
- - SURFACE SOIL SAMPLE

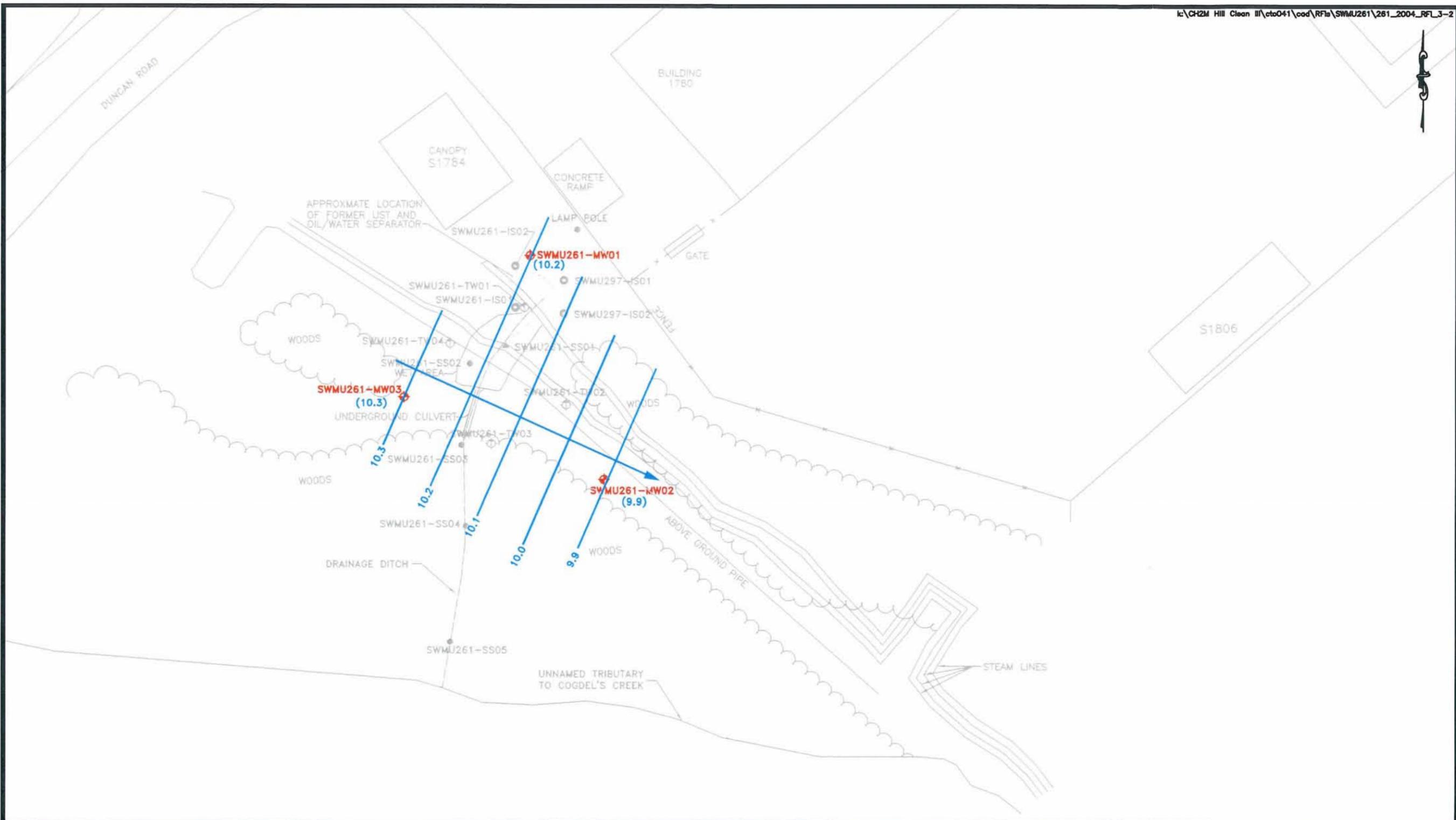
FIGURE 1-2
RCRA FACILITY INVESTIGATION SWMU 261/297
CURRENT CONDITIONS
APRIL 2004
CTO-0041
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



SOURCE: MCB CAMP LEJEUNE MARCH 2000

- LEGEND**
- ◊ - PHASE II TEMPORARY WELL
 - - PHASE II SURFACE SOIL SAMPLE
 - - PHASE I SOIL BORING
 - ▲ - PHASE I SURFACE SOIL
 - - RFI SURFACE SOIL SAMPLE
 - ◊ - RFI MONITORING WELL

FIGURE 2-1
SAMPLE LOCATION MAP
 RCRA FACILITY INVESTIGATION-SWMU 261/297
 CTO-0041
 MARINE CORPS BASE, CAMP LEJEUNE
 NORTH CAROLINA



SOURCE: MCB CAMP LEJEUNE MARCH 2000

LEGEND

	- PHASE II TEMPORARY WELL
	- PHASE II SURFACE SOIL SAMPLE
	- PHASE I SOIL BORING
	- PHASE I SURFACE SOIL
	- RFI SURFACE SOIL SAMPLE LOCATION
	- RFI MONITORING WELL SAMPLE LOCATION
	- GROUNDWATER FLOW DIRECTION
	- GROUNDWATER CONTOUR
	- GROUNDWATER ELEVATION

FIGURE 3-2
INTERPRETIVE GROUNDWATER CONTOUR MAP
FOR APRIL 2004
RCRA FACILITY INVESTIGATION-SWMU 261/297
CTO-0041
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

SAMPLE ID	SWMU261-SS01-00
SAMPLE DATE	9/17/1997
DEPTH	0' - 2'
METALS (mg/kg)	
Cadmium	31.6
Chromium	65.8
Lead	604

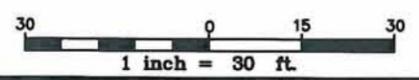
SAMPLE ID	SWMU261-SS03-00
SAMPLE DATE	3/26/2002
DEPTH	0' - 1'
METALS (mg/kg)	
Cadmium	11.9 J
Chromium	28.7 J
Lead	587 J
Mercury	0.19 J

NOTES:
Shaded - Exceeds AOC Background Concentrations
Bold - Exceeds Base Background Concentrations
Underline - Exceeds North Carolina Soil to Groundwater Concentrations
Boxed - Exceeds USEPA Region IX Industrial Soil PRGs

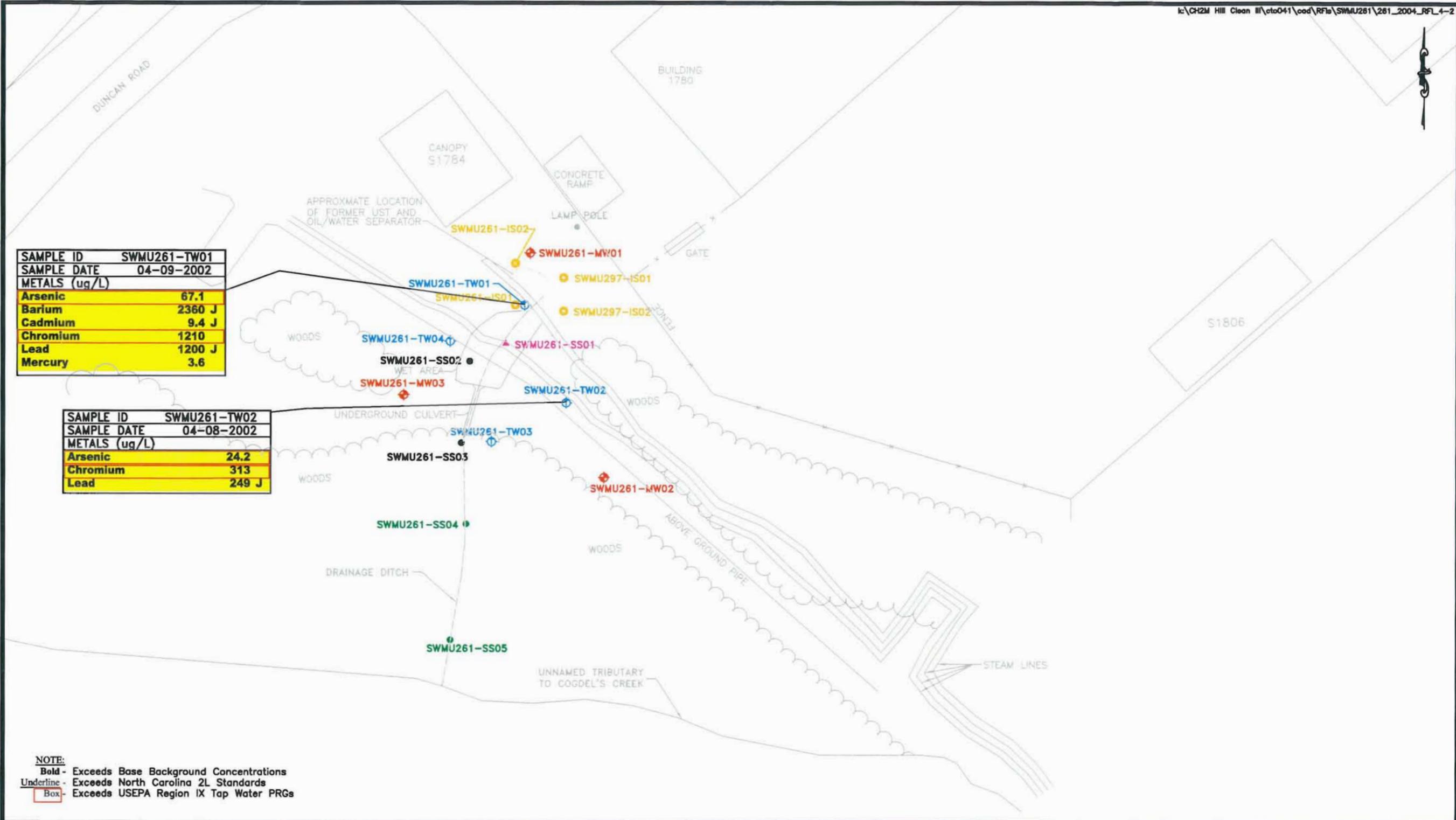
Phase I sample locations were not surveyed, locations are approximate.

- LEGEND**
- ⊕ - PHASE II TEMPORARY WELL
 - - PHASE II SURFACE SOIL SAMPLE
 - - PHASE I SOIL BORING
 - ▲ - PHASE I SURFACE SOIL
 - - RFI SURFACE SOIL SAMPLE
 - ⊕ - RFI MONITORING WELL

FIGURE 4-1
DISTRIBUTION OF CONSTITUENTS
EXCEEDING SCREENING VALUES IN SOIL
RCRA FACILITY INVESTIGATION-SWMU 261/297
CTO-0041
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



SOURCE: MCB CAMP LEJEUNE MARCH 2000

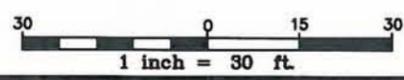
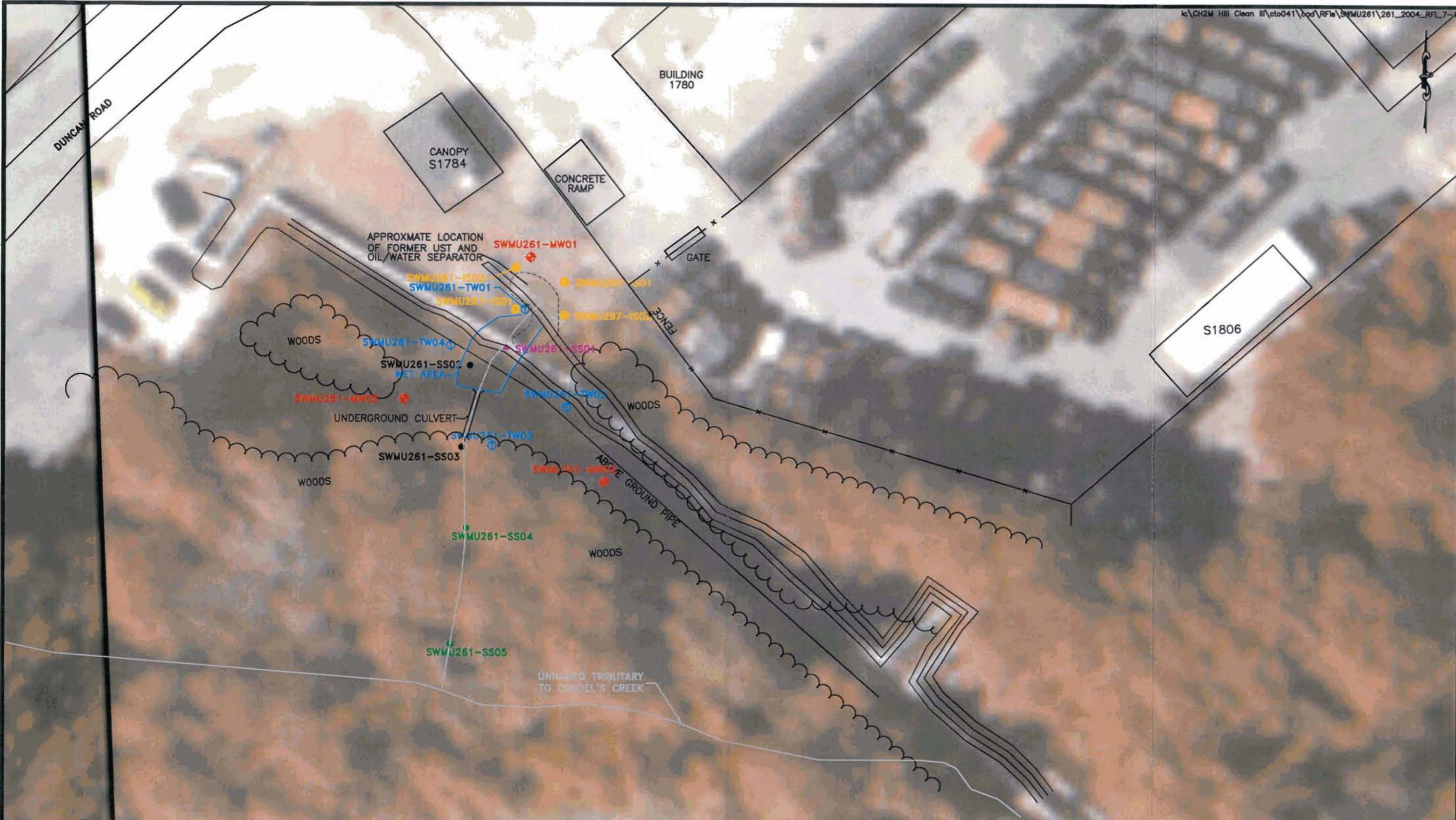


NOTE:
Bold - Exceeds Base Background Concentrations
Underline - Exceeds North Carolina 2L Standards
Box - Exceeds USEPA Region IX Tap Water PRGs

- LEGEND**
- ◆ - PHASE II TEMPORARY WELL
 - - PHASE II SURFACE SOIL SAMPLE
 - - PHASE I SOIL BORING
 - ▲ - PHASE I SURFACE SOIL
 - - RFI SURFACE SOIL SAMPLE
 - ◆ - RFI MONITORING WELL

FIGURE 4-2
 DISTRIBUTION OF CONSTITUENTS
 EXCEEDING SCREENING VALUES IN GROUNDWATER
 RCRA FACILITY INVESTIGATION-SWMU 261/297
 CTO-0041
 MARINE CORPS BASE, CAMP LEJEUNE
 NORTH CAROLINA





LEGEND

	- PHASE II TEMPORARY WELL
	- PHASE II SURFACE SOIL SAMPLE
	- PHASE I SOIL BORING
	- PHASE I SURFACE SOIL
	- RFI SURFACE SOIL SAMPLE
	- RFI MONITORING WELL

SOURCE: MCB CAMP LEJEUNE MARCH 2000

FIGURE 7-1
SWMU 261
SAMPLE LOCATION MAP
 RCRA FACILITY INVESTIGATION-SWMU 261/297
 CTO-0041
 MARINE CORPS BASE, CAMP LEJEUNE
 NORTH CAROLINA

SAMPLE ID	SWMU261-TW01-00
SAMPLE DATE	3/26/2002
DEPTH (feet bgs)	0'-1'
Metals (mg/kg)	
Cadmium	0.13 U
Chromium	16.9 J
Lead	7.2 U
Mercury	0.03 J

SAMPLE ID	SWMU261-TW04-00
SAMPLE DATE	3/26/2002
DEPTH (feet bgs)	0'-1'
Metals (mg/kg)	
Cadmium	0.3 U
Chromium	6.9 J
Lead	17.2 J
Mercury	0.04 J

SAMPLE ID	SWMU261-SS02-00
SAMPLE DATE	3/26/2002
DEPTH (feet bgs)	0'-1'
Metals (mg/kg)	
Cadmium	1.3 J
Chromium	9.6 J
Lead	53.9 J
Mercury	0.05 J

SAMPLE ID	SWMU261-TW02-00
SAMPLE DATE	3/26/2002
DEPTH (feet bgs)	0'-1'
Metals (mg/kg)	
Cadmium	0.19 U
Chromium	5.5 J
Lead	12.3 J
Mercury	0.03 J

SAMPLE ID	SWMU261-SS03-00
SAMPLE DATE	3/26/2002
DEPTH (feet bgs)	0'-1'
Metals (mg/kg)	
Cadmium	11.9 J
Chromium	28.7 J
Lead	587 J
Mercury	0.19 J

SAMPLE ID	SWMU261-TW03-00
SAMPLE DATE	3/26/2002
DEPTH (feet bgs)	0'-1'
Metals (mg/kg)	
Cadmium	0.03 U
Chromium	5.6 J
Lead	5.7 U
Mercury	0.03 J

SAMPLE ID	SWMU261-SS04
SAMPLE DATE	3/21/2004
DEPTH (feet bgs)	0'-1'
Metals (mg/kg)	
Cadmium	1.9 J
Chromium	13.1 J
Lead	92.2 J
Mercury	0.07 J

USEPA Region IV Soil Screening Value	
Volatiles (ug/kg)	
Xylenes, total	50
Metals (mg/kg)	
Cadmium	1.6
Chromium	0.4
Lead	50
Mercury	0.1

SAMPLE ID	SWMU261-SS05
SAMPLE DATE	3/21/04
DEPTH (feet bgs)	0'-1'
Metals (mg/kg)	
Cadmium	0.84 J
Chromium	8.6 J
Lead	48.9 J
Mercury	0.035 J

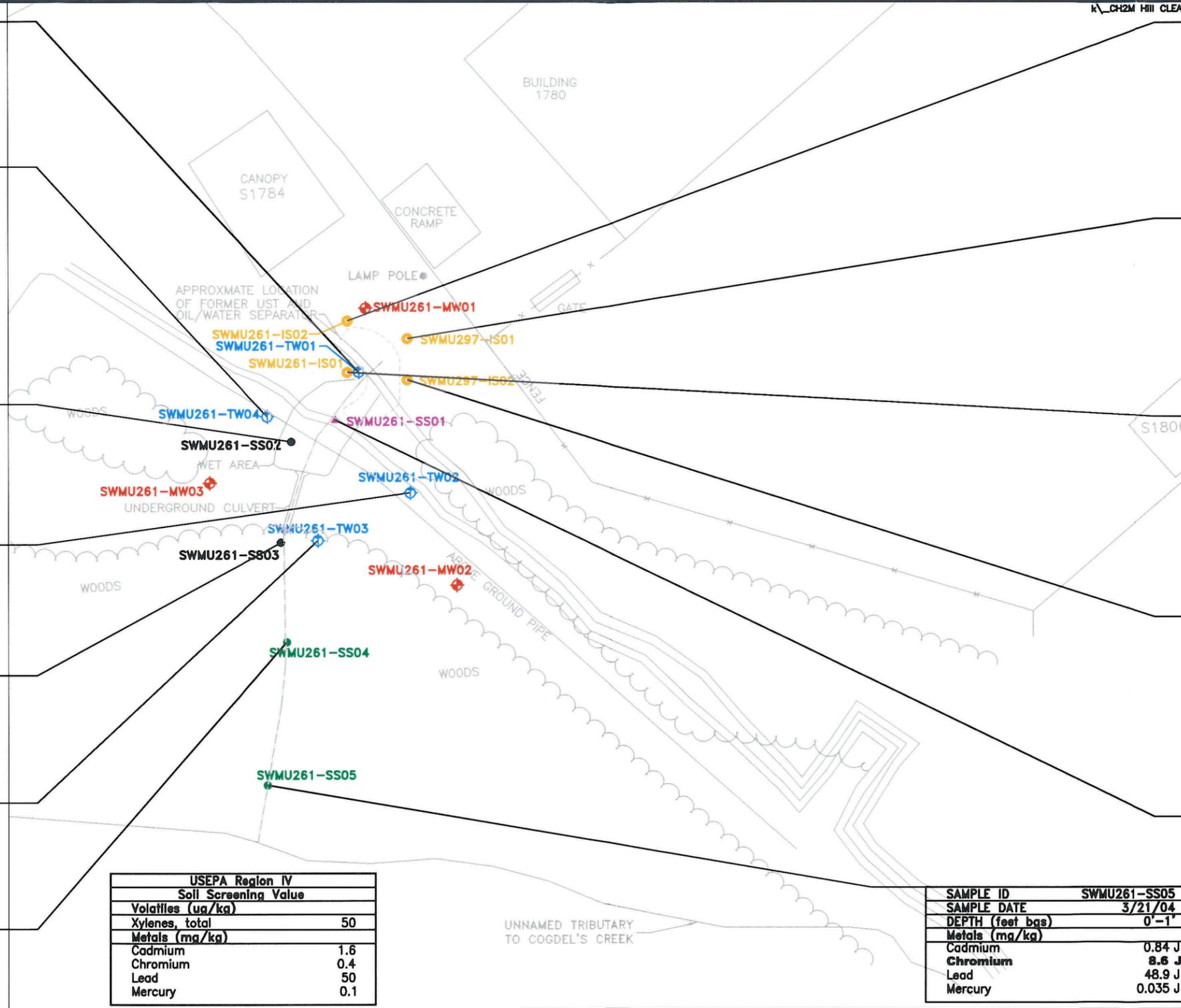
SAMPLE ID	SWMU261-IS02-00
SAMPLE DATE	9/13/1997
DEPTH (feet bgs)	0'-2'
Volatiles (ug/kg)	
Xylenes, total	2.6 J
Metals (mg/kg)	
Cadmium	0.55 U
Chromium	10.9
Lead	4.1
Mercury	0.036 U

SAMPLE ID	SWMU297-IS01-00
SAMPLE DATE	9/13/1997
DEPTH (feet bgs)	0'-2'
Volatiles (ug/kg)	
Xylenes, total	1.2
Metals (mg/kg)	
Cadmium	1.7
Chromium	8.5
Lead	22.9
Mercury	0.038 U

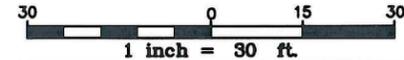
SAMPLE ID	SWMU261-IS01-00
SAMPLE DATE	9/13/1997
DEPTH (feet bgs)	0'-2'
Volatiles (ug/kg)	
Xylenes, total	1.1 U
Metals (mg/kg)	
Cadmium	0.54 U
Chromium	15.7
Lead	5.4
Mercury	0.036 U

SAMPLE ID	SWMU297-IS02-00
SAMPLE DATE	9/13/1997
DEPTH (feet bgs)	0'-2'
Volatiles (ug/kg)	
Xylenes, total	1.1 U
Metals (mg/kg)	
Cadmium	0.56 U
Chromium	6.8
Lead	4.7
Mercury	0.037 U

SAMPLE ID	SWMU261-SS01-00
SAMPLE DATE	9/17/1997
DEPTH (feet bgs)	0'-2'
Volatiles (ug/kg)	
Xylenes, total	210
Metals (mg/kg)	
Cadmium	31.6
Chromium	65.8
Lead	604
Mercury	0.048 U



Note:
Concentrations in **BOLD** font exceed USEPA
Region IV Soil Screening Value

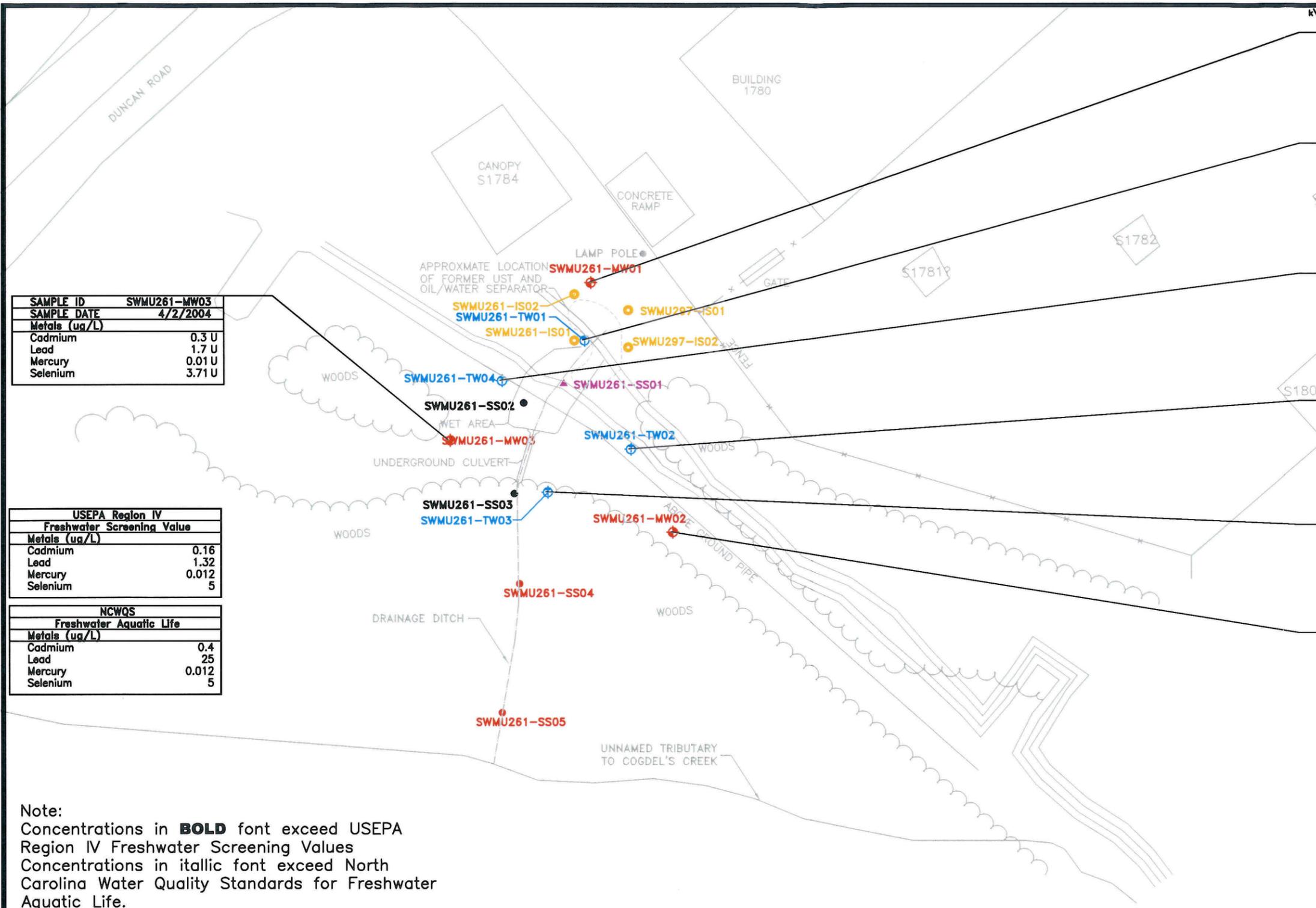


LEGEND

- ◊ - PHASE II TEMPORARY WELL
- - PHASE II SURFACE SOIL SAMPLE
- - PHASE I SOIL BORING
- ▲ - PHASE I SURFACE SOIL
- - SURFACE SOIL SAMPLE LOCATION
- ⊕ - MONITORING WELL SAMPLE LOCATION

SOURCE: MCB CAMP LEJEUNE MARCH 2000

FIGURE 7-3
CATEGORY 1 ECOLOGICAL
COPCS IN SURFACE SOIL
RCRA FACILITY INVESTIGATION-SWMU 261/297
CTO-0041
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



SAMPLE ID	SWMU261-MW01
SAMPLE DATE	4/2/2004
Metals (ug/L)	
Cadmium	0.3 U
Lead	1.7 U
Mercury	0.01 U
Selenium	3.71 U

SAMPLE ID	SWMU261-GW01
SAMPLE DATE	04-09-2002
Metals (ug/L)	
Cadmium	<i>9.4 J</i>
Lead	<i>1200 J</i>
Mercury	<i>3.6</i>
Selenium	<i>23.7</i>

SAMPLE ID	SWMU261-GW04
SAMPLE DATE	04-08-2002
Metals (ug/L)	
Cadmium	0.3 U
Lead	2 U
Mercury	0.1 U
Selenium	4.6 U

SAMPLE ID	SWMU261-GW02
SAMPLE DATE	04-08-2002
Metals (ug/L)	
Cadmium	<i>4.4 J</i>
Lead	<i>249 J</i>
Mercury	<i>1.1</i>
Selenium	<i>7.7</i>

SAMPLE ID	SWMU261-GW03
SAMPLE DATE	04-08-2002
Metals (ug/L)	
Cadmium	0.4 U
Lead	<i>8.1</i>
Mercury	0.1 U
Selenium	2.1 U

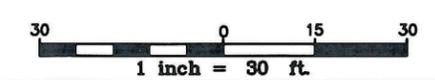
SAMPLE ID	SWMU261-MW02
SAMPLE DATE	3/5/2004
Metals (ug/L)	
Cadmium	0.25 U
Lead	4.4
Mercury	0.02 J
Selenium	2.32 U

SAMPLE ID	SWMU261-MW03
SAMPLE DATE	4/2/2004
Metals (ug/L)	
Cadmium	0.3 U
Lead	1.7 U
Mercury	0.01 U
Selenium	3.71 U

USEPA Region IV	
Freshwater Screening Value	
Metals (ug/L)	
Cadmium	0.16
Lead	1.32
Mercury	0.012
Selenium	5

NCWQS	
Freshwater Aquatic Life	
Metals (ug/L)	
Cadmium	0.4
Lead	25
Mercury	0.012
Selenium	5

Note:
 Concentrations in **BOLD** font exceed USEPA Region IV Freshwater Screening Values
 Concentrations in *italic* font exceed North Carolina Water Quality Standards for Freshwater Aquatic Life.



LEGEND

- ⊕ - PHASE II TEMPORARY WELL
- - PHASE II SURFACE SOIL SAMPLE
- - PHASE I SOIL BORING
- ▲ - PHASE I SURFACE SOIL
- - SURFACE SOIL SAMPLE LOCATION
- ⊕ - MONITORING WELL SAMPLE LOCATION

SOURCE: MCB CAMP LEJEUNE MARCH 2000

FIGURE 7-4
 CATEGORY 1 ECOLOGICAL
 COPCs IN GROUNDWATER
 RCRA FACILITY INVESTIGATION-SWMU 261/297
 CTO-0041
 MARINE CORPS BASE, CAMP LEJEUNE
 NORTH CAROLINA