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# Remedial Investigation Report
# Operable Unit No. 1
# (Sites 21, 24 & 78)

## Marine Corps Base
## Camp Lejeune, North Carolina

## Text and Figures
## Volume 2 of 2

Prepared For:

**Department of the Navy**
**Atlantic Division**
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Under the

**LANTDIV CLEAN Program**

**Comprehensive Long-Term**
**Environmental Action Navy**

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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AOC | Area of concern |
| AQUIRE | Aquatic Information Retrieval Database |
| ARARs | Applicable or relevant and appropriate requirements |
| ASTM | American Society for Testing and Materials |
| ATV | all terrain vehicle |
| AWQC | Federal Ambient Water Quality Criteria |
| | |
| Baker | Baker Environmental, Inc. |
| BCF | bioconcentration factor |
| BDC | Beaver Dam Creek |
| BDDA | Burrow and Debris Disposal Area |
| bgs | below ground surface |
| BMDA | Buried Metal Disposal Area |
| BTEX | benzene, toluene, ethylbenzene, xylenes |
| BOD | biological oxygen demand |
| BRA | baseline risk assessment |
| | |
| $CaCO_3$ | calcium carbonate |
| CAMA | Coastal Area Management Act |
| CC | Cogdel Creek |
| $CCl_4$ | carbon tetrachloride |
| CDI | chronic daily intake |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CH | high plasticity clay |
| $CHCl_3$ | chloroform |
| CL | low plasticity clay |
| CLEAN | Comprehensive Long-Term Environmental Action Navy |
| CLP | Contract Laboratory Program |
| COE | Corps of Engineers |
| COPC | contaminant of potential concern |
| COD | chemical oxygen demand |
| CRAVE | Carcinogen Risk Assessment Verification Endeavor |
| CRQL | Contract Required Quantitation Limit |
| CSF | cancer slope factor |
| | |
| DON | Department of the Navy |
| DQOs | data quality objectives |
| | |
| 1,1-DCE | 1,1-dichloroethene |
| 1,2-DCE | 1,2-dichloroethene |
| 1,1-DCA | 1,1-dichloroethane |
| DD | drainage ditches |
| DEM | Division of Enviromental Management |
| | |
| ECD | electron capture detector |
| Eh | oxidation reduction potential |
| EM | electromagnetic |
| EMD | Environmental Management Department |

| | |
|---|---|
| EPIC | Environmental Photographic Interpretation Center |
| ERA | ecological risk assessment |
| ER-L | effects range - low |
| ER-M | effects range-median |
| ESE | Environmental Science and Engineering, Inc. |
| ETC | electromagnetic terrain conductivity |
| FADA | Fly Ash Disposal Area |
| FFA | Federal Facilities Agreement |
| FID | flame ionization detector |
| FSAP | Field Sampling and Analysis Plan |
| FWS | Fish and Wildlife Service |
| FWQSV | Freshwater Water Quality Screening Values |
| gpd/ft | gallons per day per foot |
| gpm | gallons per minute |
| GPR | ground penetrating radar |
| GW | groundwater well |
| HA | health advisory |
| HEAST | Health Effects Assessment Summary Tables |
| HHAG | Human Health Assessment Group |
| HHI | Hardin and Huber, Inc. |
| HI | hazard index |
| Hoggard-Eure | Hoggard-Eure Associates |
| HCl | hydrochloric acid |
| $HNO_3$ | nitric acid |
| HPIA | Hadnot Point Industrial Area |
| HQ | hazard quotient |
| HQW | high quality water |
| i | hydraulic gradient |
| IAS | Initial Assessment Study |
| ICR | incremental cancer risk |
| ID | inside diameter |
| IDW | investigative derived wastes |
| IRA | interim remedial action |
| IRIS | Integrated Risk Information System |
| IRP | Installation Restoration Program |
| K | hydraulic conductivity |
| $K_d$ | soil sorption coefficient |
| $K_{oc}$ | organic carbon partition coefficient |
| $K_{ow}$ | octanol-water partition coefficient |
| LANTDIV | Naval Facilities Engineering Command, Atlantic Division |
| LANTNAVFACENGCOM | Naval Facilities Engineering Command, Atlantic Division |
| LEL | lower explosive limit |
| LOAEL | lowest observed adverse effect level |
| MCAS | Marine Corps Air Station |
| MCB | Marine Corps Base |
| MCL | maximum contaminant level |
| MEK | methylethyl ketone |

| | |
|---|---|
| mg/kg | milligram per kilogram |
| mg/l | milligram per liter |
| MF | modifying factor |
| MH | plastic silt |
| MI | mobility index |
| ml | milliliter |
| ML | low plasticity silt |
| mmhos/m | millimohos/meter |
| msl | mean sea level |
| MW | monitoring well |
| | |
| NACIP | Navy Assessment and Control of Installation Pollutants Program |
| NC DEHNR | North Carolina Department of Environment, Health and Natural Resources |
| NCMFC | North Carolina Marine Fisheries Commission |
| NCSPCS | North Carolina State Plane Coordinate System |
| NCWP | Near Coastal Waters Program |
| NCWQS | North Carolina Water Quality Standards |
| NCWRC | North Carolina Wildlife Resources Commission |
| $N_e$ | effective porosity |
| NEESA | Naval Energy and Environmental Support Activity |
| NEP | National Estuary Program |
| NOAA | National Oceanic and Atmospheric Administration |
| NOAEL or NOEL | No observed adverse effect level |
| NPL | National Priorities List |
| NPS | National Park Service |
| NSW | nutrient sensitive waters |
| NUS | NUS Environmental Corporation |
| NWI | national wetlands inventory |
| | |
| OU | operable unit |
| | |
| PAH | polynuclear aromatic hydrocarbon |
| PA/SI | preliminary assessments/site investigations |
| PC | permeability constant |
| PCBs | polychlorinated biphenyls |
| PCE | tetrachloroethene |
| PEF | particulate emissions factor |
| PHA | public health assessment |
| PID | photoionization detector |
| ppb | parts per billion |
| ppm | parts per million |
| psi | pounds per square inch |
| PVC | polyvinyl chloride |
| | |
| QA/QC | quality assurance/quality control |
| QI | quotient index |
| | |
| RA | risk assessment |
| RBC | risk based concentrations |
| RCRA | Resource Conservation and Recovery Act |
| RfD | reference dose |

| | |
|---|---|
| RI/FS | remedial investigation/feasibility study |
| ROD | record of decision |
| | |
| S, S | storativity, water solubility |
| SA | site assessment |
| SARA | Superfund Amendments and Reauthorization Act |
| SB | soil boring |
| SCS | Soil Conservation Service |
| SD | sediment |
| SM | silty sand |
| SMCL | Secondary Drinking Water Regulations |
| SQC | sediment quality criteria |
| SOPs | standard operating procedures |
| SSDA | Spiractor Sludge Disposal Area |
| SSVs | sediment screening values |
| STP | sewage treatment plant |
| SVOCs | semivolatile organic compounds |
| SW | surface water |
| SWQSVs | surface water quality screening values |
| | |
| T | transmissivity |
| TAL | target analyte list |
| Target | Target Environment Services, Inc. |
| TBC | to be considered |
| TCA | trichloroethane |
| TCE | trichloroethene |
| TCL | target compound list |
| TCLP | toxicity characteristic leaching procedure |
| TDS | total dissolved solids |
| TEF | toxicity equivalency factor |
| TICs | tentatively identified compounds |
| TOC | total organic carbon or top of casing |
| trans-1,2-DCE | trans-1,2-dichloroethene |
| TRC | Technical Review Committee |
| TRVs | terrestrial reference values |
| TSS | total suspended solids |
| TVS | total volatile solids |
| | |
| UCL | upper confidence limit |
| UF | uncertainty factor |
| µg/g | micrograms per gram |
| µg/l | micrograms per liter |
| USDI | United States Department of the Interior |
| USEPA | United States Environmental Protection Agency |
| USCS | Unified Soil Classification System |
| USGS | United States Geological Survey |
| UST | underground storage tank |
| | |
| VOCs | volatile organic compounds |
| VP | vapor pressure |
| $V_x$ | average seepage velocity |
| | |
| WAR | Water and Air Research, Inc. |
| Weston | Weston Geophysical Corporation |

| | |
|---|---|
| WOE | weight of evidence |
| WQS | water quality standards |
| WQSV | water quality screening values |
| WS | Wilderness Society |

# 4.0 NATURE AND EXTENT OF CONTAMINATION

This section presents the analytical findings of the environmental investigations performed at Site 21, Site 24, and Site 78 (OU No. 1), and a discussion of the nature and extent of contamination for the various media. Soil, test pit (Site 24 only), groundwater, surface water (Sites 21 and 78), and sediment (Sites 21 and 78 only) investigation results and extent of contamination for each media are presented by site. Appendices K through R provide a summary of laboratory results, statistical summaries of analytical data, QA/QC laboratory results (i.e., data and frequency summary), TCLP results (i.e., field duplicates), engineering parameter results, field QA/QC samples (e.g., field blanks), chain-of-custodies, and sample tracking summaries of OU No. 1 for the various media.

Analytical parameters can be segregated into two broad categories: organics and inorganics. The organic parameters included in the analytical program for OU No. 1 do not occur naturally. Any organics detected in the samples collected from OU No. 1 can, therefore, be attributed to either contamination from site operations (site-related) or to sampling/laboratory contamination. Unlike the organics, many of the inorganic parameters included in the analytical program for OU No. 1 can occur naturally. For example, lead is an element that occurs naturally in most soils (in low concentrations) but is also considered a contaminant if its concentration is well above background levels or its presence can be attributable to site operations (e.g., lead in gasoline). In order to accurately present the nature and extent of inorganic contamination at OU No. 1, those detected parameters that are either common laboratory contaminants (organics) or are naturally occurring on site (inorganics) must be segregated from those that can be attributed to site operations.

It is important to note that third-party validation was performed on the complete set of data. The validation procedures followed the National Functional Guidelines for Organic and Inorganic Analyses. Data validation serves to reduce some of the inherent uncertainty associated with the analytical data by establishing the usability of the data. Data qualified as "J" (estimated) were retained as valid data for OU No. 1. Data can be qualified as estimated for many reasons including a slight exceedance of holding times, high or low surrogate recovery, or if the reported value is below the CRDL or CRQL, or intra sample variability. Organic data qualified "B" (detected in blank) or "R" (unreliable) were not included in the analytical database due to the unusable nature of the data.

Due to the comprehensive sampling and analytical program at OU No. 1, the loss of some data points qualified "B" or "R" did not significantly effect the overall quality of the analytical database.

The only unreliable data for the entire analytical database included:

- The analysis for antimony in one subsurface soil sample collected at Site 21
- The analysis for 4-nitrophenol in three surface soil samples and endrin in one subsurface soil sample collected at Site 24
- The analysis for 2-chloroethyl vinyl ether in 21 groundwater samples
- The analysis for arsenic, antimony, mercury, selenium, and cyanide in 9, 26, 7, 5, and 5 groundwater samples, respectively.
- The analysis for acetone in one surface water sample
- The analysis for 4-nitrophenol in 5 sediment samples

A discussion of non-site related analytical results with respect to organics and inorganics is presented in Section 4.1. Section 4.2 presents a summary of the "site-related" analytical results. Section 4.3 discusses the extent of contamination at each of the three sites; whereas Section 4.4 summarizes the overall nature and extent of contamination at OU No. 1.

## 4.1 Non-Site Related Analytical Results

Many of the organic compounds and inorganic constituents detected in the various environmental media investigations at OU No. 1 are attributable to non-site related conditions. Two primary sources of non-site related results include laboratory (blank) contaminants and naturally occurring inorganic elements. Non-site related results for OU No. 1 are discussed below.

### 4.1.1 Laboratory Contaminants

Blank samples provide a measure of contamination that has been introduced into a sample set during the collection, transportation, preparation, and/or analysis of samples. To remove non-site related contaminants from further consideration, the concentrations of chemicals detected in blanks were compared with concentrations of the same chemicals detected in environmental samples.

Common laboratory contaminants (i.e., acetone, 2-butanone, chloroform, methylene chloride, toluene, and phthalate esters) were considered as positive results only when observed concentrations exceeded ten times the maximum concentration detected in any blank. If the concentration of a common laboratory contaminant was less than ten times the maximum blank concentration, then it was concluded that the chemical was not detected in that particular sample (USEPA, 1989a). The maximum concentrations of detected common laboratory contaminants in blanks were as follows:

| | |
|---|---|
| • Acetone | 23 µg/l |
| • Methylene Chloride | 4.0 µg/l |
| • Di-n-butylphthalate | 2.0 µg/l |
| • bis-(2-Ethylhexyl)phthalate | 93 µg/l |

Blanks containing organic constituents that were not considered common laboratory contaminants (i.e., all other TCL compounds) were considered as positive results only when observed concentrations exceeded five times the maximum concentration detected in any blank (USEPA, 1989a). All TCL compounds at less than five times the maximum level of contamination noted in any blank were considered to be not detected in that sample. The maximum concentrations of all other detected blank contaminants were as follows:

| | |
|---|---|
| • Chloroform | 6.0 µg/l |
| • Bromodichloromethane | 3.0 µg/l |
| • Bromomethane | 2.0 µg/l |
| • Dichloromethane | 8.0 µg/l |

A limited number of solid environmental samples that exhibited high concentrations of tentatively identified compounds (TICs) underwent an additional sample preparation. Medium level sample preparation provides a corrected Contract Required Quantitation Limit

(CRQL) based on the volume of sample used for analysis. The corrected CRQL produces higher detection limits than the low level sample preparation. A comparison to laboratory blanks used in the medium level preparation was used to evaluate the relative amount of contamination within these samples.

### 4.1.2 Naturally Occurring Inorganic Elements

In order to delineate inorganic contamination due to site operations from inorganic elements naturally occurring in site media, the results of the sample analyses (concentrations) were compared to information regarding background conditions at MCB Camp Lejeune and to applicable regulatory levels. The following guidelines were used for each media:

| | |
|---|---|
| Soil: | MCB Camp Lejeune Background Samples |
| Groundwater: | State and Federal Drinking Water Standards |
| Surface Water: | State and Federal Surface Water Quality Standards |
| Sediment: | USEPA Region IV Sediment Screening Criteria |

In general, chemical-specific ARARs are not available for soil. Therefore, base-specific background concentrations were compiled to evaluate background levels of organic and inorganic constituents in the surface and subsurface soil. Organic contaminants were not detected in the base-specific background samples. Therefore, it is likely that all organic contaminants detected in the surface and subsurface soil, within OU No. 1, are attributable to the practices which have or are currently taking place within the areas of concern.

The only enforceable Federal regulatory standards for water are the Federal MCLs. In addition to the Federal standards, the State of North Carolina has developed the North Carolina Water Quality Standards (NCWQS) for groundwater and surface water. Regulatory guidelines were used for comparative purposes to infer the potential health risks and environmental impacts when necessary. Relevant regulatory guidelines include Ambient Water Quality Criteria (AWQC).

**Maximum Contaminant Levels (MCLs)** - MCLs are enforceable standards for public water supplies promulgated under the Safe Drinking Water Act and are designed for the protection of human health. MCLs are based on laboratory or epidemiological studies and apply to drinking water supplies consumed by a minimum of 25 persons. They are designed for prevention of human health effects associated with a lifetime exposure (70-year lifetime) of an average adult (70 kg) consuming 2 liters of water per day. MCLs also consider the technical feasibility of removing the contaminant from the public water supply.

**North Carolina Water Quality Standards (Groundwater)** - NCWQSs are the maximum allowable concentrations resulting from any discharge of contaminants to the land or waters of the state, which may be tolerated without creating a threat to human health or which otherwise render the groundwater unsuitable for its intended purpose.

**Ambient Water Quality Criteria (AWQC)** - AWQC are non-enforceable regulatory guidelines and are of primary utility in assessing acute and chronic toxic effects in aquatic systems. They may also be used for identifying the potential for human health risks. AWQCs consider acute and chronic effects in both freshwater and saltwater aquatic life, and potential carcinogenic and noncarcinogenic health effects in humans from ingestion of both water (2 liters/day) and aquatic organisms (6.5 grams/day), or from ingestion of water alone (2 liters/day). The AWQCs for the protection of human health for potential carcinogenic substances are based on the USEPA's specified incremental cancer risk range of one additional case of cancer in an exposed population of 10,000,000 to 100,000 (i.e. the 10E-7 to 10E-5 range).

**North Carolina Water Quality Standards (Surface Water)** - The NCWQSs for surface water are the standard concentrations, that either alone or in combination with other wastes, in surface waters that will not render waters injurious to aquatic life or wildlife, recreational activities, public health, or impair the waters for any designated use.

### 4.1.2.1 Soil

Typical background concentration values for inorganic elements in soils at MCB Camp Lejeune are presented in Section 6.0. These ranges are based on analytical results of background (collected in areas not known to be impacted by site operations) samples collected at MCB Camp Lejeune during this and previous investigations. In the subsequent sections, which discuss the analytical results of samples collected during the soil investigation, only those inorganic parameters with concentrations significantly exceeding these ranges will be considered.

### 4.1.2.2 Groundwater

Unlike soil, there is no extensive data base of groundwater background samples at MCB Camp Lejeune. In the subsequent sections, which discuss the analytical results of samples collected during the groundwater investigation, only those inorganic parameters with concentrations exceeding applicable State or Federal regulations will be discussed.

Groundwater samples were analyzed for total and dissolved ("filtered") inorganic parameters. Concentrations of dissolved inorganics were found to be generally lower than total inorganics for each sample. Filtering (with a 45-micron filter) in the field removes small particles of silt and clay that would otherwise be dissolved during sample preservation and generate an unrealistically high apparent value of metals in the groundwater. The total metals, or unfiltered samples, thus reflect the concentrations of inorganics in the natural lithology in addition to inorganics dissolved in and transportable by groundwater.

Relatively high concentrations of metals in unfiltered groundwater are not considered abnormal, based on experience gained from several other studies at MCB Camp Lejeune. The difference between the two analytical results (total and filtered) is important in terms of understanding and separating naturally occurring elements (such as lead) from contamination by site operations (such as lead in gasoline).

USEPA Region IV requires that total inorganic concentrations be used in evaluating ARARs and risk to human health and the environment. In the subsequent sections which discuss the groundwater sample analytical results, both total and dissolved inorganics (which exceed applicable Federal or State limits) will be presented and discussed.

Groundwater in the MCB Camp Lejeune area is naturally rich in manganese. Manganese concentrations (total and filtered) in groundwater at MCB Camp Lejeune often exceed the NCWQS of 50 µg/l. Elevated levels of manganese at concentrations above the NCWQS were reported in samples collected from base potable water supply wells throughout the base which are installed at depths greater than 162 feet bgs. (Greenhorne and O'Mara, 1992). Manganese concentrations from several wells at OU No. 1 exceeded the NCWQS but fell within the range of concentrations for samples collected elsewhere at MCB Camp Lejeune. There is no record of any historical use of manganese at OU No. 1. In light of this, it is assumed that manganese is a naturally occurring inorganic element in groundwater, and its presence is not attributable to site operations.

#### 4.1.2.3 Sediment

There is no extensive data base of background sediment samples at MCB Camp Lejeune (although data is starting to be generated from recent studies at other Camp Lejeune sites, such as Site 69 and Site 48). In the subsequent sections, which discuss the analytical results of samples collected during the sediment investigation, only those inorganic parameters with concentrations exceeding EPA Region IV Sediment Screening Criteria will be considered. Inorganic parameters detected below these levels are assumed to be naturally occurring elements.

#### 4.1.2.4 Surface Water

There is no extensive data base of background surface water samples at MCB Camp Lejeune (although data is starting to be generated from recent studies at other Camp Lejeune sites, such as Site 69 and Site 48). In the subsequent sections, which discuss the analytical results of samples collected during the surface water investigation, only those inorganic parameters with concentrations exceeding applicable State or Federal guidelines will be considered. Inorganic parameters detected below these levels are assumed to be naturally occurring elements.

## 4.2 Summary of Analytical Results

The "site-related" analytical results of the environmental investigations conducted at Site 21, Site 24, and Site 78 are presented by media in Sections 4.2.1, 4.2.2, and 4.2.3, respectively.

### 4.2.1 Site 21 Analytical Results

This section presents the analytical results of the soil, groundwater, surface water, and sediment investigations performed at Site 21.

#### 4.2.1.1 Site 21 Soil Investigation

Positive detection analytical summaries of surface soils for organics and inorganics (i.e. metals and cyanide) are presented on Tables 4-1 and 4-2, respectively (note that due to quantity, all tables for Section 4.0 are presented in the back of this section). Positive detection summaries of subsurface soils for organics and inorganics are presented on Tables 4-3 and 4-4, respectively. Note that several notations were used to identify specific sample locations (i.e., areas of concern) at Site 21 as presented on the summary tables. Samples designated with the prefix "PST" were collected from soil borings located near the Former Pesticide Mixing/Disposal Area while samples designated with the prefix "PCB" were collected form borings located near the Former PCB Transformer Disposal Area. Further, samples designated with the prefix "GW" were collected from borings advanced for monitoring well installation.

Soil samples collected at Site 21 were analyzed for full TCL organics and TAL inorganics (i.e., metals and cyanide). Selected samples collected from within the Former PCB Transformer Disposal Area and the Former Pesticide Mixing/Disposal Area were analyzed exclusively for TCL PCBs and TCL pesticides/herbicides, respectively. In addition, samples collected from boring 21PCBSB06 under went analysis for full (i.e., organics and metals) TCLP and RCRA hazardous waste characteristics. A complete summary of the analytical program for the soil investigation conducted at Site 21 is provided in Appendix G (G.1).

### *Surface Soil Results*

As shown on Tables 4-1 and 4-2, surface soil (i.e., samples collected from ground surface to 6 inches) analytical results indicated the presence of organics (including VOCs, SVOCs, pesticides, and PCBs), and TAL metals. The following summarizes the results :

- VOCs were detected in only one out of 24 samples. Xylenes (total) were detected in soils collected from boring 21PSTSB04 (1,100 µg/kg). No other VOCs were detected.

- SVOCs were detected in seven samples. Boring 21PCBSB11 exhibited the overall highest SVOC concentrations [e.g., fluoranthene (560 J µg/kg), pyrene (520 J µg/kg), benzo(b)fluoranthene (560 J µg/kg)]. Three other borings including 21PCBSB03, 21PCBSB04, and 21PCBSB07 also exhibited somewhat elevated detections of SVOCs ranging from 46 to 250 J µg/kg.

- Pesticides (including: 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, alpha chlordane, and/or gamma chlordane) were detected in 18 out of 24 borings. Herbicides were not detected in any of the surface soil samples. The range of the detected concentrations and the maximum (boring locations shown in parentheses) detections of each pesticide are as follows:

| | |
|---|---|
| 4,4'-DDE | 4.5 J to 160 µg/kg (21PSTSB10) |
| 4,4'-DDD | 3.6 to 34,000 J µg/kg (21PSTSB03) |
| 4,4'-DDT | 15 to 4,100 J µg/kg (21PSTSB11) |
| alpha chlordane | 6.2 J to 1,800 J µg/kg (21PSTSB03) |
| gamma chlordane | 4.6 J to 2,200 J µg/kg (21PSTSB03) |

- PCBs, specifically PCB-1260, were detected in 10 out of 24 borings. The highest overall concentration was detected in boring 21PCBSB19 at 4,600 µg/kg. The majority of the PCB detections were found within the Former PCB Transformer Disposal Area.

- Twenty of the 24 TAL inorganics were detected in Site 21 soils (antimony, cyanide, silver, and thallium were not detected). In general, the concentrations were within a magnitude or less than base-specific (i.e., Camp Lejeune) background levels for surface soils. Table 4-5 summarizes the range of inorganic (surface and subsurface) concentrations for base soil (refer to Section 6.0 for specific details on background samples). Manganese and calcium, however, were detected at concentrations an order of one magnitude or higher above base-specific background levels in borings 21PCBSB01, 21PCBSB04, 21PCBSB07, 21PCBSB11, and 21PSTSB08.

*Subsurface Soil Results*

As shown on Tables 4-3 and 4-4, subsurface soil (soils collected below one-foot in depth) analytical results also indicated the presence of organics and metals. The following summarizes the results:

- VOCs including toluene, ethylbenzene, and total xylenes were only detected in boring 21PSTSB04 at a depth of 2 to 4 feet. The detected concentrations were as follows: toluene - 37 J µg/kg; ethylbenzene - 570 µg/kg; and total xylenes - 3,400 µg/kg.

- SVOCs were only detected in boring 21PSTSB04. A sample collected from 2 to 4 feet exhibited SVOCs at the following concentrations: naphthalene - 2,100 µg/kg; and 2-methylnaphthalene - 10,000 µg/kg.

- Pesticides (including: 4,4'-DDD, 4,4'-DDT, alpha chlordane, and/or alpha chlordane) were detected in six of the 33 subsurface samples. The borings which exhibited positive detections included: 21PCBSB08 (6 to 8 feet), 21PCBSB12 (6 to 8 feet), 21PSTSB03 (4 to 6 feet), 21PSTSB04 (2 to 4 feet), 21PSTSB07 (2 to 4 feet), and monitoring well boring 21GW02 (10 to 12 feet). The maximum concentrations of each detected pesticide were obtained from borings 21PSTSB04 [4,4'-DDD (2,800 µg/kg), alpha chlordane (59 J µg/kg), and gamma chlordane (90 µg/kg)], and 21PCBSB12 [4,4'-DDT (12 µg/kg)].

- Twenty of 24 inorganics were detected in subsurface soils (antimony, cyanide, mercury, and silver were not detected). The concentration ranges of most of the inorganics detected were similar to the background ranges of subsurface soils at Camp Lejeune (Table 4-5). Aluminum, however, was detected an order of one magnitude or higher above base-specific background levels at borings 21PCBSB05, 21PCBSB07, and 21PSTSB08.

### *General Conclusions*

Pesticides (4,4'-DDE, 4,4'-DDD, 4,4'-DDT, alpha chlordane, and/or gamma chlordane) are the dominant contaminants present in soils at Site 21. The most significant pesticide levels were found in surface soils collected in the vicinity of the Former Pesticide Mixing/Disposal Area. These elevated concentrations (ranging from 4.6 to 34,000 J µg/kg) are believed to be related to the previous handling practices which were reported by base personnel.

PCBs (PCB-1260) were also present in significant concentrations primarily in surface soils in the vicinity of the Former PCB Transformer Disposal Area. The presence of the PCBs is presumed to be related to the previous disposal practices at the site.

VOCs and SVOCs were not extensively found in Site 21 soils. In general, the VOCs and SVOCs appear to be limited to the surface soils. The detected VOCs and their maximum concentrations included toluene (37 J µg/kg), ethylbenzene 570 µg/kg), and total xylenes (1,100 to 3,400 µg/kg). Furthermore, several of the more prevalent detected SVOCs and their maximum concentrations included naphthalene (3,200 J µg/kg), fluorene (1,300 µg/kg), pyrene (520 µg/kg), benzo(b and k) fluoranthene (560 µg/kg), and chrysene (450 µg/kg). Because these constituents are petroleum based, they may be associated with the pesticide mixing/disposal since petroleum products are used for a base-medium.

Based on a comparison of inorganic background levels, the detected levels of inorganics at Site 21 do not appear to be elevated due to past practices.

### 4.2.1.2 Site 21 Groundwater Investigation

#### *Shallow Groundwater Results*

Shallow (less than 25 feet) groundwater samples were collected and analyzed for full TCL organics and TAL inorganics (i.e., total and dissolved metals, and cyanide) from eight site wells. Note that there were no deep monitoring wells (e.g., greater than 100 feet) installed or existing at Site 21. Groundwater analytical results for Site 21 (along with Sites 24 and 78) are provided on Table 4-6 for organics, and Tables 4-7 and 4-8 for inorganics (i.e., total and dissolved metals and cyanide, respectively). Note that Site 21 monitoring wells displayed on these tables are designated with the number "21" (e.g., 21-GW01-01 is the sample designation for monitoring well 21GW1).

The analytical results from the groundwater samples collected from Site 21 indicated the presence of both organics and metals. Two of the eight wells, 21GW02 and 21GW03, exhibited concentrations of VOCs and/or SVOCs. Monitoring well 21GW02 exhibited the following compounds at the respective concentrations:

- VOCs:
  - TCE - 41 J µg/l
  - benzene - 77 J µg/l
  - toluene - 210 J µg/l
  - ethylbenzene - 540 J µg/l
  - total xylenes - 1,300 J µg/l

- SVOCs:
  - 4-methylphenol - 2.0 J µg/l
  - 2,4-dimethylphenol - 6.0 J µg/l
  - naphthalene - 51 µg/l
  - 2-methylnaphthalene - 20 µg/l

Well 21GW03 exhibited a low level of dichloromethane at 2.0 µg/l. The six other wells sampled at Site 21 did not contain any organic contamination.

The concentrations of several VOCs detected in well 21GW02 exceeded the Federal MCLs and/or the NCWQS. Both the Federal MCLs and NCWQS for TCE (5.0 and 2.8 μg/l, respectively) and benzene (5.0 and 1.0 μg/l, respectively) were exceeded in this well. The NCWQSs for ethylbenzene (29 μg/l) and total xylenes (400 μg/l) were also exceeded.

TAL metals (total and dissolved) were detected in seven of the eight wells sampled at Site 21. The following metal contaminants exceeded either the Federal MCL or NCWQS for drinking water: arsenic (MCL and NCWQS of 50 μg/l), manganese (Secondary MCL and NCWQS of 50 μg/l), cadmium (MCL and NCWQS of 5.0 μg/l), beryllium (MCL of 4.0 μg/l), chromium (MCL of 100 μg/l; NCWQS of 50 μg/l), lead (Federal Action Level and NCWQS of 15 μg/l), and nickel (MCL and NCWQS of 100). The following wells exhibited elevated concentrations of total and/or dissolved TAL metals above the standards:

| | | |
|---|---|---|
| • 21GW01 | manganese | - 64 J μg/l (total) |
| | | - 70 μg/l (dissolved) |
| | cadmium | - 5.0 μg/l (total) |
| • 21GW02 | beryllium | - 5.0 μg/l (total) |
| | chromium | - 348 J μg/l (total) |
| | lead | - 214 J μg/l (total) |
| | manganese | - 179 J μg/l (total) |
| • 21GW03 | manganese | - 134 J μg/l (total) |
| | | - 134 μg/l (dissolved) |
| • 21GW04 | lead | - 33 J μg/l (total) |
| | manganese | - 193 J μg/l (total) |
| | | - 119 μg/l (dissolved) |
| • 21GW0A | lead | - 29 μg/l (total) |
| | manganese | - 59 μg/l (total) |

- 21GW0B
  - beryllium - 6.0 µg/l (total)
  - chromium - 192 J µg/l (total)
  - lead - 2,000 J µg/l (total)
    - 94 µg/l (dissolved)
  - manganese - 276 J µg/l (total)
    - 124 µg/l (dissolved)

- 21GW0C
  - arsenic - 101 µg/l (total)
  - chromium - 291 J µg/l (total)
  - lead - 92.5 µg/l J (total)
  - manganese - 273 J µg/l (total)
    - 116 µg/l (dissolved)
  - nickel - 123 J µg/l (total)

Note that sample numbers 21GW0A, 21GW0B, and 21GW0C are identified on the figures as wells BOGW11, BOGW12, and BOGW20, respectively.

### *Groundwater Field Parameter Results*

Groundwater field parameter results for pH, temperature, and specific conductance are presented on Table 4-9. Specific conductance values ranged from 22 to 799 micromhos/cm, pH values ranged from 4.80 to 7.09 standard units (s.u.) (acidic to slightly basic), and temperature values ranged from 17.1°C to 20.4° C. These values represent all field measurements obtained during groundwater sampling activities (i.e., from each well volume purged) which may account for the wide ranges.

### *General Conclusions*

Metals are the most prevalent contaminants in groundwater at Site 21. Concentrations of arsenic, manganese, cadmium, beryllium, chromium, lead, or nickel were found in seven of the eight wells sampled above drinking water standards or groundwater standards. The highest concentrations were detected in wells 21GW0B and 21GW0C, which are both located near the southwestern portion of the site. No source areas for these elevated levels of metals were identified during the RI. As previously stated, the on-site soil inorganic concentrations were typically similar to Camp Lejeune background ranges.

VOCs in the groundwater are primarily limited to well 21GW02, which is located near the northeastern portion of the site. Concentrations of TCE (41 µg/l), benzene (77 J µg/l), toluene (210 J µg/l), ethylbenzene (540 µg/l), and total xylenes (1,300 µg/l) were detected in this well. All five of these compounds were detected at concentrations which exceeded both Federal and state standards. Additionally, a low level of dichloromethane (2.0 µg/l) was detected in well 21GW03. Note that pesticides and PCBs, which were found extensively in site soils, were not detected in the groundwater at Site 21.

#### 4.2.1.3 Site 21 Surface Water and Sediment Investigation

Positive detection analytical summaries of surface water at Site 21 for organic chemicals and metals are presented in Tables 4-10 and 4-11, respectively. Positive detection summaries of sediments at Site 21 for organic chemicals and metals are presented in Tables 4-12 and 4-13, respectively. Note that sample locations 21-DD-SW/SD14 and 21-DD-SW/SD15 were the only two locations where surface water was collected. Cyanide was not analyzed in any of the surface water or sediment samples.

Surface water at Site 21 consists primarily of storm water runoff which collects in the drainage ditch surrounding the site. During sampling activities, the only portion of the drainage ditch to contain surface water was the deeper, northern end of the ditch, where two surface water samples were collected (21-DD-SW14 and 21-DD-SW15). Surface water contaminant detections were compared to North Carolina Water Quality Standards for Freshwater Classes (WQSs) and USEPA Region IV Freshwater Water Quality Screening Values (WQSVs). Sediment contaminant detections were compared to the National Oceanic and Atmospheric (NOAA) Effects Range-Low (ER-L) and Effects Range-Median (ER-M) Sediment Screening Values (SSVs). The ER-L represents the lower ten percentile and the ER-M represents the median percentile of adverse biological effects caused by specific chemical constituents in sediments (USEPA, 1992f).

*Surface Water Results*

As shown in Tables 4-10 and 4-11, surface water samples collected from Site 21 indicate the presence of pesticides and metals. No VOCs or SVOCs were detected. The following summarizes the results:

- Pesticides were detected in one of two samples. 4,4'-DDD was detected in sample 21-DD-SW14 (0.24 µg/l). This was the only analyte with a detected concentration above freshwater WQS and/or WQSV standards.

- Twelve of the 23 TAL inorganics were detected in Site 21 surface water samples. Aluminum, barium, calcium, copper, iron, magnesium, manganese, potassium, selenium, and sodium were detected in both samples. Thallium was detected in sample 21-DD-SW14 only, and zinc was detected in sample 21-DD-SW15 only. None of the detected inorganics were found in concentrations exceeding freshwater WQS or WQSV standards.

*General Conclusions - Surface Water*

Surface water samples collected from the drainage ditches which surround Site 21 indicated that limited contamination is present at the site. The only contaminant detected in Site 21 surface water was 4,4'-DDD. Note that this contaminant was not widely found in the ditches sampled.

*Sediment Results*

As shown in Tables 4-12 and 4-13, sediment samples collected from Site 21 indicated the presence of pesticides, PCBs and inorganics. No VOCs or SVOCs were detected in any of the samples. The following summarizes the results:

- Pesticides were detected in 20 out of 30 samples. The maximum concentrations of each detected pesticide were found in sediments collected from sample locations 21-DD-SD04-06 [heptachlor epoxide (32 J µg/kg), 21-DD-SD04-612 [4,4'-DDD (1100 µg/kg), alpha-chlordane (860 J µg/kg), and gamma-chlordane (960 J µg/kg)], and 21-DD-SD06-06 [4,4'-DDE (230 µg/kg) and 4,4'-DDT (3500 J µg/kg)]. All detected pesticides were found in concentrations above ER-L and ER-M standards. The pesticides detected and range of concentrations are listed below:

    - 4,4'-DDD: 18 samples (3.9 J - 1100 µg/kg)
    - 4,4'-DDE: 15 samples (4.2 J - 230 µg/kg)
    - 4,4'-DDT: 15 samples (5.2 D - 3500 J µg/kg)
    - alpha-chlordane: 9 samples (3.8 J - 860 J µg/kg)

  - gamma-chlordane: 8 samples ( 3.7 - 960 J µg/kg)
  - heptachlor epoxide: 1 sample (32 J µg/kg)

- PCB-1260 was detected in four samples at two locations, the maximum being detected in sample 21-DD-SD01-06 (120 µg/kg). All detected PCBs were detected at concentrations above ER-L and ER-M values.

- Eighteen of the 23 TAL inorganics were detected in sediment samples (antimony, cobalt, mercury, silver, thallium, and zinc were not detected). The only TAL inorganic detected at a concentration above the ER-L was lead, found in sample 21-DD-SD09-612, which had a concentration of 38.2 mg/kg.

*General Conclusions - Sediment*

Pesticides and PCBs are present in sediments at Site 21. Pesticides were detected 66 times in the sediment samples, all of which exceeded established ER-L and ER-M values. Generally, the most significant pesticide levels were found in sediment samples collected at locations downgradient of the suspected pesticide mixing area, along the southwestern portion of the site. PCB concentrations were detected in sediment samples collected adjacent to the Former PCB Transformer Disposal Area. The highest concentrations were detected in samples collected from the first six inches.

#### 4.2.1.4 Quality Assurance/Quality Control Results

QA/QC samples were collected during this RI field program. These samples included trip blanks, field blanks, equipment rinsates, and field duplicate samples. Analytical results of the field duplicates are provided in Appendix N and other field QA/QC (e.g., rinsate blanks, trip blanks, etc.) results are provided in Appendix P. Results indicated low levels (less than 23 µg/l) of phthalates, chloroform, bromomethane, acetone, and methylene chloride in the various QA/QC samples. These compounds, as discussed in Section 4.1, are attributed to laboratory contaminants or decontamination liquids.

### 4.2.2 Site 24 Analytical Results

The results of the soil, test pit, and groundwater investigations performed at Site 24 are presented in the following sections. Several of the surface water and sediment stations established in Cogdels Creek (78-CC-SW/SD01 through 78-CC-SW/SD08) were located adjacent to Site 24 but will be discussed under Site 78 results. These samples were included under Site 78 because the headwaters of the stream originate near Site 78.

#### 4.2.2.1 Site 24 Soil and Test Pit Investigation

In general, most of the soil samples collected at Site 24 were analyzed for full TCL organics and TAL inorganics. Selected samples obtained from within the areas of concern (e.g., Buried Metals Area) were also analyzed exclusively for TAL inorganics. Appendix G (G.2) summarizes the analytical program initiated for the Site 24 soil investigation.

*Surface Soil Results*

Surface soil analytical results are presented on Tables 4-14 (organics) and 4-15 (inorganics). Analytical results of the surface soils indicated the presence of organic and inorganic contaminants. The following summarizes the results:

- Styrene was the only VOC detected in the surface soils within Site 24. A low concentration of 5.0 µg/kg was detected in boring 24BM SB14.

- SVOCs were detected in five borings (24BDASB09, 24BDASB13, 24BMSB11, 24BMSB14, and 24SSASB05). The highest concentrations and the most frequent detections (14 contaminants) were present at boring 24BDASB09. The compounds exhibiting the highest concentrations included phenanthrene (380 µg/kg), fluoranthene (520 J µg/kg), pyrene (870 µg/kg), and benzo(b)fluoranthene (350 µg/kg).

- Pesticides (including: 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, dieldrin, alpha chlordane, gamma chlordane, heptachlor, and/or heptachlor epoxide) were detected in 12 borings within Site 24. The highest concentrations of pesticides were detected in samples obtained from borings 24BMSB11 [alpha chlordane (26 J µg/kg), heptachlor (1.8 J µg/kg), heptachlor epoxide (5.0 J µg/kg)]; 24 SSASB03 [4,4'-DDE (350 µg/kg), 4,4'-DDD (130 µg/k)]; 24SSASB02 [gamma chlordane (24 J µg/kg)]; and 24SSASB05 [dieldrin (13 J µg/kg) and 4,4'-DDT (320 µg/kg)].

- PCB-1254 and PCB-1260 were detected in only one boring. A surface sample collected from 24BMSB11 indicated concentrations of 85 J and 130 µg/kg, respectively.

- Twenty-four of 24 TAL inorganics (including cyanide) were detected in Site 24 surface soils. Most of the inorganic concentrations, however, were within the range of the surface base-specific background levels (Table 4-5). Several of the borings exhibited inorganic levels an order of one magnitude or higher (i.e., elevated) above base-specific background levels. The most frequent elevated inorganics included aluminum, calcium, manganese, and chromium. Samples from boring 24BMSB03 exhibited the most detections (12) of elevated inorganics above background.

*Subsurface Soil Results*

Subsurface soil analytical results also indicated the presence of organics and inorganics but at lower overall concentrations as shown on Tables 4-16 and 4-17. The following summarizes the results:

- VOCs were not detected in any of the subsurface soils collected at Site 24.

- Fluoranthene was the only SVOC detected in subsurface soils. It was detected in boring 24BDASB13 (1.5 feet) at 45 J µg/kg.

- Pesticides (4,4'-DDD and/or 4,4'-DDT) were detected in 11 borings of the 44 subsurface samples. The highest concentrations were detected in boring 24SSASB06 [4,4'-DDD (19 µg/kg) and 4,4'-DDT (220 µg/kg)] at a depth of 12 to 14 feet.

- PCBs were not detected in any subsurface soils collected from Site 24.

- Twenty-one of 24 TAL inorganics (including cyanide) were detected in subsurface soils (antimony, cadmium, silver were not detected) at Site 24. Several of the subsurface samples exhibited inorganic concentrations an order of one magnitude or higher above base-specific background levels. The most common elevated inorganics included aluminum, barium, calcium, copper, manganese, and nickel. Samples from borings 24BMSB06 (8 to 10 and 10 to 12 feet) and 24BMSB07 (8 to 10 feet) exhibited the most detections (nine and 11, respectively) of inorganics elevated above background levels.

*Test Pit Results*

Test pit samples were collected and analyzed for full TCL organics and TAL inorganics. In addition, three selected samples from test pits TPW04, TPW06, and TPW07 were analyzed for full TCLP and RCRA hazardous waste characteristics. Analytical results from test pit samples indicated low concentrations of organics (Table 4-18) and inorganics (4-19) as summarized below:

- TCE was the only VOC detected in the test pit samples. Low levels of TCE were detected in samples 24TP01 and 24TP05 at concentrations of 7.0 J and 2.0 J, respectively.

- No SVOCs were detected in any of the test pit samples.

- Pesticides including 4,4'-DDD and 4,4'-DDT were detected in low concentrations in two of the samples. Sample 24TP03 exhibited a 4,4'-DDD concentration of 12 µg/kg and sample 24TP05 exhibited a 4,4'-DDT concentration of 8.4 µg/kg.

- No PCBs were detected in any of the test pit samples.

- Twenty-one of 24 TAL inorganics were detected in test pit samples (cyanide, antimony, and cadmium were not detected).

None of the samples classify as RCRA hazardous as defined in 40 CFR Part 260. TCLP results (Table 4-20) indicated that all organic and metal concentrations from the three samples analyzed for TCLP were below the Federal TCLP regulatory levels.

*General Conclusions*

Analytical results indicate that pesticides (including: 4,4'-DDE, 4,4'DDD, 4,4'-DDT, dieldrin, alpha chlordane, gamma chlordane, heptachlor, and/or heptachlor epoxide) and metals are the predominant contaminants impacting soils at Site 24. Pesticide concentrations (highest concentration at 350 µg/kg), overall, were not significantly elevated (as compared to other areas within MCB Camp Lejeune); however, they are present throughout the site, primarily in the surface soils. The presence of the pesticides appear to be the result of spraying activities rather than direct disposal due to their relatively low concentrations and widespread detections. In addition, there is no record of pesticide disposal or pesticide mixing activities at the site.

Detections of metals in surface and subsurface soils are one order of magnitude or higher above base-specific background levels. The presence of metals is most likely attributed to the disposal of fly ash material and various metal debris. These materials were reportedly disposed within the vicinity of Site 24, as discussed in Section 1.0. The metals detected above base-specific background levels (surface and/or subsurface soils) included: aluminum, calcium, barium, copper, chromium, iron, lead, manganese, nickel, and selenium. In general, samples collected from the Buried Metal Area exhibited the highest overall concentration of these metals. A few of these elevated metals were detected to depths of 12 feet.

Test pit samples, which were collected in the vicinity of the suspected buried metal and fly ash disposal areas, tested below Federal regulatory levels for TCLP organics and inorganics. Therefore, the soils classify as nonhazardous under RCRA.

#### 4.2.2.2 Site 24 Groundwater Investigation

##### *Shallow Groundwater Results*

Shallow groundwater samples (less than 25 feet) were collected from the nine site wells during this RI. Note that there are no deep monitoring wells (e.g., greater than 100 feet) installed or existing at Site 24. Groundwater samples collected from the four newly installed wells (24GW07, 24GW08, 24GW09, and 24GW10) were analyzed for full TCL organics and TAL inorganics. Further, samples collected from the existing site wells (24GW01 through 24GW04 and 24GW06) were for TAL inorganics only.

As shown on Table 4-6, heptachlor epoxide was the only organic compound detected in groundwater samples collected at Site 24. Heptachlor epoxide, a pesticide, was detected above the NCWQS of 0.038 μg/l in wells 24GW08 (0.083 J μg/l), 24GW09 (0.13 J μg/l), and 24GW10 (0.078 J μg/l). This compound is also present at low concentrations in surface soils (5.0 μg/kg) but was not detected in subsurface soils.

Results of the inorganic analyses from the Site 24 monitoring wells indicated detections of 21 of the 24 total TAL inorganics (antimony, silver, and cyanide were not detected) and 18 of 24 dissolved TAL inorganics (chromium, cobalt, lead, nickel, vanadium, and cyanide were not detected). Seven TAL metals were detected at concentrations above the Federal MCLs and/or the NCWQS. These analytes included: arsenic (MCL and NCWQS of 50 µg/l), cadmium (MCL and NCWQS of 5.0 µg/l), chromium (MCL of 100 µg/l; NCWQS of 50 µg/l), lead (Federal Action Level and NCWQS of 15 µg/l), manganese (Secondary MCL and NCWQS of 50 µg/l), mercury (MCL of 2.0; NCWQS of 1.1 µg/l), and nickel (MCL and NCWQS of 100). The wells, with their respective total metals concentrations, which exceeded either MCLs and/or NCWQS are as follows:

- 24GW01 chromium - 296 µg/l
  lead - 89 µg/l
  manganese - 117 µg/l

- 24GW02 cadmium - 12 µg/l
  chromium - 316 µg/l
  lead - 17.9 µg/l
  manganese - 518 µg/l
  mercury - 2.6 µg/l
  nickel - 140 µg/l

- 24GW03 chromium - 110 µg/l
  lead - 21.6 µg/l
  manganese - 393 µg/l

- 24GW04 arsenic - 116 J µg/l
  chromium - 153 µg/l
  lead - 23.6 µg/l
  manganese - 66 µg/l

- 24GW06 cadmium - 5.0 µg/l
  chromium - 78 µg/l
  manganese - 431 µg/l
  mercury - 3.2 µg/l

- 24GW08 chromium - 85 µg/l
  lead - 23.8 µg/l

- 24GW09 manganese - 180 µg/l

Manganese was the only dissolved inorganic detected above the Federal MCLs and/or the NCWQS. Wells 24GW03 (320 µg/l), 24GW06 (137 µg/l), and 24GW09 (151 µg/l) were the only wells which exhibited elevated dissolved manganese concentrations.

### *Groundwater Field Parameter Results*

Groundwater field parameter results for pH, temperature, and specific conductance are presented on Table 4-21. Specific conductance values ranged from 58 to 866 micromhos/cm, pH values ranged from 5.34 to 7.60 s.u. (acidic to slightly basic), and temperature values ranged from 15.9°C to 19.6° C. These values represent all field measurements collected (i.e., from each well volume purged) which may account for the wide ranges.

### *Groundwater Engineering Parameter Results*

Groundwater engineering parameters were also analyzed at well 24GW08. Samples were analyzed for BOD, TSS, TDS, TVS, COD, and TOC. Results are summarized on Table 4-22 and analytical data sheets are provided in Appendix O.

Engineering parameters analyzed from well 24GW08 indicate the following concentration levels in the deep groundwater:

- BOD - < 2.0 mg/l
- COD - < 10 mg/l
- TSS - 1,300 mg/l
- TDS - 120 mg/l
- TVS - 1,500 mg/l

Note that the TDS concentration was below the Federal Secondary MCL of 500 mg/l.

*General Conclusions*

The analytical findings indicated that TAL metals are the predominant contaminants impacting Site 24 groundwater. The most elevated concentrations above the standards occurred near the suspected Buried Metals Area and the Fly Ash Disposal Area. As discussed in Section 4.2.2.1 for Site 24 soils, the source of the elevated metals at the site is most likely related to the previous disposal practices. Base records indicated that the area was used for the disposal of metal debris and fly ash materials. The most common elevated metals in groundwater at Site 24, chromium, lead, and manganese, were also elevated in site soils. Subsequently, the source of the metals in the groundwater may be attributed to the contaminated soils in the area.

Low levels of heptachlor epoxide were also detected in three wells at a concentration slightly above the NCWQS. The source of the heptachlor epoxide appears to be related to pesticide spraying activities since the overall concentrations levels were relatively low in both the groundwater and soil. Additionally, there is no history of pesticide disposal or mixing operations at the site.

#### 4.2.2.3 Quality Assurance/Quality Control Results

Results indicated low levels (less than 13 µg/l) of chloroform, acetone, and methylene chloride in the various QA/QC samples collected from Site 24. These compounds, as discussed in Section 4.1, are attributed to laboratory contaminants or decontamination liquids. Analytical results of the field duplicates are provided in Appendix N and other field QA/QC (e.g., rinsate blanks, trip blanks, etc.) results are provided in Appendix P.

### 4.2.3 Site 78 Analytical Results

The results of the soil, groundwater, surface water, and sediment investigations performed at Site 78 are presented in the following sections.

#### 4.2.3.1 Site 78 Soil Investigation

Surface soil analytical results are presented on Tables 4-23 (organics) and 4-24 (inorganics). Further, subsurface soil results are presented on Tables 4-25 (organics) and 4-26 (inorganics). Note that samples obtained from the selected building locations at Site 78 are designated on the tables with "B1300" (Building 1300), "B1502" (Building 1502), "B1103" (Building 1103), "B1601" (Building 1601), "B1608" (Building 1608), and "B903" (Building 903).

The analytical program implemented at each of the buildings investigated focused on the contaminants identified from previous investigations or the contaminants from various substances (e.g., solvents) which may have been used or stored at the buildings. For example, pesticides and PCBs were detected during a previous investigation conducted at Building 1300. Subsequently, the samples collected during this RI were analyzed only for these compounds. A summary of the analytical program for the soil investigation conducted at Site 78, per building, is provided in Appendix G (G.3).

*Surface Soil Results*

Analytical results of the surface soils indicated the presence of organic and/or inorganic contaminants at each building investigated. The following summarizes the results for each building.

*Building 903*

- VOCs - none detected
- SVOCs - SVOCs, primarily PAHs, were detected in all three of the borings. The total number of SVOCs detected in each boring are as follows:
    - 17 SVOCs detected at boring 78B903SB01
    - 13 SVOCs detected at boring 78B903SB02
    - 17 SVOCs detected at boring 78B903SB03
- Pesticides - Five different pesticides were detected at the following concentration ranges and maximum detections (boring location shown in parentheses):
    - dieldrin [78B903SB02 only (37 µg/kg)]
    - 4,4'-DDE [23 J to 37 J mg/kg (78B903SB01)]
    - endrin [78B903SB01 only (24 J µg/kg)]
    - 4,4'-DDD [78B903SB02 only (6.5 J µg/kg)]
    - 4,4'-DDT [5.4 J to 10 J µg/kg (78B903SB01)]

- PCBs - none detected

- Inorganics - All inorganics were detected at concentrations within an order of one magnitude or lower of base-specific background levels.

*Building 1103*

- VOCs - toluene [78B11SB04 only (9.0 J µg/kg)]
  - total xylenes [78B11SB04 only (10 J µg/kg)]

- SVOCs - SVOCs, primarily PAHs, were detected in four of the five borings. The total number of SVOCs detected in each boring are as follows:

  - 7 SVOCs detected at boring 78B11SB02
  - 12 SVOCs detected at boring 78B11SB03
  - 11 SVOCs detected at boring 78B11SB04
  - 10 SVOCs detected at boring 78B11SB05

- Pesticides - Seven different pesticides were detected at the following concentration ranges and maximum detections (boring location shown in parentheses):

  - heptachlor [78B11SB04 only (48 µg/kg)]
  - dieldrin [78B11SB03 only (390 µg/kg)]
  - 4,4'-DDE [140 to 960 µg/kg (78B11SB04)]
  - 4,4'-DDD [18 J to 330 J µg/kg (78B11SB04)]
  - 4,4'-DDT [70 to 580 µg/kg (78B11SB04)]
  - alpha chlordane [12 J to 1,900 J µg/kg (78B11SB04)]
  - gamma chlordane [78B11SB04 only (1,300 J µg/kg)]

- PCBs - none detected

- Inorganics - Three metals were detected at concentrations one order of magnitude or higher above base-specific background levels (i.e., elevated). The concentration ranges and maximum detections (boring location shown in parentheses) of these inorganics included:

  - barium [140 to 425 mg/kg (78B11SB02)]
  - lead [86.5 to 962 mg/kg (78B11SB05)]
  - zinc [87.2 J to 2,900 mg/kg (78B11SB05)]

*Building 1300*

- VOCs - not analyzed

- SVOCs - not analyzed

- Pesticides - Four different pesticides were detected at the following concentration ranges and maximum detections (boring location shown in parentheses):

  - 4,4'-DDE [7.8 J to 67 J µg/kg (78B13SB01)]
  - 4,4'-DDD [78B13SB02 only (3.7 J µg/kg)]
  - 4,4'-DDT [3.8 to 35 J µg/kg (78B13SB01)]
  - endrin aldehyde [78B13SB01 only (7.1 J µg/kg)]

- PCB-1260 [78B13SB01 only (100 J µg/kg)].

- Inorganics - not analyzed

Note that VOCs, SVOCs, and inorganics were analyzed for soils at Building 1300 because previous investigations (ESE 1984 and 1986) indicated that pesticides and PCBs were the contaminants of concern at the site.

*Building 1502*

- VOCs - Three VOCs were detected within the Building 1502 area.

  - 1,1-DCE [78B150SB02 only (2.0 J µg/kg)]
  - chloromethane [78B15SB05 only (12 µg/kg)]
  - bromomethane [78-B1502-SB05 only (8.0 µg/kg)]

- SVOCs - SVOCs, primarily PAHs, were detected in five of the nine borings. The total number of SVOCs detected in each boring are as follows:

    - 8 SVOCs were detected at boring 78B15SB01
    - 7 SVOCs were detected at boring 78B15SB02
    - 4 SVOCs were detected at boring 78B15SB03
    - 9 SVOCs were detected at boring 78B15SB04
    - 8 SVOCs were detected at boring 78B15SB06

- Pesticides - Four different pesticides were detected at the following concentration ranges and maximum detections (boring location shown in parentheses):

    - dieldrin [6.2 to 1,300 J µg/kg (78B15SB02)]
    - 4,4'-DDE [9.7 to 1,400 µg/kg (78B15SB09)]
    - 4,4'-DDD [8.4 to 2,900 J µg/kg (78B15SB02)]
    - 4,4'-DDT [33 J to 16,000 J µg/kg (78B15SB02)]

- PCBs - none detected

- Inorganics - Four metals were detected at concentrations an order of one magnitude or higher (i.e., elevated) above base-specific background levels. The concentration ranges and maximum detections (boring location shown in parentheses) of these elevated inorganics included:

    - barium [78B15SB01 only (109 mg/kg)]
    - lead [101 to 404 mg/kg (78B15SB02)]
    - mercury [78B15SB09 only (2.2 mg/kg)]
    - zinc [74.3 J to 230 J mg/kg (78B15SB02)]

*Building 1601*

- VOCs - none detected

- SVOCs - SVOCs, primarily PAHs, were detected in all four of the borings. The total number of SVOCs detected for each boring are as follows:

  - 2 SVOCs were detected in boring 78B16SB01
  - 10 SVOCs were detected in boring 78B16SB02
  - 4 SVOCs were detected in boring 78B16SB03
  - 9 SVOCs were detected in boring 78B16SB04

- Pesticides - Four different pesticides were detected at the following concentration ranges and maximum detections (boring location shown in parentheses):

  - dieldrin [4.2 to 8.5 J µg/kg (78B16SB01)]
  - 4,4'-DDE [8.2 J to 26 µg/kg (78B16SB01)]
  - 4,4'-DDD [78B16SB01 only (10 µg/kg)]
  - 4,4'-DDT [5.6 J to 23 J µg/kg (78B16SB03)]

- PCBs - none detected

- Inorganics - All inorganics were detected at concentrations within an order of one magnitude or lower of base-specific background levels.

*Building 1608*

- VOCs - none detected

- SVOCs - SVOCs, primarily PAHs, were detected in one of the four borings. Three SVOCs were only detected in boring 78B16SB05.

- Pesticides - none detected

- PCBs - none detected

- Inorganics - All inorganics were detected at concentrations within an order of one magnitude or lower of base-specific background levels.

*Subsurface Soil Results*

Analytical results of the subsurface soils indicated the presence of organic and inorganic contaminants. The following summarizes the results for samples collected from borings and for samples collected from monitoring well borings.

*Building 903*

- VOCs - 1,2-DCE [78B903SB03 at 4 to 5 feet (6.0 J µg/kg) and 78B903SB02 at 4 to 5 feet (16 µg/kg)].

- SVOCs - Fourteen SVOCs, primarily PAHs, were detected at boring 78B903SB02 in a sample collected from 5 to 6 feet.

- Pesticides- none detected

- PCBs - none detected

- Inorganics - All inorganics were detected at concentration within an order of one magnitude or lower of base-specific background levels.

*Building 1103*

- VOCs - none detected

- SVOCs - none detected

- Pesticides - Two different pesticides were detected at the following concentration ranges and maximum detections (boring location shown in parentheses):

  - 4,4'-DDE [78B11SB05 (34 J µg/kg at 6 to 7 feet)]
  - 4,4'-DDT [78B11SB05 (9.7 J µg/kg at 6 to 7 feet)]

- PCBs - none detected

- Inorganics - All inorganics were detected at concentrations within an order of one magnitude or lower of base-specific background levels.

*Building 1300*

- VOCs - not analyzed
- SVOCs - not analyzed
- Pesticides - 4,4'-DDD was the only pesticide detected in subsurface soils at Building 1300. A sample collected from 78 B13SB02 at 6 to 8 feet exhibited a concentration of 6.3 µg/kg.
- PCBs - none detected
- Inorganics - not analyzed

*Building 1502*

- VOCs - none detected
- SVOCs - none detected
- Pesticides - 4,4'-DDT was the only pesticide detected in the subsurface soils at Building 1502. A sample collected from 78B15SB06 at 6 to 8 feet exhibited a concentration of 7.5 µg/kg.
- PCBs - none detected
- Inorganics - All inorganics were detected at concentrations within an order of one magnitude or lower of base-specific background levels.

*Building 1601*

- VOCs - Ethylbenzene (55 J µg/kg) and total xylenes (450 J µg/kg) were the only detected VOCs. Both of these compounds were detected in boring 78B16SB01 in a sample collected from 6 to 7 feet.

- SVOCs - Five SVOCs, predominantly PAHs, were detected in 78B16SB01 in a sample collected from 6 to 7 feet.

- Pesticides - Two pesticides, 4,4'-DDE (4.0 J µg/kg) and 4,4'-DDD (4.0 µg/kg), were detected at boring 78B16SB01 in a sample collected from 6 to 7 feet.

- PCBs - not detected

- Inorganics - All inorganics were detected at concentrations within an order of one magnitude or lower of base-specific background levels.

*Building 1608*

- VOCs - none detected

- SVOCs - none detected

- Pesticides - none detected

- PCBs - none detected

- Inorganics - All inorganics were detected at concentrations within an order of one magnitude or lower of base-specific background levels.

### *Monitoring Well Borings*

Subsurface soil samples (i.e., below one-foot) were collected from borings advanced for monitoring well installation. A total of eight monitoring well borings were advanced (78GW33 through 78GW39 and replacement well 78GW09-1) during the investigation at Site

78. The following summarizes the analytical soil data. Note that the samples collected from replacement well 78GW09-01 were analyzed for TCL VOCs only.

- VOCs - Toluene was detected at boring 78GW39. A sample collected from 10 to 12 feet exhibited a concentration of 3.0 J µg/kg. TCE and 1,2-DCE (total) were detected at boring 78GW09-1. At the 3 to 5 foot interval, the TCE and 1,2-DCE concentrations were 140 µg/kg and 26 µg/kg, respectively. The TCE and 1,2-DCE concentrations at the 11 to 13 foot interval were 35 µg/kg and 22 µg/kg, respectively.

- SVOCs - none detected

- Pesticides - 4,4'-DDD was detected in two subsurface samples collected from boring 78GW37. Samples collected from 4 to 6 feet and 6 to 8 feet exhibited concentrations of 48 and 42 µg/kg, respectively.

- PCBs - none detected

- Inorganics - All inorganics were detected at concentrations within an order of one magnitude or lower of base-specific background levels.

*General Conclusions*

Pesticides (including heptachlor, dieldrin, 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, alpha chlordane, gamma chlordane, and/or endrin) are present in the Site 78 soils. The concentrations of these pesticides were generally below 500 µg/kg, with the exception of a few samples exhibiting levels above 1,000 µg/kg at Buildings 1103 and 1502. The higher pesticide concentrations were detected in surface soils compared to the subsurface soils. The data suggests that the pesticide impacted soils at Site 78 are the result of routine spraying activities since disposal of pesticides (e.g., buried drums, pesticide mixing) have not been documented at these building locations, and the fact that the overall concentrations are relatively low and comparable to other surface soils within OU No. 1.

SVOCs are present in soils in the vicinity of Buildings 903, 1103, 1502, and 1608. The higher SVOC concentrations and the more frequent detections occurred in surface soils. A few detections of SVOCs, however, were also noted in subsurface soils near Building 1601. The most frequently detected SVOCs were PAHs, which included phenanthrene, anthracene, fluoranthene, pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and benzo(g, h, i)perylene. These compounds are found in petroleum fuels such as fuel oil No.2, diesel, and kerosene which are used for heating purposes, emergency generators, or refueling base vehicles. Storage of these fuels in aboveground or underground storage tanks are common practices at a number of buildings throughout Site 78. Note that suspected USTs were identified during the RI at Buildings 903, 1502, and 1601. It is possible that the source of the SVOCs is related to surface (i.e., spills) or subsurface releases (i.e., leaking tanks) of fuels.

Barium, lead, and zinc, were the three most common metals detected at an order of one magnitude or higher above base-specific background levels. These metals were found in predominantly in surface soils collected from Buildings 1103, 1502, and 1601. The specific sources of these metals are unknown since there is no history of disposal at these buildings that would relate to these three contaminants.

Analytical data indicated that VOCs and PCBs are not significantly impacting soils at the five buildings investigated. Detected VOC (i.e., TCE and 1,2-DCE) concentrations were the highest at boring 78GW09-1. This well/boring is located within a known shallow groundwater area of concern (i.e., near Building 1601). Low levels of toluene (9.0 µg/kg) and total xylenes (10 µg/kg) were detected at Building 1103 (surface); somewhat higher levels of ethylbenzene (55 J µg/kg) and total xylenes (450 µg/kg) were detected in subsurface soils (6 to 7 feet) at Building 1601. The source of the ethylbenzene and xylenes at Building 1601 may be related to releases of fuel from the suspected UST at the building. Moreover, PCBs were only detected in a surface sample collected at Building 1300 (PCB-1260 at 100 J µg/kg).

#### 4.2.3.2 Site 78 Groundwater Investigation

Shallow (less than 25 feet), intermediate (between 50 and 78 feet), and deep (approximately 153 feet) wells were sampled for TCL volatiles and TAL inorganics to evaluate groundwater quality. Six wells could not be found during the initial investigation. These wells were found or replaced in December 1993 and then sampled. The samples were analyzed for TCL VOCs only. A summary of the groundwater results with respect to the shallow, intermediate, and deep monitoring wells is presented below.

### *Shallow Groundwater Results*

Sixteen of the shallow wells sampled exhibited positive detections of organic compounds as shown on Tables 4-6 and 4-27 (note that the results from the wells sampled in December 1993 are listed separately). The Federal MCLs or NCWQS are presented where they were exceeded by analytical results. The organics detected in each of these wells are listed below:

- 78GW01
  - TCE [62 µg/l (MCL of 5.0 µg/l; NCWQS of 0.56 µg/l)]
  - 1,2-DCE [27 µg/l (MCL and NCWQS of 70 µg/l)]
- 78GW04-1
  - TCE (2.0 J µg/l)
- 78GW05
  - dichloromethane (2.0 µg/l)
- 78GW08
  - dichlorodifluoromethane [2.0 µg/l (NCWQS of 0.19 µg/l)]
  - trichlorofluoromethane (1.0 µg/l)
- 78GW09-1
  - 1,2-DCE (2400 D µg/l)
  - TCE (2100 D µg/l)
  - 1,1-DCE (280 D µg/l)
  - 1,1-DCA (61 JD µg/l)
  - 1,1,1-TCA (750 D µg/l)
  - chloroform (6 J µg/l)
- 78GW12
  - 1,2-dichloropropane [1.0 µg/l (MCL of 5.0 µg/l; NCWQS of 0.56 µg/l)]
- 78GW14
  - dichloromethane (1.0 µg/l)
- 78GW15
  - PCE [1.0 µg/l (MCL of 5.0 µg/l; NCWQS of 0.7 µg/l)]
  - TCE (1.0 µg/l)
- 78GW17-1
  - dieldrin (0.2 µg/l)
- 78GW19
  - PCE (1.0 µg/l)
  - TCE (1.0 µg/l)
- 78GW21
  - TCE (2.0 µg/l)
- 78GW22-1
  - benzene [9,200 J µg/l (MCL of 5.0 µg/l; NCWQS of 1.0 µg/l)]
  - toluene [18,000 J µg/l (MCL and NCWQS of 1,000 µg/l)]
  - ethylbenzene [3,000 J µg/l (MCL of 700 µg/l; NCWQS of 29 µg/l)]
  - total xylenes [16,000 J µg/l (MCL of 10,000 µg/l; NCWQS of 400 µg/l) ]
  - naphthalene (260 µg/l)
  - 2-methylnaphthalene (36 µg/l)

- phenanthrene (2.0 J µg/l)
- carbazole (12 µg/l)
- fluoranthene (2.0 J µg/l)

| | |
|---|---|
| • 78GW23 | - cis-1,2-DCE [14,000 J µg/l (MCL and NCWQS of 70 µg/l)]<br>- TCE (440 J µg/l)<br>- trans-1,2-DCE [190 J µg/l (MCL of 100 µg/l; NCWQS of 70 µg/l)]<br>- ethylbenzene (5.0 J µg/l)<br>- total xylenes (28 J µg/l)<br>- naphthalene (2.0 J µg/l) |
| • 78GW24-1 | - cis-1,2-DCE (3,400 µg/l)<br>- trans-1,2-DCE (140 µg/l)<br>- vinyl chloride [97 µg/l (MCL of 2.0 µg/l; NCWQS of 0.015 µg/l)]<br>- 1,1-DCE [7.0 µg/l (MCL and NCWQS of 7.0 µg/l)]<br>- 1,1,2-TCA (2.0 µg/l)<br>- benzene (51 µg/l)<br>- toluene (2.0 µg/l)<br>- total xylenes (1.0 µg/l)<br>- naphthalene (22 µg/l) |
| • 78GW35 | - chloroform (8.0 µg/l)<br>- bromodichloromethane (1.0 µg/l) |
| • 78GW39 | - PCE (1.0 µg/l) |

Elevated levels of TAL metals (total and dissolved metals) above the standards were detected in 29 of the 33 shallow wells (Tables 4-7 and 4-8). The following wells exhibited concentrations of TAL metals above (or at) the Federal MCLs and/or NCWQS. Unless specified, total metal concentrations are listed.

| | |
|---|---|
| • 78GW02 | - arsenic [405 J µg/l (MCL and NCWQS of 50 µg/l)]<br>- beryllium [12 µg/l (MCL of 4.0 µg/l)]<br>- cadmium [8.0 µg/l (MCL and NCWQS of 5.0 µg/l)]<br>- lead [19.6 µg/l (Action Limit and NCWQS of 15 µg/l)]<br>- manganese [141 µg/l (Secondary MCL and NCWQS of 50 µg/l)] |

- 78GW04-1 - beryllium (19 µg/l)
  - cadmium (12 µg/l)
  - chromium [496 J µg/l (MCL of 100; NCWQS of 50 µg/l)]
  - lead (126 µg/l)
  - manganese [703 µg/l (total); 96 µg/l (dissolved)]
  - nickel [136 µg/l (MCL and NCWQS of 100 µg/l)]

- 78GW05 - manganese - [161 J µg/l (total); 152 µg/l (dissolved)]

- 78GW06 - barium [1,200 µg/l (NCWQS of 1,000 µg/l)]
  - beryllium (9.0 µg/l)
  - chromium (858 J µg/l)
  - lead (155 J µg/l)
  - manganese (184 J µg/l)
  - mercury [1.1 J µg/l (NCWQS of 1.1 µg/l)]

- 78GW07 - barium (1,250 µg/l)
  - beryllium (5.0 µg/l)
  - chromium (400 J µg/l)
  - lead (61.5 J µg/l)
  - manganese (135 J µg/l)

- 78GW08 - arsenic (60.5 µg/l)
  - beryllium (9.0 µg/l)
  - chromium (491 J µg/l)
  - lead (131 J µg/l)
  - manganese (213 J µg/l)
  - mercury (1.3 J µg/l)

- 78GW10 - beryllium (8.0 µg/l)
  - chromium (362 J µg/l)
  - lead (257 J µg/l)
  - manganese (326 µg/l)
  - mercury (1.5 µg/l)
  - nickel (108 µg/l)

- 78GW11
  - beryllium (5.0 µg/l)
  - chromium (412 µg/l)
  - lead (195 µg/l)
  - manganese (174 µg/l)

- 78GW12
  - chromium [114 J µg/l (total); 59 µg/l (dissolved)]
  - lead (35.5 µg/l)

- 78GW13
  - chromium (222 J µg/l)
  - lead (26.4 J µg/l)
  - manganese (57 J µg/l)

- 78GW14
  - chromium (113 J µg/l)
  - lead (63 µg/l)
  - manganese (68 µg/l)

- 78GW15
  - beryllium (4.0 µg/l)
  - chromium (215 J µg/l)
  - lead (53 µg/l)
  - manganese (115 µg/l)

- 78GW16
  - beryllium (6.0 µg/l)
  - chromium (353 J µg/l)
  - lead (224 µg/l)
  - manganese (150 µg/l)

- 78GW17-1
  - beryllium (4.0 µg/l)
  - chromium (200 J µg/l)
  - lead (81 µg/l)
  - manganese (96 µg/l)

- 78GW20
  - beryllium (4.0 µg/l)
  - chromium (231 J µg/l)
  - lead (119 J µg/l)
  - manganese (93 J µg/l)

- 78GW21
  - lead (19.1 µg/l)
  - manganese (85 J µg/l)

- 78GW22
  - chromium (83 J µg/l)
  - lead [37.2 µg/l (total); 17.2 µg/l (dissolved)]
  - manganese [70 µg/l (total); 53 µg/l (dissolved)]

- 78GW22-1
  - beryllium (4.0 µg/l)
  - chromium (238 µg/l)
  - lead (272 µg/l)
  - manganese (158 µg/l)

- 78GW23
  - chromium (101 J µg/l)
  - lead (50 µg/l)
  - manganese (87 µg/l)

- 78GW24-1
  - arsenic (100 J µg/l)
  - beryllium (7.0 µg/l)
  - chromium (264 µg/l)
  - lead (152 µg/l)
  - manganese (714 µg/l)

- 78GW25
  - chromium (82 J µg/l)
  - lead (30.5 µg/l)

- 78GW29
  - barium (1,070 µg/l)
  - beryllium (12 µg/l)
  - chromium (252 J µg/l)
  - lead (25.5 µg/l)
  - manganese (341 µg/l)
  - nickel (125 µg/l)

- 78GW33
  - chromium (65 µg/l)
  - lead (18.1 µg/l)
  - manganese [86 µg/l (total); 56 µg/l (dissolved)]

- 78GW34 - manganese [96 µg/l (total); 64 µg/l (dissolved)]

- 78GW35 - chromium (55 µg/l)
  - manganese (57 µg/l)

- 78GW36 - chromium (111 µg/l)
  - lead (30.2 µg/l)
  - manganese (62 µg/l)

- 78GW37 - chromium (65 µg/l)
  - lead (21.8 µg/l)
  - manganese (62 µg/l)

- 78GW38 - chromium (201 µg/l)
  - lead (41.2 µg/l)
  - manganese (106 µg/l)

- 78GW39 - chromium (60 µg/l)
  - lead (186 µg/l)
  - manganese (84 µg/l)

Note that shallow monitoring wells that were sampled in December 1993 were not analyzed for TAL metals. These wells include 78GW01, 78GW09-1, 78GW18, and 78GW26.

*General Conclusions - Shallow Groundwater*

The analytical findings indicated that shallow groundwater at Site 78 is impacted by organics and metals. The primary organic contaminants are VOCs, namely BTEX, PCE, TCE, vinyl chloride, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, and 1,2-DCE. The highest overall concentrations of these compounds were detected in wells 78GW22-1, 78GW23, and 78GW24-1 which are located near the northeastern portion of Site 78 in the vicinity of the 900 Series buildings. A second area within Site 78 also detected significant contamination. This is the area near Building 1601 and includes wells 78GW01, 78GW04-1, and 78GW09-1. A number of the buildings in these two areas, as mentioned in Section 1.0, reportedly stored/handled petroleum fuels and/or solvents. The TAL metals which were detected at elevated concentrations above the standards included: arsenic, barium, beryllium, cadmium, chromium, lead, manganese, mercury, and nickel. In general, there is no particular area which exhibits excessive metals contamination since the entire site appears to be impacted.

The VOCs detected at Site 78 represent two different categories of volatiles including: halogenated compounds (e.g., PCE, TCE, vinyl chloride, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, and 1,2-DCE) and nonhalogenated compounds (e.g., BTEX). The halogenated compounds are typically associated with items such as solvents, degreasing agents, and paint strippers. Nonhalogenated compounds on the other hand, especially the lighter compounds such as BTEX, are typically associated with petroleum fuels (e.g., gasoline). A variety of these substances are stored or handled extensively through Site 78 at maintenance facilities, gas stations, fuel farms, and waste storage areas. Many of these facilities were identified in Section 1.0. Subsequently, the presence of VOCs in groundwater through accidental spills or leaking pipelines or tanks at Site 78 is not uncommon.

*Intermediate Groundwater Results*

As previously mentioned, seven intermediate wells were sampled at Site 78 during this RI. Organic compounds were detected in all seven intermediate wells. Table 4-6 presents the detected results for six of these wells [note that intermediate wells displayed on Table 4-5 are designated with the well number followed by a "- 2" (e.g., 78-GW09-2)]. The results from well 78GW30-2 are included on Table 4-27. A summary of the detected organics from well 78GW30-2 and the other wells is listed below:

- 78GW04-2
  - benzene (5.0 J µg/l)
  - phenol - (8.0 J µg/l)
- 78GW09-2
  - TCE (6.0 µg/l)
  - phenol (4.0 J µg/l)
- 78GW17-2
  - dichloromethane (1.0 µg/l)
- 78GW24-2
  - naphthalene (8.0 J µg/l)
  - acenaphthene (3.0 J µg/l)
  - carbazole (3.0 J µg/l)

- 78GW30-2
  - benzene (7.0 J μg/l)
  - toluene (3.0 J μg/l)
  - xylenes (3.0 J μg/l)
  - vinyl chloride (33 μg/l)
  - 1,2-DCE (12 μg/l)
- 78GW31-2
  - TCE (3.0 μg/l)
  - phenol (3.0 J μg/l)
- 78GW32-2
  - dichloromethane (1.0 μg/l)

Several of the intermediate wells exhibited VOC contaminant levels which exceed the Federal MCLs and/or NCWQS. Benzene was detected in wells 78GW04-2 and 78GW30-2 at concentrations equal to or above the Federal MCL and NCWQS. Moreover, TCE was detected at levels which slightly exceeded both standards in well 78GW09-2; TCE was detected only above NCWQS at well 78GW31-2. Vinyl chloride was detected in well 78GW30-2 at levels above both the MCL and NCWQS.

TAL metals (total metals only) were detected in several wells at elevated concentrations above the standards. The following wells exhibited elevated TAL metals:

- 78GW04-2
  - manganese (51 μg/l)
- 78GW24-2
  - cadmium (5.0 μg/l)
- 78GW32-2
  - beryllium (10 μg/l)
  - cadmium (10 μg/l)
  - chromium (215 J μg/l)
  - lead (146 μg/l)
  - manganese (328 μg/l)
  - nickel (166 μg/l)

*General Conclusions - Intermediate Groundwater*

The intermediate wells sampled at Site 78 exhibited low levels of VOCs and a few metals which exceeded the standards. The level of contamination detected in the intermediate wells were significantly lower than the contamination detected in the shallow wells. Benzene, TCE, vinyl chloride, 1,2-DCE, and dichloromethane were the most prevalent VOCs detected. As mentioned previously, these contaminants are representative of both halogenated and nonhalogenated compounds. The overall highest VOC concentrations were found in wells 78GW30-2, 78GW04-2 and 78GW09-2. Additionally, several SVOCs including naphthalene, acenaphthene, and carbazole were also detected in well 78GW24-2. With respect to TAL metals, well 78GW32-2 exhibited the overall highest concentrations. Beryllium, cadmium, chromium, lead, manganese, and nickel concentrations in this well exceeded the Federal MCLs and/or the NCWQS.

*Deep Groundwater Results*

Six deep monitoring wells were sampled at Site 78. Organic compounds were detected in five of the six deep intermediate wells. No compounds were detected in well 78GW30-3. Table 4-6 presents the detected results for these five wells [note that deep wells displayed on Table 4-6 are designated with the well number followed by a "- 3" (e.g., 78-GW09-3)]. A summary of the detected organics per well is listed below:

- 78GW04-3 - benzene (30 µg/l)
  - cis-1,2-DCE (3.0 µg/l)
  - phenol (5.0 J µg/L)

- 78GW09-3 - alpha chlordane (0.11 J µg/l)
  - phenol (8.0 J µg/l)

- 78GW24-3 - cis-1,2-DCE (3.0 µg/l)
  - trans-1,2-DCE (1.0 µg/l)
  - benzene (35 µg/l)
  - phenol (5.0 J µg/l)
  - naphthalene (2.0 J µg/l)

- 78GW31-3 - cis-1,2-DCE (1.0 µg/l)
  - benzene (15 J µg/l)
  - phenol (4.0 J µg/l)

- 78GW32-3 - 1,2-DCA (1.0 µg/l)
  - TCE (6.0 µg/l)
  - phenol (2.0 J µg/l)
  - 2-methylphenol (2.0 J µg/l)

Benzene was present in wells 78GW04-3, 78GW24-3, and 78GW31-3 at levels which exceeded both the Federal MCLs and NCWQS. Alpha chlordane was detected slightly above the NCWQS of 0.027 µg/l in well 78GW09-3. Further, the TCE concentration exhibited in well 78GW32-3 exceeded both standards.

Two of the deep wells exhibited TAL metals (total metals only) at or above the standards. Note that the sample collected from well 78GW30-3 was not analyzed for TAL metals. These wells and their concentrations are as follows:

- 78GW04-3 - arsenic (118 J µg/l)
  - cadmium (21 µg/l)
  - manganese (591 µg/l)

- 78GW24-3 - cadmium ( 5.0 µg/l)

*General Conclusions - Deep Groundwater*

The analytical data indicated that organic compounds, namely VOCs, are the predominant contaminants in the deep wells. The detected contamination levels in the deep wells were lower than the levels detected in the intermediate wells. The most prevalent VOCs (i.e., both halogenated and nonhalogenated compounds) included benzene, cis-1,2-DCE, trans-1,2-DCE, and TCE. Wells 78GW04-3, 78GW24-3, and 78GW32-3 exhibited the overall highest concentrations of VOCs. Further, well 78GW09-3 exhibited elevated alpha chlordane levels above the NCWQS.

*Groundwater Field Parameter Results*

Groundwater field parameter results for pH, temperature, and specific conductance are presented on Table 4-28 for shallow, intermediate, and deep wells. The following summarizes the ranges of values for the various sampling depths:

- Shallow -

Specific conductance: 11 to 546 micromhos/cm

pH: 4.12 to 7.19 s.u.

temperature: 15.6° to 22.9° C.

- Intermediate -

Specific conductance: 238 to 656 micromhos/cm

pH: 6.04 to 11.34 s.u.

temperature: 17.4° to 25° C.

- Deep -

Specific conductance: 169 to 1,144 micromhos/cm

pH: 7.18 to 12.15 s.u.

temperature: 18.2° to 23.9° C.

These values represent all field measurements collected (i.e., from each well volume purged) which may account for the wide ranges. As shown on Table 4-28, the specific conductance and pH values were generally higher in the deeper groundwater.

### *Groundwater Engineering Parameter Results*

Groundwater engineering parameters were also analyzed at wells 78GW04-1 (shallow well), 78GW31-3 (deep well), and 78GW34 (shallow well). Samples were analyzed for BOD, TSS, TDS, TVS, COD, and TOC. Results are presented on Table 4-22 and analytical data sheets are provided in Appendix O. The concentration ranges and the maximum detection (well shown in parentheses) of the engineering parameters were as follows:

- BOD - < 2.0 to 5.0 mg/l (well 78GW04-1)
- COD - < 10 to 17 mg/l (well 78GW34)
- TSS - 38 to 8,800 mg/l (well 78GW34)
- TDS - 270 to 860 mg/l (well 78GW31-1)
- TOC - 1.0 to 2.0 mg/l (well 78GW31-3)
- TVS - 84 to 1,300 mg/l (well 78GW34)

Note that the TDS concentration of 860 mg/l detected at deep well 78GW31-3 was above the Federal Secondary MCL of 500 mg/l.

*Summary of Site 78 Groundwater Results*

The groundwater data indicates that VOCs (both halogenated and nonhalogenated compounds) and metals are the predominant contaminants impacting Site 78 groundwater. The most prevalent halogenated compounds detected included TCE, cis-1,2-DCE, and trans-1,2-DCE. These compounds, are associated with various types of solvents and degreasing agents. The presence of these substances are common at numerous facilities within Site 78 as discussed in Section 1.0 (refer to Table 1-1). Concentrations of BTEX are also present in groundwater at Site 78. Several likely sources of the BTEX contamination at Site 78 include underground and aboveground storage tanks, surface releases of fuel, and the Hadnot Point Fuel Farm.

Metals were found in the groundwater throughout OU No. 1. The source of the metals contamination is unknown, with the exception of the Buried Metal Areas and Fly Ash Disposal Area at Site 24. No plumes of metals contamination are evident.

Groundwater analytical data from the three most recent sampling events at Site 78 for the shallow and deep wells are presented on Tables 4-29 and 4-30, respectively. Deep well data are from 1991 and 1993, and the shallow well data are from 1987, 1991, and 1993. The groundwater samples collected in 1993 were obtained by Baker during this RI. Note that the quality of the data from the non-Baker sampling events is unknown.

As shown on Table 4-29, the overall contamination levels in shallow groundwater appear to have decreased over time. Several wells which exhibited elevated VOCs in 1987 and/or 1991 either had nondetectable or significantly lower concentrations in 1993. These wells included 78GW01, 78GW02, 78GW03, 78GW09-1, 78GW10, 78GW11, 78GW17-1, and 78GW19. Several possible explanations may account for the decrease in contaminant levels including:

- The contaminants may have migrated vertically from the shallow aquifer into the underlying aquifer, or horizontally to other portions of the site.
- The contaminant concentrations may have dissipated over time through natural processes.

Since the validity of the previous data in unknown, it is difficult to conclude which one of these possible explanations above is the most valid.

Three of the wells including 78GW22-1, 78GW23, and 78GW24-1 either had increased contaminant levels or had detections of compounds not previously detected. These three wells are situated near the northeastern portion of Site 78 where multiply sources of contamination are known to exist (e.g., Hadnot Point Fuel Farm, numerous maintenance shops). These sources are presumed to be continually impacting the groundwater in the area.

As shown on Table 4-30, several of the deep wells have exhibited increased levels of VOCs over time. Wells 78GW04-3, 78GW09-3, 78GW24-3, and 78GW32-3, which all indicated nondetectable levels of VOCs in 1991, had positive detections of benzene, TCE, 1,2-DCE, cis-1,2-DCE, and/or trans-1,2-DCE in 1993. Only one of the deep wells, 78GW31-3, revealed lower overall concentrations in 1993 compared to 1991. The data suggest that the contaminants may be migrating into the deeper water-bearing zone at Site 78. Additional rounds of sampling, however, may be required to support this conclusion.

Metals are also prevalent in groundwater at Site 78, especially shallow groundwater. The most frequently detected metals above the MCLs or NCWQSs included beryllium, chromium, lead, and manganese. Manganese, as discussed earlier, is commonly found at elevated concentrations in soil and groundwater at Camp Lejeune. The elevated lead concentrations at some areas within OU No. 1 (e.g., fuel farm, gasoline stations) may be related to releases of leaded fuels which may have been stored at the Base at one time. The specific source of elevated lead at other areas of OU No. 1 is unknown. The specific source for beryllium and chromium are unknown but they are most likely related to industrial processes or buried metal debris.

#### 4.2.3.3 Site 78 Surface Water and Sediment Investigation

Surface water and sediment analytical results were divided into two areas based on sampling locations: Cogdels Creek and the New River, and Beaver Dam Creek. Surface water results from Cogdels Creek and the New River are presented in Tables 4-31 (organics) and 4-32 (inorganics). Sediment sample results from Cogdels Creek and the New River are presented in Tables 4-33 (organics) and 4-34 (inorganics). Surface water results from Beaver Dam Creek are presented in Table 3-35 (inorganics). Sediment sample results from Beaver Dam Creek are presented in Tables 4-36 (organics) and 4-37 (inorganics). Cyanide was not analyzed in any of the surface water or sediment samples.

Since Cogdels Creek, the New River, and Beaver Dam Creek are all classified as tidal saltwaters by the State of North Carolina Environmental Management Commission, surface water contaminant detections were compared to North Carolina WQSs for Saltwater Classes and USEPA Region IV Saltwater WQSVs. Sediment contaminant detections were compared to the NOAA ER-L and ER-M values.

*Cogdels Creek and the New River - Surface Water Results*

As indicated on Tables 4-31 and 4-32, surface water results from Cogdels Creek and the New River indicated the presence of VOCs, pesticides, PCBs and TAL metals. No SVOCs were detected. The following summarizes the results:

- VOCs were detected in five of the 20 surface water samples. TCE was detected in four samples, the maximum being detected in sample 78-CC-SW02 (47 µg/l). Toluene (3 J µg/l in sample 78-CC-SW05) and 1,2-dichloroethene (6 J µg/l in sample 78-CC-SW02) were each detected in one sample. None of the detected VOCs exceeded WQS or WQSV standards.

- Pesticides were detected in two (2) of the 20 surface water samples. Sample 78-CC-SW03 had detectable amounts of 4,4'-DDD (0.19 µg/l) and 4,4'-DDT (0.18 µg/l). Sample

78-CC-SW15 had a detectable amount of 4,4'-DDD (0.13 µg/l). All of the detected pesticide concentrations exceeded WQSV standards.

- Nineteen of the 23 inorganics were detected in surface water samples (antimony, cadmium, cobalt, and mercury were not detected). Copper exceeded WQS and/or WQSVs in eighteen of the twenty samples (all but 78-CC-SW11 and 78-CC-SW12). In addition to the samples which exceeded copper standard values, the following samples which exceeded TAL metal WQSs and/or WQSVs are as follows:

- 78-CC-SW04 lead - 29.8 J µg/l
  zinc - 152 J µg/l

- 78-CC-SW07 lead - 11.9 µg/l

- 78-CC-SW18 lead - 35.6 µg/l

- 78-CC-SW19 chromium - 30 J µg/l
  lead - 42 µg/l
  zinc - 125 µg/l

- 78-CC-SW20 lead - 6.5 µg/l

*General Conclusions*

The only contaminants found in Cogdels Creek and New River surface water samples which exceeded WQS and/or WQSV were TAL inorganics, particularly copper, which was detected in all 20 samples (18 of which exceeded WQS and WQSV standards), and lead, which exceeded WQS and/or WQSV standards in five samples. A majority of maximum detection concentrations were found at sample locations 78-CC-SW19 (including lead and eight other TAL inorganics) and 78-CC-SW-17, both of which are situated near the Hadnot Point Sewage Treatment Plant, along the southern end of Site 78.

*Cogdels Creek and the New River - Sediment Results*

As indicated on Tables 4-33 and 4-34, sediment sample results from Cogdels Creek and the New River indicated the presence of VOCs, SVOCs, pesticides, and TAL metals. No PCBs were detected. The following summarizes the results:

- VOCs were detected in 4 of 40 sediment samples. Ethylbenzene was detected in sample 78-CC-SD03-612 (16 J µg/kg) with 2-butanone was detected in three samples the maximum concentration detected in sample 78-CC-SD08-612 (60 J µg/kg). No established ER-L or ER-M standards exist for detected VOCs.

- SVOCs were detected in 15 of 40 samples. Eighteen SVOCs, primarily PAHs, were detected in Cogdels Creek sediments. The most frequently detected SVOCs were fluoranthene and pyrene (14 samples each), chrysene (13 samples), benzo(b)fluoranthene (12 samples), benzo(a)pyrene and indeno(1,2,3-cd)pyrene (11 samples each), phenanthrene and benzo(a)anthracene (10 samples each), and benzo(g, h, i)perylene (eight samples). No other SVOC was detected in more than three samples. The majority of the SVOC maximum concentrations were found in sample 78-CC-SD18-612, which produced the following maximum concentration results:

    - naphthalene - 240 J µg/kg
    - acenaphthene - 550 J µg/kg
    - dibenzofuran - 380 J µg/kg
    - fluorene - 600 J µg/kg
    - phenanthrene - 4500 µg/kg
    - anthracene - 1000 µg/kg
    - carbazole - 660 µg/kg
    - fluoranthene - 6800 µg/kg
    - pyrene - 4500 µg/kg
    - benzo(a)anthracene - 2500 µg/kg
    - chrysene - 2400 µg/kg
    - benzo(b)fluoranthene - 2800 µg/kg
    - benzo(k)fluoranthene - 1800 µg/kg
    - benzo(a)pyrene - 1700 µg/kg

SVOCs that exceeded WQS and/or WQSV standards are as follows: pyrene (seven samples), phenanthrene (5 samples), benzo(a)anthracene (5 samples), chrysene (4 samples), fluoranthene (3 samples), and benzo(a)pyrene (3 samples), and acenaphthene (1 sample).

Samples 78-CC-SD06-612, 78-CC-SD09-06, and 78-CC-SD18-612 all exceeded the total PAH ER-L standard of 4000 µg/kg.

- Pesticides were detected in 22 of 40 samples, with 4,4'-DDD being detected in 20 of the samples. The highest concentrations of pesticides were detected in sediments obtained from samples 78-CC-SD19-06 (4,4'-DDE - 33 mg/kg); 78-CC-SD15-612 (4,4'-DDD-400 µg/kg); 78-CC-SD18-612 4,4'-DDT - 150 µg/kg); 78-CC-SD14-612 (alpha-chlordane - 5.9 J µg/kg); and 78-CC-SD08-612 (gamma-chlordane - 6.3 µg/kg). All pesticides detected exceeded ER-L standards, and many exceeded ER-M standards. The pesticides detected and the range of detection concentrations are listed below:

  - 4,4'-DDE: 8 samples (5 - 33 µg/kg)
  - 4,4'-DDD: 20 samples (4.4 J - 400 µg/kg)
  - 4,4'-DDT: 11 samples ( 4.6 J - 150 µg/kg)
  - alpha-chlordane: 5 samples (2.5 J - 5.9 J µg/kg)
  - gamma-chlordane: 3 samples (3.2 J - 6.3 µg/kg)

- Twenty-two of the 23 TAL inorganics were detected in Cogdel Creek sediments. Nickel was not detected. The following TAL metals exceeded the ER-L: lead (12 samples), zinc (6 samples), cadmium (3 samples), copper (2 samples), and silver (2 samples). Of the 14 TAL metals detected, six of them exhibited maximum concentrations at sample location 78-CC-SD08-06. Sediment samples which exceeded ER-L TAL metal standards are as follows:

  - 78-CC-SD03-612 lead - 48.3 J mg/kg

  - 78-CC-SD04-06 lead - 40.4 mg/kg

  - 78-CC-SD06-612 lead - 45.7 J mg/kg

| | | | |
|---|---|---|---|
| • 78-CC-SD08-06 | cadmium | - | 11.9 mg/kg |
| | copper | - | 78.3 mg/kg |
| | lead | - | 178 mg/kg |
| | zinc | - | 301 mg/kg |
| • 78-CC-SD08-612 | cadmium | - | 10.9 mg/kg |
| | lead | - | 296 mg/kg |
| | zinc | - | 363 mg/kg |
| • 78-CC-SD09-06 | cadmium | - | 9.6 mg/kg |
| | lead | - | 92.3 mg/kg |
| | zinc | - | 254 mg/kg |
| • 78-CC-SD18-06 | lead | - | 83.6 mg/kg |
| • 78-CC-SD18-612 | copper | - | 116 mg/kg |
| | lead | - | 359 mg/kg |
| | zinc | - | 322 mg/kg |
| • 78-CC-SD19-06 | lead | - | 93.1 mg/kg |
| | silver | - | 2.3B mg/kg |
| | zinc | - | 162 mg/kg |
| • 78-CC-SD19-612 | lead | - | 58.5 mg/kg |
| • 78-CC-SD20-06 | lead | - | 103 mg/kg |
| | silver | - | 3.9B mg/kg |
| | zinc | - | 140 mg/kg |
| • 78-CC-SD20-612 | lead | - | 71.6 mg/kg |

### *General Conclusions*

The most prevalent contaminants found in Cogdels Creek and New River sediments were PAH compounds, pesticides (particularly 4,4'-DDD), and several TAL inorganics (lead and zinc were most often in exceedance of ER-L and/or ER-M standards). The sample locations that produced a majority of maximum concentrations were 78-CC-SD08, and 78-CC-SD18. Location 78-CC-SD08 is located south of the Borrow and Debris Disposal Area at Site 24. Location 78-CC-SD18 is located in the downstream location in the New River.

PAH compounds can be found in petroleum fuels such as No. 2 oil, diesel, and kerosene, which are used for heating purposes, emergency generators, or refueling base vehicles. PAHs can also be associated with combustion; therefore runoff from roadways could be a potential source of PAHs. As mentioned earlier, storage of these fuels in aboveground or USTs is a common practice throughout Site 78. It is likely, therefore that the source of SVOCs, and possibly lead, is related to surface or subsurface releases of fuels and/or from roadway runoff and storm sewers discharging into Cogdels Creek.

Pesticides were detected throughout Site 78, but in concentrations that were relatively low. This suggests that the presence of pesticides throughout Cogdels Creek and New River sediments are the result of spraying activities rather than disposal practices or spill incidents, since pesticide detections are not exceptionally high or concentrated in any specific area.

A number of TAL inorganics were detected at every sample location. Lead and zinc were most often in exceedance of ER-L and ER-M standards, while sample location 78-CC-SD08-06 was the site of 6 of the 14 TAL inorganics maximum concentrations.

Beaver Dam Creek - Surface Water Results

As shown in Table 4-35, surface water results from Beaver Dam Creek indicate the presence of TAL metals. No VOCs, SVOCs, pesticides, or PCBs were detected. Fifteen of the 23 TAL inorganics were detected, including aluminum, arsenic, barium, beryllium, calcium, chromium, copper, iron, lead, magnesium, manganese, potassium, sodium, vanadium, and zinc. The majority of TAL metal maximum detection concentrations were found in sample 78-BD-SD07, which produced the following maximum concentration results:

- aluminum - 5610 µg/l
- barium - 75B µg/l
- calcium - 141000 µg/l
- chromium - 18 J µg/l
- iron - 11800 J µg/l
- lead - 22.2 µg/l

- potassium - 4380 µg/l
- sodium - 15600 µg/l
- vanadium - 17B µg/l

The only inorganics which exceeded WQS or WQSV standards were zinc in sample 78-BD-SW06 (96 µg/l), lead in samples 78-BD-SW02 (7.4 J µg/L) and 78-BD-SW07, and copper which exceeded the WQS or WQSVs in all seven samples, the maximum concentration in sample 78-BD-SW02 (17 J µg/l).

*General Conclusions*

The only contaminants that were present in Beaver Creek surface water were TAL inorganics. The only TAL inorganics that exceeded WQS or WQSV standards were copper (in all seven samples), lead (in two samples), and zinc (in one sample).

Sample location 78-BD-SW07, which exhibited a majority of maximum detections, is situated along a very narrow stretch of Beaver Dam Creek west of the northern corner of Site 78. It is possible that stormwater runoff from Site 78 or Holcomb Boulevard may be a contributing factor to this contamination.

*Beaver Dam Creek - Sediment Results*

As Tables 4-36 and 4-37 demonstrate, sediment sample results from Beaver Dam Creek indicated the presence of SVOCs, pesticides, PCBs, and TAL inorganics. No VOCs were detected. The following summarizes the results:

- Sixteen SVOCs, consisting primarily of PAHs were detected, the maximum concentration for each found in sample 78-BD-SD02-06. Sediment samples that exceeded SVOC ER-L standards are as follows:

- 78-BD-SD02-06

| | | | |
|---|---|---|---|
| 78-BD-SD02-06 | acenaphthene | - | 340 J µg/kg |
| | fluorene | - | 270 J µg/kg |
| | phenanthrene | - | 1900 µg/kg |
| | anthracene | - | 410 J µg/kg |
| | fluoranthene | - | 2100 µg/kg |
| | pyrene | - | 1500 µg/kg |

benzo(a)anthracene- 950 μg/kg
chrysene - 920 μg/kg
benzo(a)pyrene - 510 μg/kg

- 78-BD-SD03-06 phenanthrene - 380 J μg/kg
  fluoranthene - 440 μg/kg
  pyrene - 360 J μg/kg

- Pesticides were detected in eight of 14 sediment samples, 4,4'-DDE being detected in six of the samples. The highest concentrations of pesticide were detected in sediments collected from samples 78-BD-SD07-06 [4,4'-DDE (93 J μg/kg), 4,4'-DDT (47 J μg/kg), alpha-chlordane (7.3 J μg/kg), and gamma-chlordane (5.6 J μg/kg)] and 78-BD-SD07612 [4,4'-DDD (39 J μg/kg)]. All pesticides detected exceeded the ER-L, and many exceeded the ER-M. The pesticides detected and the range of detection concentrations are listed below:

  - 4,4'-DDE: 6 samples (4.8 J - 93 μg/kg)
  - 4,4'-DDD: 2 samples (33 J - 39 J μg/kg)
  - 4,4'-DDT: 3 samples (8 J - 47 J μg/kg)
  - alpha-chlordane: 4 samples (2.5 - 7.3 J μg/kg)
  - gamma-chlordane: 6 samples (2.4 - 5.6 J μg/kg)
  - PCB-1260: 1 sample (70 μg/kg)

- PCB-1260 was detected in one sample, 78-BD-SD02-612 (70 mg/kg), which exceeded the ER-L.

- Nineteen of 23 inorganics were detected in sediment samples. Antimony, cadmium, mercury, and silver were not detected. Most of the maximum concentrations were found in one of two sediment sample locations: 78-BD-SD04-612 contained maximum concentrations of arsenic (12.1 J mg/kg), beryllium (1.1 J mg/kg), copper (24.7 mg/kg), nickel (10.1 J mg/kg), selenium (2.6 J mg/kg), and thallium (0.53 J mg/kg); 78-BD-SD05-612 contained maximum concentrations of aluminum (37100 mg/kg), barium (49.1 mg/kg), chromium (41.2 mg/kg), magnesium (1400B mg/kg), manganese (30.9 mg/kg), potassium (1550 mg/kg), sodium (146B mg/kg), and vanadium (50.5 mg/kg). The only TAL inorganic that exceeded WQS and/or WQSV standards was lead, which exceeded the ER-L in four samples.

*General Conclusions*

The most prevalent contaminants found in Beaver Creek sediments were PAHs, pesticides, and TAL inorganics (lead was the only TAL inorganic to exceed ER-L standards). A possible source of the SVOCs may be from stormwater runoff from roads (Holcomb Boulevard) or HPIA.

Pesticides were detected throughout Beaver Dam Creek sediments, but in concentrations that were relatively low. As is the case with Cogdels Creek and New River sediments, this data suggests that the presence of pesticides in Beaver Dam Creek are the result of spraying activities rather than disposal practices or spill incidents, since pesticides detections are not exceptionally high or concentrated in any specific area.

#### 4.2.3.4 Quality Assurance/Quality Control Results

Results from Site 78 indicated low levels (less than 10 µg/l) of chloroform, acetone, and methylene chloride in the various QA/QC samples. These compounds, as discussed in Section 4.1, are attributed to laboratory contaminants or decontamination liquids. Additionally, low levels (less than 3.0 µg/l) of benzene [trip blank (1.0 µg/l)], 1,1-DCA [equipment rinsate (1.0 µg/l)], trans-1,2-DCE [equipment rinsate (2.0 µg/l)], and cis-1,2-DCE [trip blank (3.0 µg/l)] were detected in a few samples. Analytical results of the field duplicates are provided in Appendix N and other field QA/QC (e.g., rinsate blanks, trip blanks, etc.) results are provided in Appendix O.

## 4.3 Extent of Contamination

This section addresses the extent of contamination for the various media sampled at OU No. 1. Note that the extent of contamination is addressed separately for each site.

### 4.3.1 Site 21 Extent of Contamination

The extent of contamination identified at Site 21 with respect to soil, groundwater, surface water, and sediment is discussed below.

### 4.3.1.1 Extent of Soil Contamination at Site 21

Positive detections of organic compounds for surface and subsurface soils at Site 21 are depicted on Figures 4-1 and 4-2, respectively. A discussion of the extent of soil contamination with respect to VOCs, SVOCs, pesticides, and PCBs follows. As discussed in Section 4.2.1.1, only a few metals (e.g., manganese and calcium) were detected at concentrations an order of one magnitude or higher above the base-specific background level at Site 21. Accordingly, the extent of metals contamination in soil for Site 21 will not be addressed.

*Volatiles*

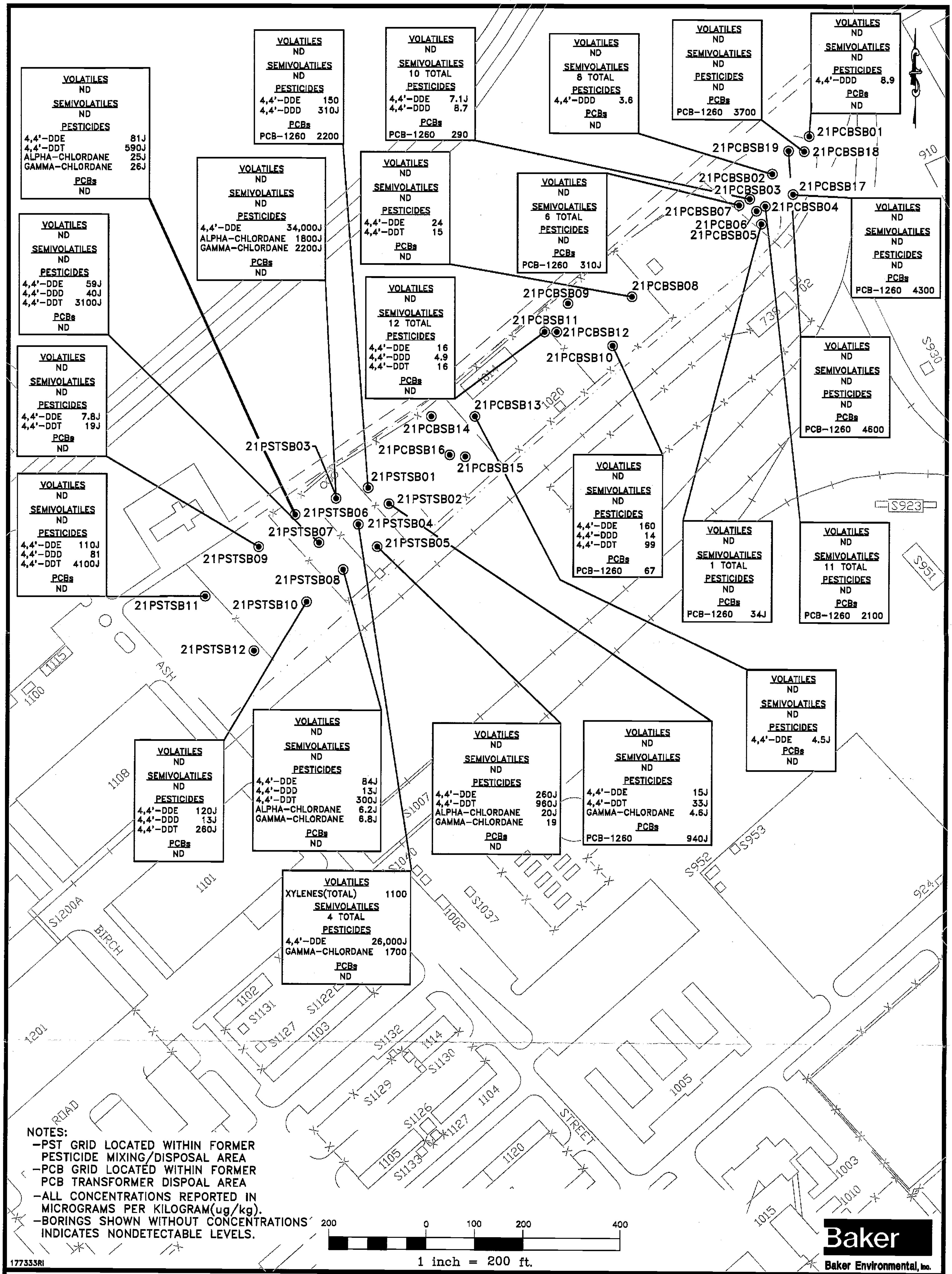
VOCs in both surface and subsurface soils at Site 21 appear to be limited to an area near boring 21PSTSB04 (located within the Former Pesticide Mixing/Disposal Area). The surface sample had detected concentrations of total xylenes of 1,100 ug/kg. Toluene, ethylbenzene, and xylenes were detected at concentrations between 37 J µg/kg and 3,400 µg/kg from the subsurface sample collected from 2 to 4 feet. Note that the other borings around 21PSTSB04 did not exhibit any VOCs.

*Semivolatiles*

SVOCs were detected in the surface soils within the Former PCB Transformer Disposal Area and at one location within the Former Pesticide Mixing/Disposal Area. Surface soils collected from borings 21PCBSB02, 21PCBSB03, 21PCBSB04, 21PCBSB05, 21PCBSB07, and 21PSTSB04 exhibited SVOC detections as depicted on Figure 4-1. Due to the area limitations on the figures, only the total number of SVOC positive detections at each boring is listed (refer to the data tables for individual concentrations). The extent of these compounds appears to be limited to the area near the former PCB oil pit and at the same location within the Former Pesticide Mixing/Disposal Area that VOCs were detected.

*Pesticides*

As depicted on Figure 4-1, pesticides are present in surface soils throughout Site 21. The highest levels of pesticides were detected in soils collected within the Former Pesticide Mixing/Disposal Area (PST borings) which is located near the western portion of Site 21. Borings 21PSTSB03, 21PSTSB04, 21PSTSB07, and 21PSTSB11 exhibited detections of pesticides at concentrations above 1,000 µg/kg. Borings 21PSTSB03, 21PSTSB04 and



NOTES:
- PST GRID LOCATED WITHIN FORMER PESTICIDE MIXING/DISPOSAL AREA
- PCB GRID LOCATED WITHIN FORMER PCB TRANSFORMER DISPOAL AREA
- ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER KILOGRAM(ug/kg).
- BORINGS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS.

Baker
Baker Environmental, Inc.

LEGEND

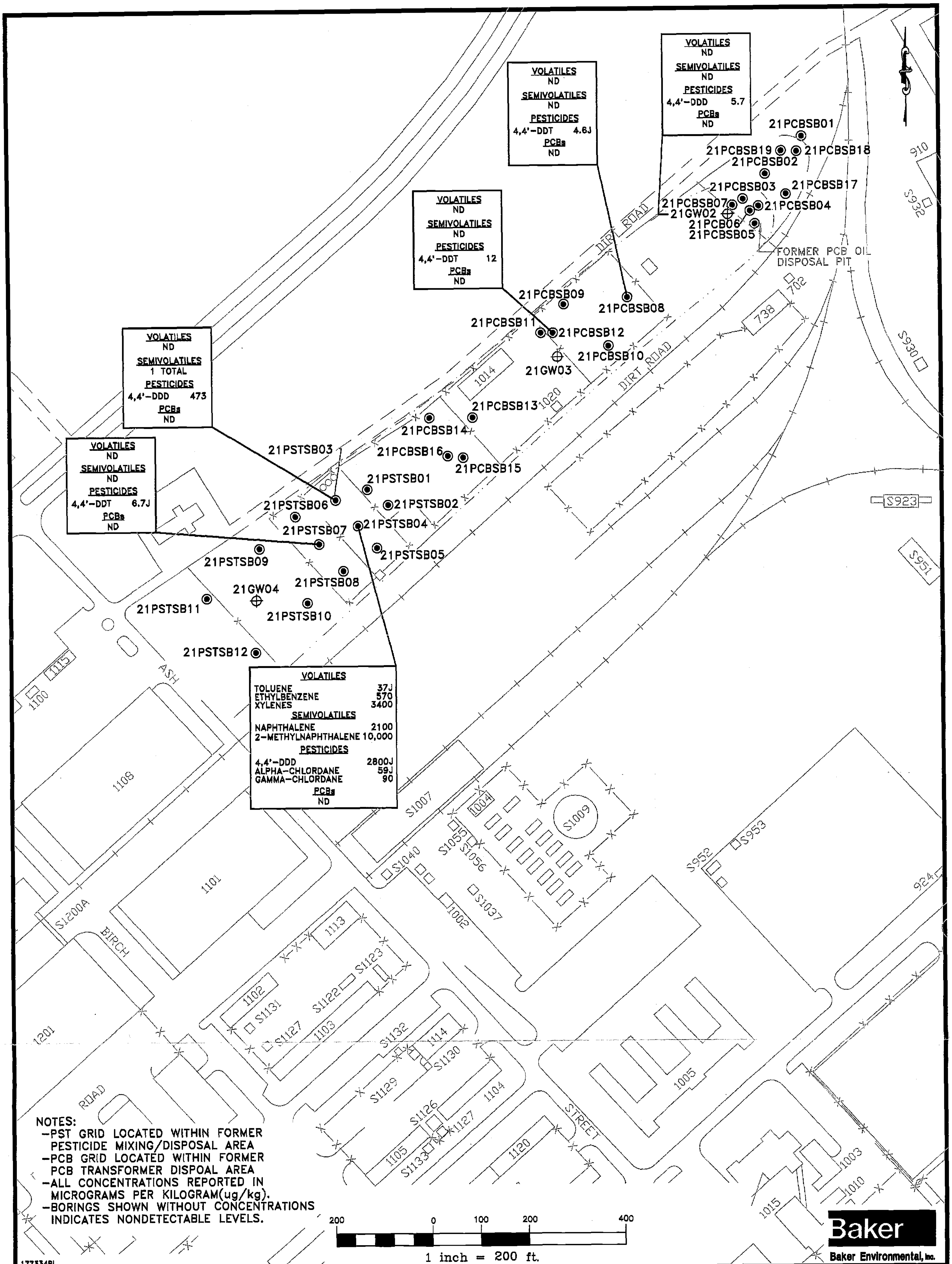
21PCBSB01 ● SOIL BORING

ND NOT DETECTED

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-1
POSITIVE DETECTIONS OF ORGANIC COMPOUNDS IN SURFACE SOILS
SITE 21
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00522WB1Z



NOTES:
- PST GRID LOCATED WITHIN FORMER PESTICIDE MIXING/DISPOSAL AREA
- PCB GRID LOCATED WITHIN FORMER PCB TRANSFORMER DISPOAL AREA
- ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER KILOGRAM(ug/kg).
- BORINGS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS.

Baker
Baker Environmental, Inc.

LEGEND

| | |
|---|---|
| 21PCBSB01 ◉ | SOIL BORING |
| 21GW02 ⊕ | SOIL BORING ADVANCED FOR MONITORING WELL |
| ND | NOT DETECTED |

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-2
POSITIVE DETECTIONS OF ORGANIC COMPOUNDS
IN SUBSURFACE SOILS
SITE 21
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

21PSTSB07 are located in the area where the previous EPIC study identified stains in the 1964 aerial photograph. Boring 21PSTSB11 is located in the southwestern corner of the site.

The frequency and overall concentration levels of pesticides detected in subsurface soils at Site 21 are significantly less compared to surface soils. As shown on Figure 4-2, fewer borings indicated detections of pesticides. The most impacted subsurface soils appear to be located near boring 21PSTSB04. Pesticides [4,4-DDD (2,800 J µg/kg), alpha-chlordane (59J µg/kg), and gamma-chlordane (90 µg/kg)] were detected in this boring to a depth of 4 feet.

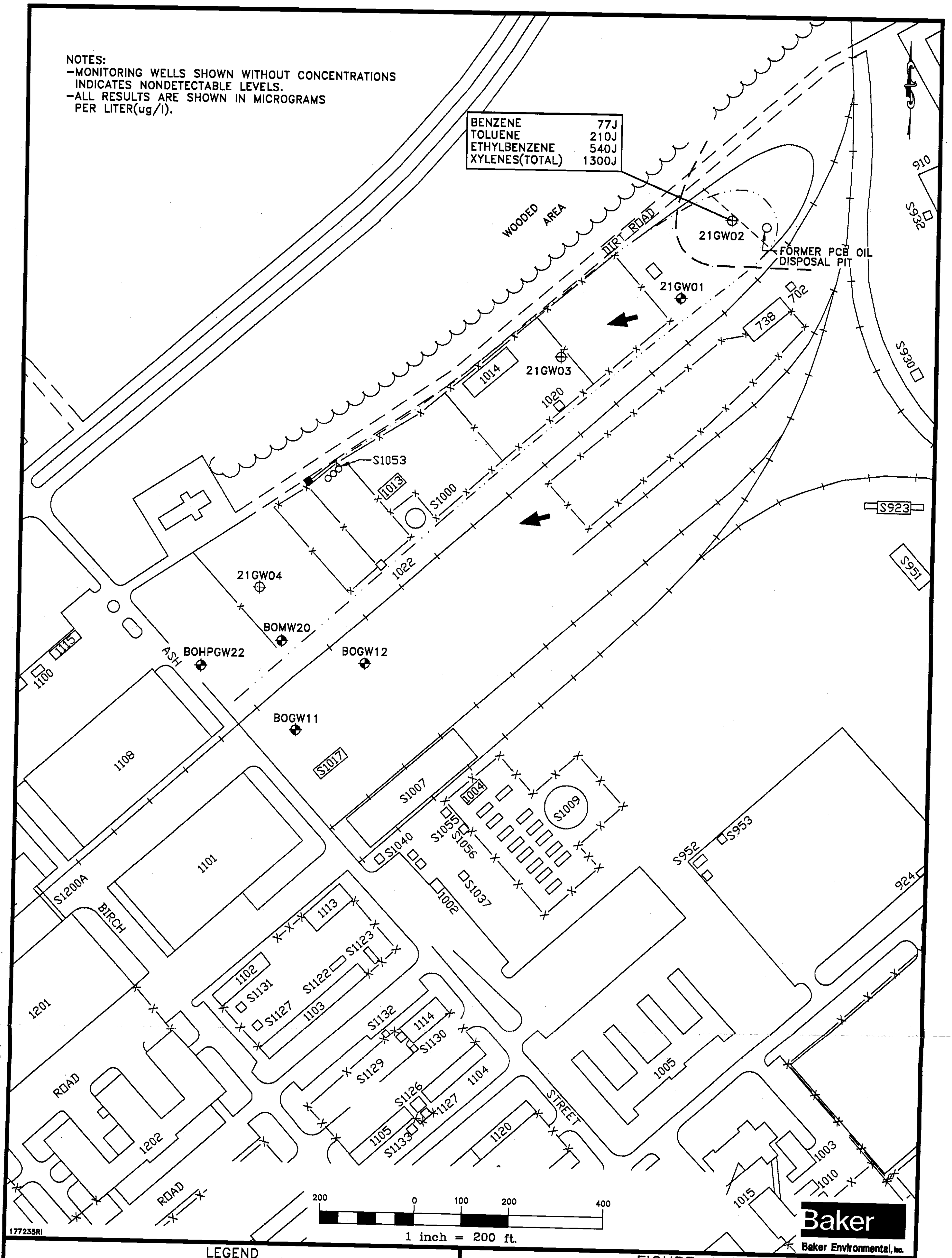
*Polychlorinated Biphenyls*

PCBs are present in surface soils within both the Former PCB Transformer Disposal Area and Former Pesticide Mixing/Disposal Area at Site 21. PCBs were not detected in any subsurface samples. As shown on Figure 4-1, the highest PCB concentrations are detected in borings 21PCBSB19 (4,600 J µg/kg), 21PCBSB18 (3,700 µg/kg), and 21PCBSB17 (4,300 µg/kg) which are all located near the northeastern portion of the site within the Former PCB Transformer Disposal Area. The source of the PCBs in this area are most likely related to the reported PCB disposal activities or leakage of PCB fluids (i.e., dielectric fluids) from transformers. Additionally, borings 21PSTSB01 (2,200 µg/kg) and 21PSTSB02 (940 J µg/kg), which are located within the Former Pesticide Mixing/Disposal Area, also had detections of PCBs. The source of the PCBs in this area may be related to leaking transformer rather than direct disposal since there is no history of disposal in the area. Overall, the extent of the PCB contaminated soils at Site 21 is limited to surface soils at the two main areas identified above.

#### 4.3.1.2 Extent of Groundwater Contamination at Site 21

Analytical data indicated that groundwater at Site 21 is not significantly impacted by organic compounds (BTEX or halogenated compounds). Of the eight wells sampled, only wells 21GW02 and 21GW03 indicated levels of detectable organics. As shown on Figure 4-3, concentrations of benzene (77 J µg/l), toluene (210 J µg/l), ethylbenzene (540 J µg/l), and xylenes (1,300 J µg/l) were detected in well 21GW02. TCE (41 J µg/l) was also detected in 21GW02 as depicted on Figure 4-4. The only compound detected in 21GW03 was dichloromethane (2.0 ug/l).

The extent of the plume has not been fully evaluated north, east, and west of well 21GW02 since there are no wells in these areas. The closest well to the north (approximately 500 feet)


NOTES:
- MONITORING WELLS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS.
- ALL RESULTS ARE SHOWN IN MICROGRAMS PER LITER(ug/l).

| | |
|---|---|
| BENZENE | 77J |
| TOLUENE | 210J |
| ETHYLBENZENE | 540J |
| XYLENES(TOTAL) | 1300J |

LEGEND

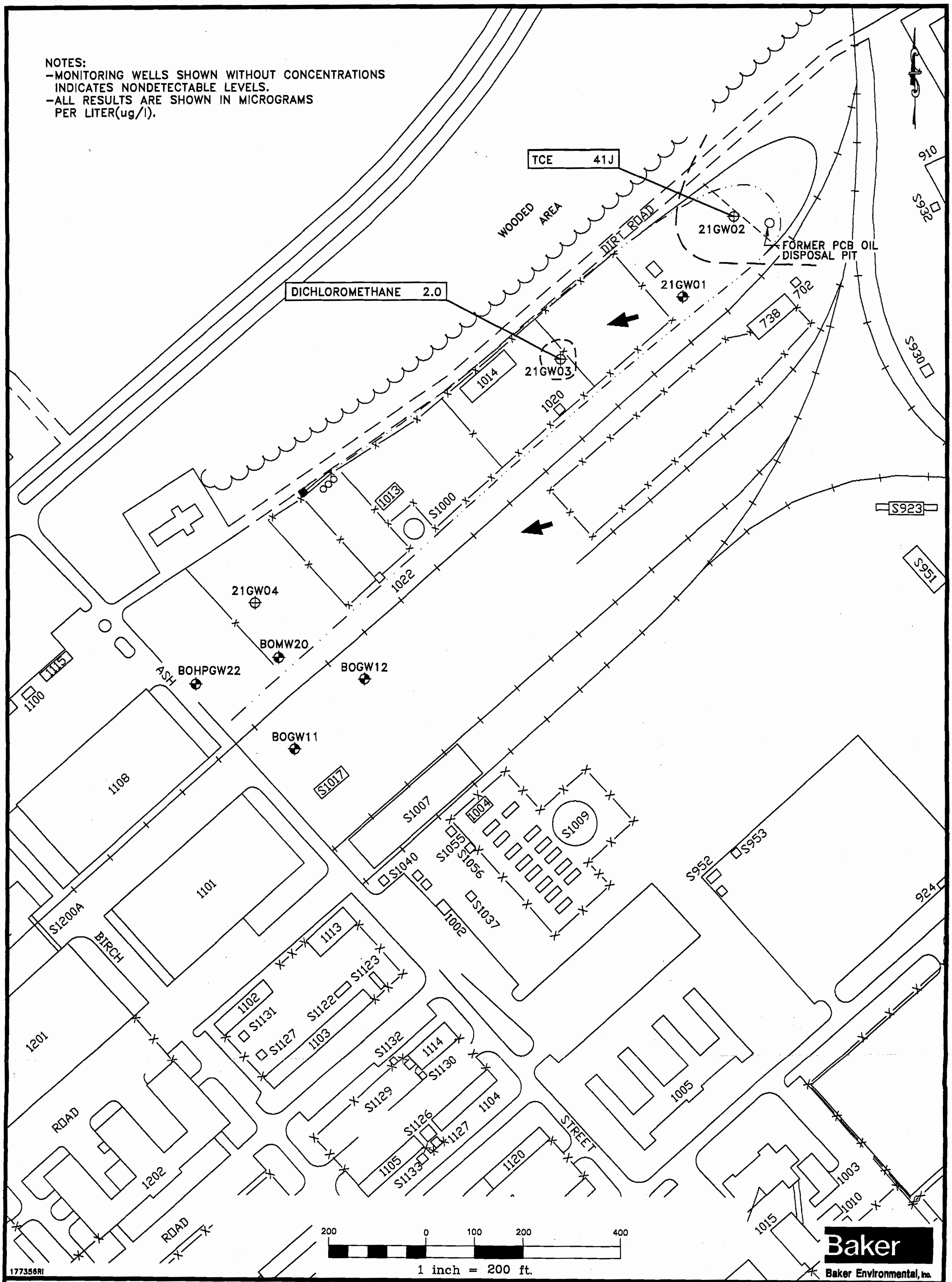
| | |
|---|---|
| 21GW01 ⊕ | EXISTING SHALLOW MONITORING WELL |
| 21GW02 ⊕ | NEWLY INSTALLED SHALLOW MONITORING WELL |
| ➔ | APPROXIMATE DIRECTION OF GROUNDWATER FLOW |
| – – – | ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION |

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-3
POSITIVE DETECTIONS OF BENZENE, TOLUENE ETHYLBENZENE, AND XYLENES (BTEX)
IN SHALLOW WELLS
SITE 21
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00522WB2Z

NOTES:
-MONITORING WELLS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS.
-ALL RESULTS ARE SHOWN IN MICROGRAMS PER LITER(ug/l).



LEGEND

21GW01 EXISTING SHALLOW MONITORING WELL

21GW02 NEWLY INSTALLED SHALLOW MONITORING WELL

➜ APPROXIMATE DIRECTION OF GROUNDWATER FLOW

– – – ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-4
POSITIVE DETECTIONS OF HALOGENATED COMPOUNDS IN SHALLOW WELLS
SITE 21
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

is 78GW24-1, and the closest well to the east (approximately 475 feet) is 78GW23 (both of these are Site 78 wells). Both of these wells exhibited elevated levels of VOCs as discussed in Section 4.2.3.2. The data suggests that the volatiles have migrated onto Site 21 from an off-site source (Site 78) since there does appear to be a source of VOCs at Site 21 (i.e., releases of solvent or petroleum fuels). This conclusion is further supported by the fact that on-site downgradient wells from 21GW02 did not exhibit significant levels of VOCs (well 21GW03 had 2.0 µg/l of dichloromethane), and that soil samples collected in the vicinity of Well 21GW02 did not exhibit concentrations of VOCs.

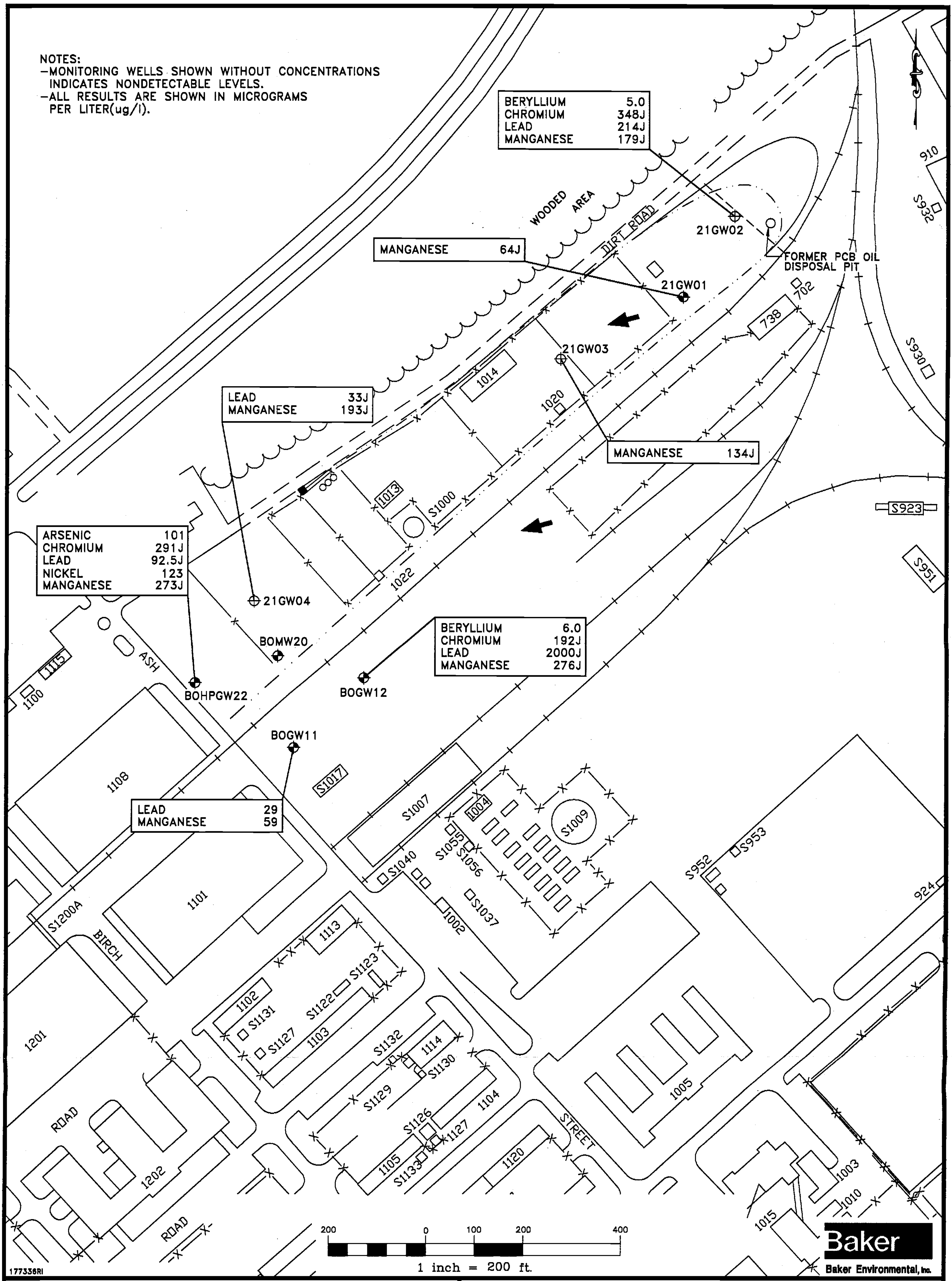
TAL metals were detected in seven of the eight wells sampled at concentrations above the Federal MCLs and/or the NCWQS (Figure 4-5). The overall distribution of the metals in groundwater do not depict a particular trend since they are fairly widespread throughout the site. Manganese and lead were also detected in soils at Site 21 as well as within soils collected throughout the entire operable unit. The highest concentrations of manganese and lead were detected in well BOGW12 which is a well located outside the site boundary. The highest levels of beryllium and chromium were detected in well 21GW02 (near Former PCB oil pit). The highest levels of arsenic and nickel were detected in BOHPGW22 which is located near Ash Street.

### 4.3.1.3 Extent of Surface Water and Sediment Contamination at Site 21

Pesticides, PCBs, and inorganics have been detected in Site 21 surface water and sediments. Figure 4-6 displays the concentrations of organic compounds in surface water and sediments at the site. A discussion of the extent of contamination with respect to pesticides and PCBs follows. As discussed ion Section 4.2.1.3, no metals detected in the surface water samples collected at Site 21 exceeded freshwater WQSs or WQSVs. With respect to Site 21 sediments, lead was the only metal detected at a concentration above an ER-L. Lead exceeded the ER-L in only one sample. Therefore, the extent of metals contamination in Site 21 surface water and sediments will not be addressed.

*Pesticides*

Pesticides were present in one surface water sample and throughout Site 21 in 20 sediment samples. As depicted on Figure 4-6, although pesticides were found throughout the site, the highest concentrations of pesticides were found at sample locations 21-DD-SD04, 21-DD-



NOTES:
- MONITORING WELLS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS.
- ALL RESULTS ARE SHOWN IN MICROGRAMS PER LITER(ug/l).

LEGEND

21GW01 ⊕ EXISTING SHALLOW MONITORING WELL

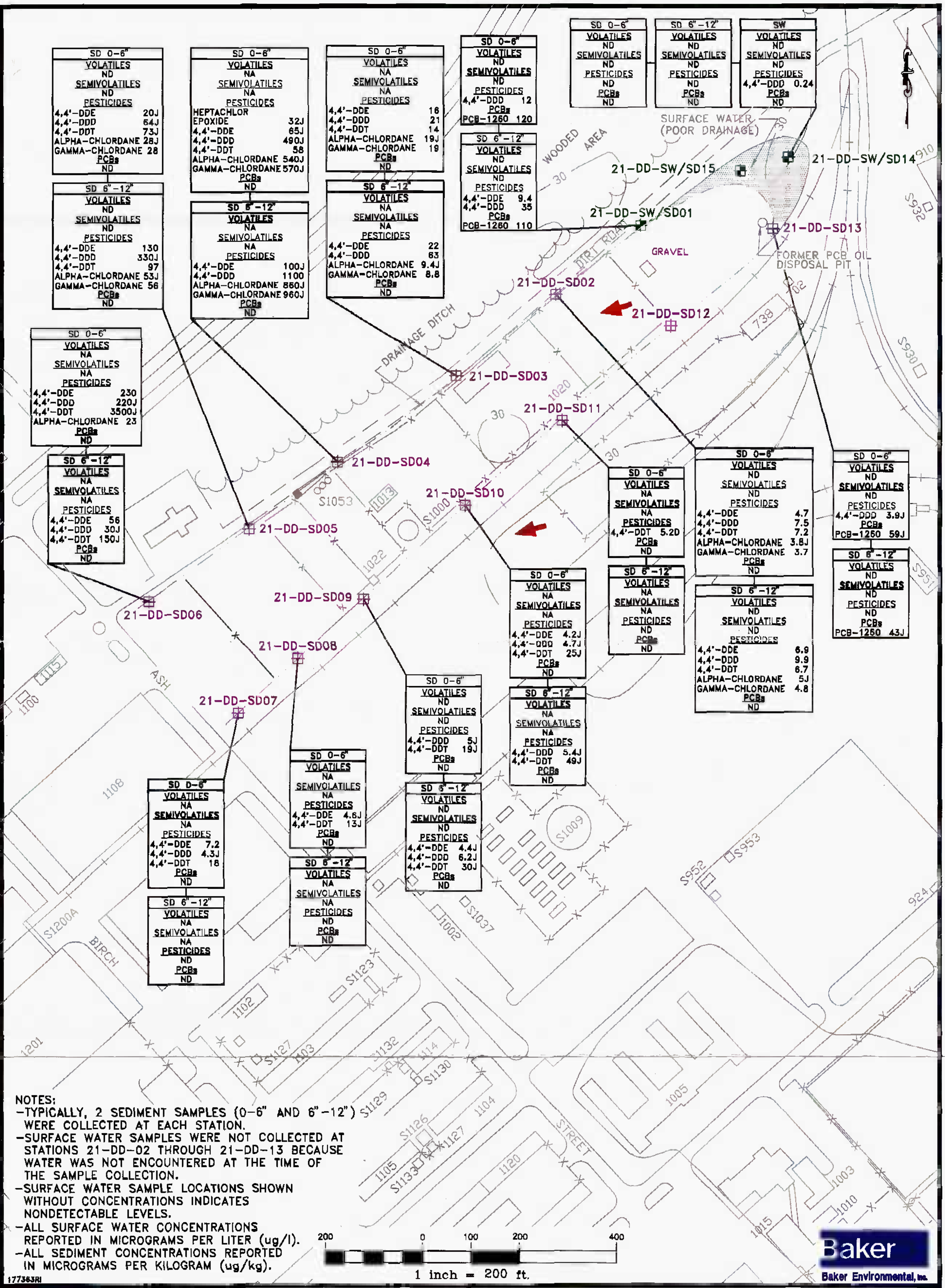
21GW02 ⊕ NEWLY INSTALLED SHALLOW MONITORING WELL

➡ APPROXIMATE DIRECTION OF GROUNDWATER FLOW

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-5
POSITIVE DETECTIONS OF TAL METALS ABOVE
FEDERAL MCLs AND/OR NCWQS IN SHALLOW WELLS
SITE 21
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00522W012



NOTES:
- TYPICALLY, 2 SEDIMENT SAMPLES (0-6" AND 6"-12") WERE COLLECTED AT EACH STATION.
- SURFACE WATER SAMPLES WERE NOT COLLECTED AT STATIONS 21-DD-02 THROUGH 21-DD-13 BECAUSE WATER WAS NOT ENCOUNTERED AT THE TIME OF THE SAMPLE COLLECTION.
- SURFACE WATER SAMPLE LOCATIONS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS.
- ALL SURFACE WATER CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ug/l).
- ALL SEDIMENT CONCENTRATIONS REPORTED IN MICROGRAMS PER KILOGRAM (ug/kg).

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LEGEND

| | |
|---|---|
| 21-DD-SW/SD01 ⊞ | SURFACE WATER(SW)/SEDIMENT(SD) SAMPLE STATION |
| 21-DD-SD02 ⊞ | SEDIMENT(SD) SAMPLE STATION ONLY |
| ➡ | APPROXIMATE GROUNDWATER FLOW DIRECTION |
| ND | NOT DETECTED |
| NA | NOT ANALYZED |

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-6
POSITIVE DETECTIONS OF ORGANIC COMPOUNDS IN SURFACE WATER AND SEDIMENTS
SITE 21
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

SD05, and 21-DD-SD06. These locations are located downgradient of the Former Pesticide Mixing/Disposal Area, along the southwestern portion of the site.

*Polychlorinated Biphenols*

PCBs were present at two sediment sample locations within Site 21: 21-DD-SD01 and 21-DD-SD13. Both of these sample locations are near the northeastern portion of the site near the Former PCB Transformer Disposal Area. PCBs were detected at both sample intervals (0 to 6 inches and 6 to 12 inches) at both sample locations. The highest detected concentration of PCBs was found in sample 21-DD-SD01-06, which had a PCB-1260 concentration of 120 µg/kg.

### 4.3.2 Site 24 Extent of Contamination

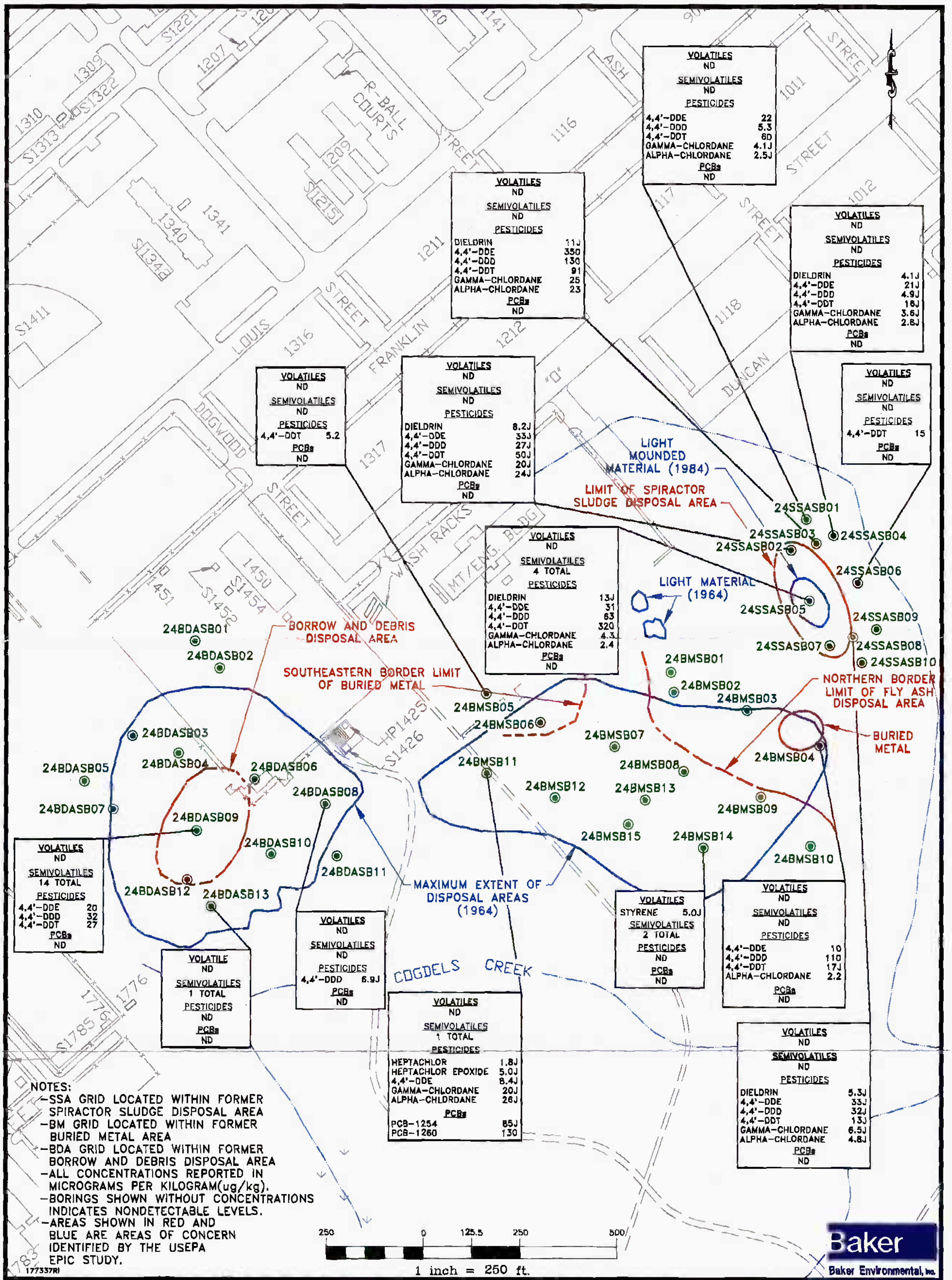
The following sections discuss the extent of contamination at Site 24 with respect to soil and groundwater. Test pit results are included as part of the subsurface soil discussion. Note that surface water and sediment samples collected in Cogdels Creek, which were located adjacent to Site 24, will be discussed under Site 78 since the headwaters of the stream are located within Site 78.

#### 4.3.2.1 Extent of Soil Contamination at Site 24

Organics and inorganics have been detected within Site 24 soils. Figures 4-7 and 4-8 display the concentrations of organic compounds detected in the surface and subsurface soils at the site, respectively.

*Volatiles*

VOCs were not extensively found in either surface or subsurface soils at Site 24. Styrene was found in one surface sample from boring 24BMSB14 at 5.0 J µg/kg (Figure 4-7). TCE was detected in test pit samples (less than 5 feet), 24TP01 at a concentration of 7.0 J µg/kg and 24TP05 at a concentration of 2.0 J µg/kg.



**VOLATILES**
ND
**SEMIVOLATILES**
ND
**PESTICIDES**

| | |
|---|---|
| 4,4'-DDE | 22 |
| 4,4'-DDD | 5.3 |
| 4,4'-DDT | 60 |
| GAMMA-CHLORDANE | 4.1J |
| ALPHA-CHLORDANE | 2.5J |

**PCBs**
ND

**VOLATILES**
ND
**SEMIVOLATILES**
ND
**PESTICIDES**

| | |
|---|---|
| DIELDRIN | 11J |
| 4,4'-DDE | 350 |
| 4,4'-DDD | 130 |
| 4,4'-DDT | 91 |
| GAMMA-CHLORDANE | 25 |
| ALPHA-CHLORDANE | 23 |

**PCBs**
ND

**VOLATILES**
ND
**SEMIVOLATILES**
ND
**PESTICIDES**

| | |
|---|---|
| DIELDRIN | 4.1J |
| 4,4'-DDE | 21J |
| 4,4'-DDD | 4.9J |
| 4,4'-DDT | 18J |
| GAMMA-CHLORDANE | 3.6J |
| ALPHA-CHLORDANE | 2.8J |

**PCBs**
ND

**VOLATILES**
ND
**SEMIVOLATILES**
ND
**PESTICIDES**

| | |
|---|---|
| 4,4'-DDT | 15 |

**PCBs**
ND

**VOLATILES**
ND
**SEMIVOLATILES**
ND
**PESTICIDES**

| | |
|---|---|
| 4,4'-DDT | 5.2 |

**PCBs**
ND

**VOLATILES**
ND
**SEMIVOLATILES**
ND
**PESTICIDES**

| | |
|---|---|
| DIELDRIN | 8.2J |
| 4,4'-DDE | 33J |
| 4,4'-DDD | 27J |
| 4,4'-DDT | 50J |
| GAMMA-CHLORDANE | 20J |
| ALPHA-CHLORDANE | 24J |

**PCBs**
ND

**VOLATILES**
ND
**SEMIVOLATILES**
4 TOTAL
**PESTICIDES**

| | |
|---|---|
| DIELDRIN | 13J |
| 4,4'-DDE | 31 |
| 4,4'-DDD | 63 |
| 4,4'-DDT | 320 |
| GAMMA-CHLORDANE | 4.3 |
| ALPHA-CHLORDANE | 2.4 |

**PCBs**
ND

**VOLATILES**
ND
**SEMIVOLATILES**
14 TOTAL
**PESTICIDES**

| | |
|---|---|
| 4,4'-DDE | 20 |
| 4,4'-DDD | 32 |
| 4,4'-DDT | 27 |

**PCBs**
ND

**VOLATILE**
ND
**SEMIVOLATILES**
1 TOTAL
**PESTICIDES**
ND
**PCBs**
ND

**VOLATILES**
ND
**SEMIVOLATILES**
ND
**PESTICIDES**

| | |
|---|---|
| 4,4'-DDD | 6.9J |

**PCBs**
ND

**VOLATILES**
ND
**SEMIVOLATILES**
1 TOTAL
**PESTICIDES**

| | |
|---|---|
| HEPTACHLOR | 1.8J |
| HEPTACHLOR EPOXIDE | 5.0J |
| 4,4'-DDE | 8.4J |
| GAMMA-CHLORDANE | 20J |
| ALPHA-CHLDRDANE | 26J |

**PCBs**

| | |
|---|---|
| PCB-1254 | 85J |
| PCB-1260 | 130 |

**VOLATILES**

| | |
|---|---|
| STYRENE | 5.0J |

**SEMIVOLATILES**
2 TOTAL
**PESTICIDES**
ND
**PCBs**
ND

**VOLATILES**
ND
**SEMIVOLATILES**
ND
**PESTICIDES**

| | |
|---|---|
| 4,4'-DDE | 10 |
| 4,4'-DDD | 110 |
| 4,4'-DDT | 17J |
| ALPHA-CHLORDANE | 2.2 |

**PCBs**
ND

**VOLATILES**
ND
**SEMIVOLATILES**
ND
**PESTICIDES**

| | |
|---|---|
| DIELDRIN | 5.3J |
| 4,4'-DDE | 33J |
| 4,4'-DDD | 32J |
| 4,4'-DDT | 13J |
| GAMMA-CHLORDANE | 6.5J |
| ALPHA-CHLORDANE | 4.8J |

**PCBs**
ND

NOTES:
- SSA GRID LOCATED WITHIN FORMER SPIRACTOR SLUDGE DISPOSAL AREA
- BM GRID LOCATED WITHIN FORMER BURIED METAL AREA
- BDA GRID LOCATED WITHIN FORMER BORROW AND DEBRIS DISPOSAL AREA
- ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER KILOGRAM(ug/kg).
- BORINGS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS.
- AREAS SHOWN IN RED AND BLUE ARE AREAS OF CONCERN IDENTIFIED BY THE USEPA EPIC STUDY.

177337RI

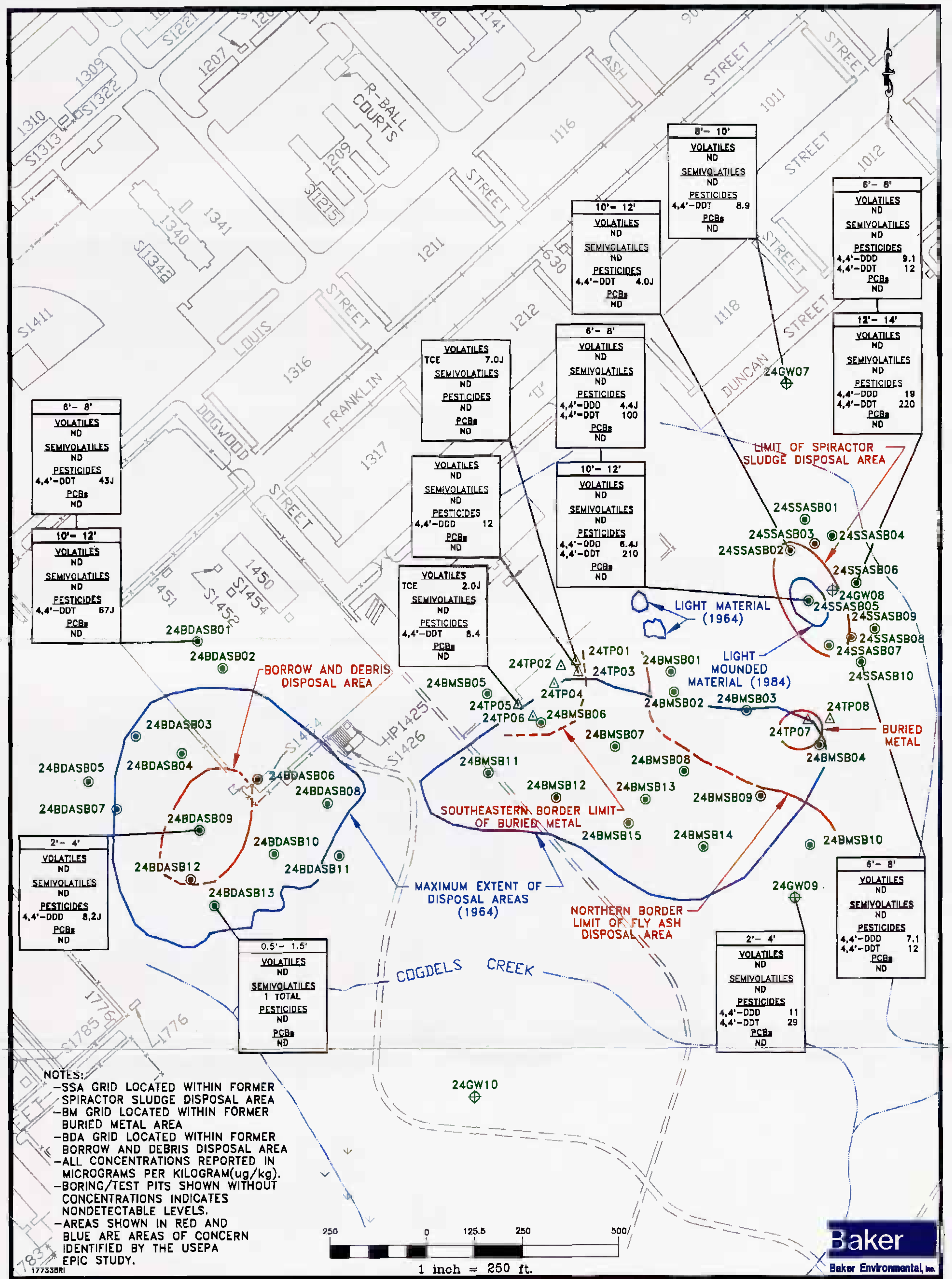
LEGEND

| | |
|---|---|
| 24BDASB01 ● | SOIL BORING |
| ND | NOT DETECTED |

SOURCE: LANTDIV, FEBRUARY 1992

# FIGURE 4-7
# POSITIVE DETECTIONS OF ORGANIC COMPOUNDS IN SURFACE SOILS
# SITE 24
# REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00522WB3V



NOTES:
- SSA GRID LOCATED WITHIN FORMER SPIRACTOR SLUDGE DISPOSAL AREA
- BM GRID LOCATED WITHIN FORMER BURIED METAL AREA
- BDA GRID LOCATED WITHIN FORMER BORROW AND DEBRIS DISPOSAL AREA
- ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER KILOGRAM(ug/kg).
- BORING/TEST PITS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS.
- AREAS SHOWN IN RED AND BLUE ARE AREAS OF CONCERN IDENTIFIED BY THE USEPA EPIC STUDY.

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LEGEND

| | |
|---|---|
| 24BDASB01 ● | SOIL BORING |
| 24GW07 ⊕ | SOIL BORING ADVANCED FOR MONITORING WELL |
| 24TP01 △ | TEST PIT SAMPLE |
| ND | NOT DETECTED |

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-8
POSITIVE DETECTIONS OF ORGANIC COMPOUNDS IN SUBSURFACE SOILS
SITE 24
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

### *Semivolatiles*

Concentrations of SVOCs were only identified in five surface samples and one subsurface sample. The most frequent detections (14 total) and the highest concentrations (68 J to 870 µg/kg) of SVOCs were exhibited in a surface sample collected from boring 24BDASB09. As shown on Figure 4-7, this boring is located near the southwestern portion of Site 24 within the Borrow and Debris Disposal Area (samples specified with a "BDA" prefix). Note that borings located adjacent to 24BDASB09 exhibited either very low or nondetectable levels of SVOCs. In addition, the subsurface soil samples collected from 24BDASB09 did not contain detectable SVOCs. The subsurface soil sample collected from boring 24BDASB13 detected fluoranthene at 45 J µg/kg at a depth of 1.5 feet. This boring is located near the southern boundary of the Borrow and Debris Disposal Area.

### *Pesticides*

Pesticides were present in surface soils at predominantly one main area of the site with some random detections throughout. As depicted on Figure 4-7, the highest concentrations of pesticides were detected near the northeastern portion of the site within the Spiractor Sludge Disposal Area (samples specified with a "SSA" prefix). Samples from borings 24SSASB03 and 24SSASB05 exhibited the highest concentrations of pesticides (as high as 350 µg/kg).

The subsurface soils at Site 24 are less impacted by pesticides compared to surface soils, as shown on Figure 4-8. Overall, the most impacted subsurface soils are situated near the northeastern portion (borings 24SSASB05, and 24SSASB06) of the site which is also where the most impacted surface soil were found. Pesticides were detected in soils to a depth of 10 to 14 feet in borings 24SSASB05 [4,4'-DDD (6.4 J µg/kg) and 4,4'-DDT (210 µg/kg)], and 24SSASB06 [4,4'-DDD (19 µg/kg) and 4,4'-DDT (220 µg/kg)].

### *Polychlorinated Biphenyls*

PCB-1254 (85 J µg/kg) and PCB-1260 (130 µg/kg) were detected in one boring (surface sample at 24BMSB11). This boring is located near the western boundary of the Buried Metals Area (Figure 4-7). The extent of the PCB impacted soil appears to be limited to this area since borings adjacent to 24BMSB11 did not exhibit levels of PCBs. Furthermore, the PCBs are limited to the surface soil. No other detections of PCBs in Site 24 soils were identified.

*Inorganics*

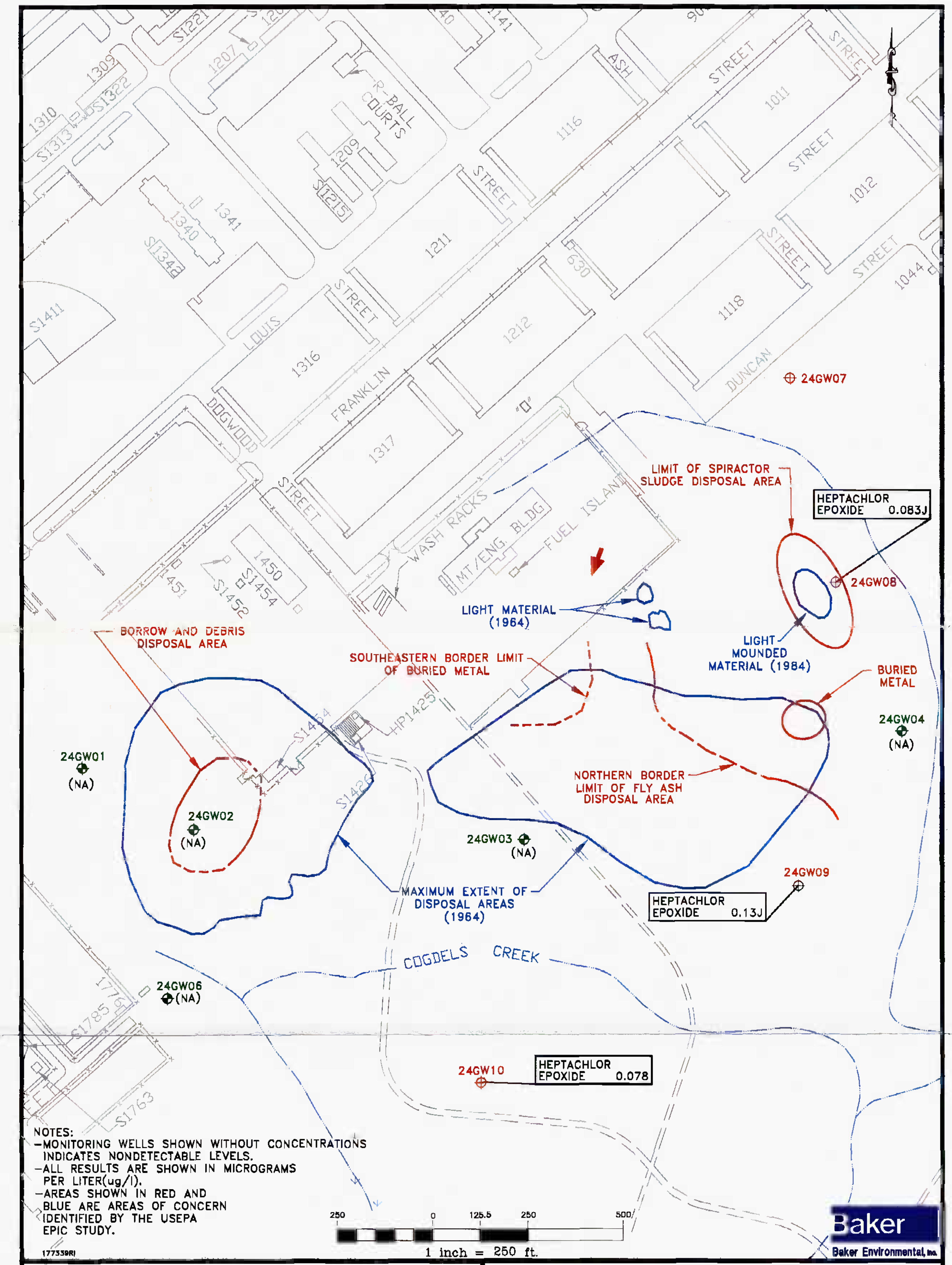
As discussed in Section 4.2.2.1, inorganics are present in both surface and subsurface soils at Site 24, particularly within the Buried Metal Area. The most frequently detected metals with the highest overall concentrations (an order of one magnitude or higher) above base-specific background were detected at borings 24BMSB03, 24BMSB06, and 24BMSB07 through 24BMSB11. These borings are located throughout the central portion of the Buried Metal Area. Note that inorganic results are not displayed on any figures due to the extensive list of detectable metals for each boring. The metals exhibiting elevated concentrations (i.e., above surface base-specific background) included: aluminum, barium, calcium, chromium, copper, iron, manganese, and nickel. The data indicates that these elevated metals are limited to soils within the Buried Metal Area.

Subsurface soils are also impacted by metals within the Buried Metal Area. The borings which exhibited the most frequent detections with the highest concentrations (i.e., above subsurface base-specific background) were 24BMSB06 (8 to 12 feet), 24BMSB07 (8 to 10 feet), 24BMSB08 (6 to 8 feet), 24BMSB10 (4 to 6 feet), and 24BMSB11 (12 to 16 feet). The metals which exhibited elevated concentrations included: barium, copper, iron, manganese, nickel, selenium, and cyanide. These metals were detected to depths between 4 to 16 feet.

### 4.3.2.2 Extent of Groundwater Contamination at Site 24

Very limited organic contamination was detected in the groundwater samples collected within Site 24. Note that only the wells installed during this RI (24GW07, 24GW08, 24GW09, and 24GW10) were analyzed for organics. Based on the results from these four wells, heptachlor epoxide was the only organic compounds detected in groundwater at Site 24. As shown on Figure 4-9, heptachlor epoxide was detected in wells 24GW08 (0.083 J µg/l), 24GW09 (0.13 J µg/l), and 24GW10 (0.078 µg/l). These levels slightly exceeded the NCWQS of 0.038 µg/l. These wells, in general, are situated along the eastern portion of Site 24 where pesticides were also detected in soils. Site background well 24GW07, which is located north of Site 24, did not exhibit any organic concentrations.

TAL metals at concentrations above the Federal MCLs and/or NCWQS were detected in seven of the nine wells (samples from wells 24GW07 and 24GW10 did not exceed the criteria) sampled at the site. As shown on Figure 4-10, the highest levels of metals were detected in the wells within and near the Borrow and Debris Disposal Area and east of the Buried Metal Area.



NOTES:
- MONITORING WELLS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS.
- ALL RESULTS ARE SHOWN IN MICROGRAMS PER LITER(ug/l).
- AREAS SHOWN IN RED AND BLUE ARE AREAS OF CONCERN IDENTIFIED BY THE USEPA EPIC STUDY.

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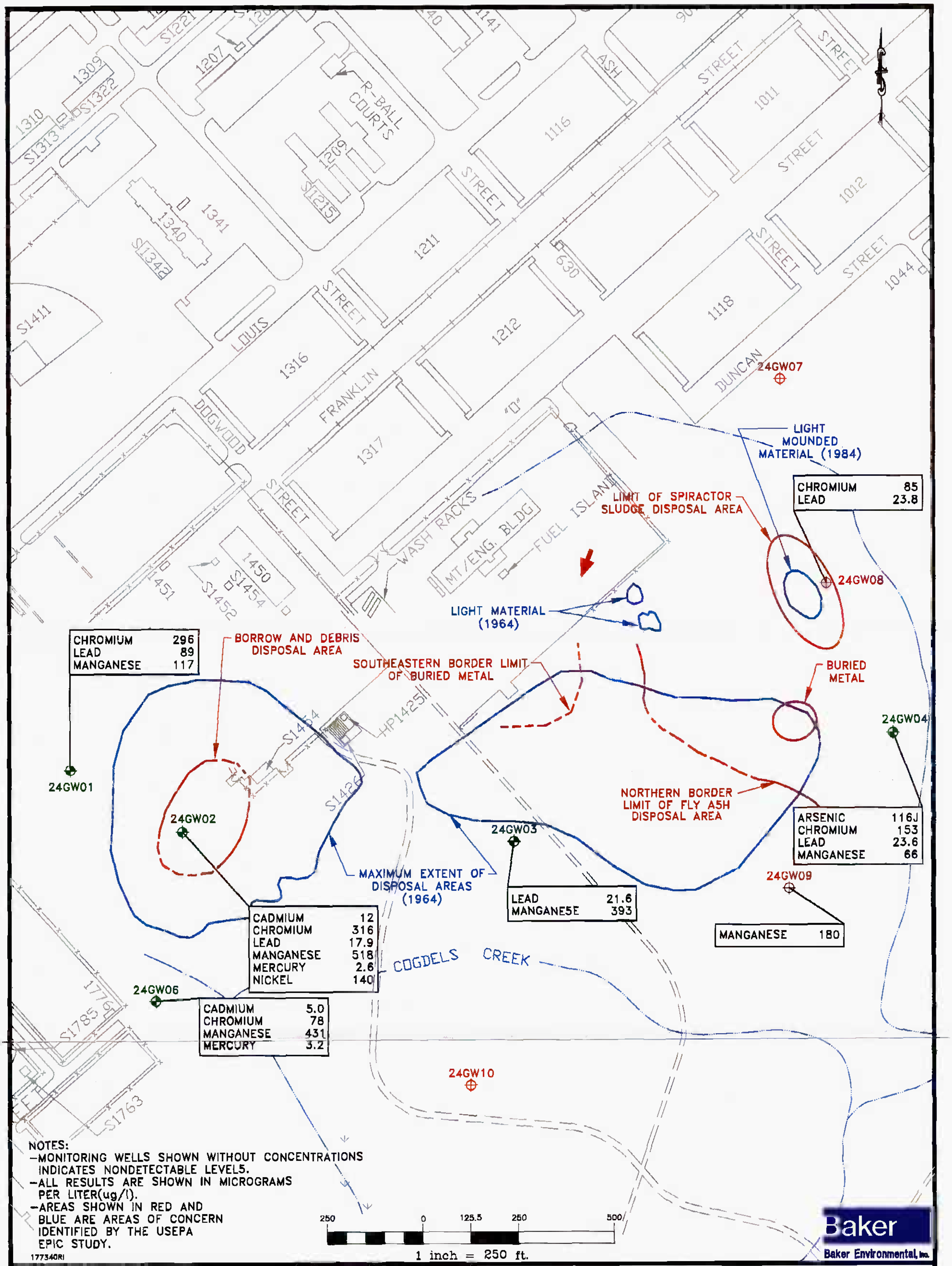
LEGEND

| | |
|---|---|
| 24GW01 ⊕ | EXISTING SHALLOW MONITORING WELL |
| 24GW07 ⊕ | SHALLOW MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC. |
| ➔ | APPROXIMATE DIRECTION OF GROUNDWATER FLOW |
| (NA) | NOT ANALYZED FOR PESTICIDES |

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-9
POSITIVE DETECTIONS OF PESTICIDES
IN SHALLOW WELLS
SITE 24
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00622WB4V



NOTES:
- MONITORING WELLS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS.
- ALL RESULTS ARE SHOWN IN MICROGRAMS PER LITER(ug/l).
- AREAS SHOWN IN RED AND BLUE ARE AREAS OF CONCERN IDENTIFIED BY THE USEPA EPIC STUDY.

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Baker Environmental, Inc.

LEGEND

| | |
|---|---|
| 24GW01 ⊕ | EXISTING SHALLOW MONITORING WELL |
| 24GW07 ⊕ | SHALLOW MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC. |
| ➡ | APPROXIMATE DIRECTION OF GROUNDWATER FLOW |

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-10
POSITIVE DETECTIONS OF TAL METALS
ABOVE FEDERAL MCLs AND/OR NCWQS
SITE 24
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Metals exhibiting elevated concentrations included: arsenic (116 µg/l), cadmium (5 to 12 µg/l), chromium (78 to 316 µg/l), lead (17.9 to 89 µg/l), manganese (66 to 518 µg/l), mercury (2.6 to 3.2 µg/l) and nickel (140 µg/l. These metals were also elevated in soils as discussed in Section 4.2.2.2. The source of the metals is believed to be related to the disposal of various metal debris and fly ash.

### 4.3.3 Site 78 Extent of Contamination

The following sections discuss the extent of contamination at Site 78 with respect to soil, groundwater, surface water, and sediment.

#### 4.3.3.1 Extent of Soil Contamination at Site 78

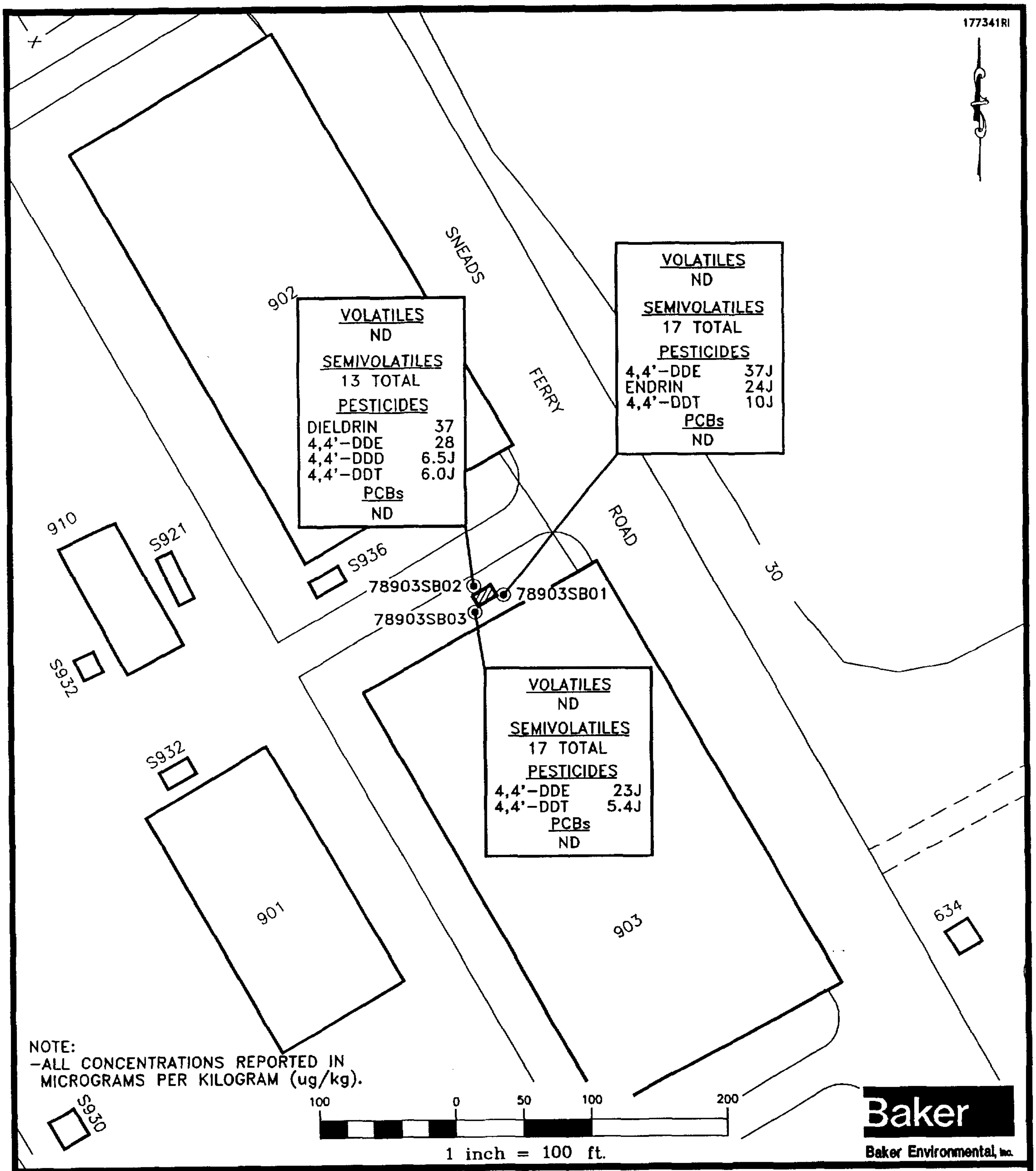
As with the other two sites within OU No 1, the soils within Site 78 exhibited detectable levels of both organics and inorganics. Positive detections of organic compounds at Buildings 903, 1103, 1300, 1502, 1601, and 1608 are depicted on Figures 4-11 through 4-18 for surface and subsurface soils. Note that the inorganic results are not displayed on any figures due to the extensive list of detectable metals for each boring. A summary of the extent of contamination at each building area investigated during this RI is presented below.

*Building 903*

Analytical data indicated that organic compounds, (i.e., VOCs, SVOCs and pesticides) are the predominant contaminants impacting soils at Building 903. Accordingly, only the extent of these contaminants will be at this site.

*Volatiles*

VOCs were not detected in any surface soil samples collected at Building 903. Low concentrations (16 µg/kg or less) of 1,2-DCE were detected in subsurface soils collected from borings 78B903SB02 (5 to 6 feet) and 78B903SB03 (4 to 5 feet). These borings are located along the northern and southern corners of the tank as shown on Figure 4-12. The source of the 1,2-DCE may be related to historical spills at the tank or solvent usage at the building.



VOLATILES
ND
SEMIVOLATILES
13 TOTAL
PESTICIDES

| | |
|---|---|
| DIELDRIN | 37 |
| 4,4'-DDE | 28 |
| 4,4'-DDD | 6.5J |
| 4,4'-DDT | 6.0J |

PCBs
ND

VOLATILES
ND
SEMIVOLATILES
17 TOTAL
PESTICIDES

| | |
|---|---|
| 4,4'-DDE | 37J |
| ENDRIN | 24J |
| 4,4'-DDT | 10J |

PCBs
ND

VOLATILES
ND
SEMIVOLATILES
17 TOTAL
PESTICIDES

| | |
|---|---|
| 4,4'-DDE | 23J |
| 4,4'-DDT | 5.4J |

PCBs
ND

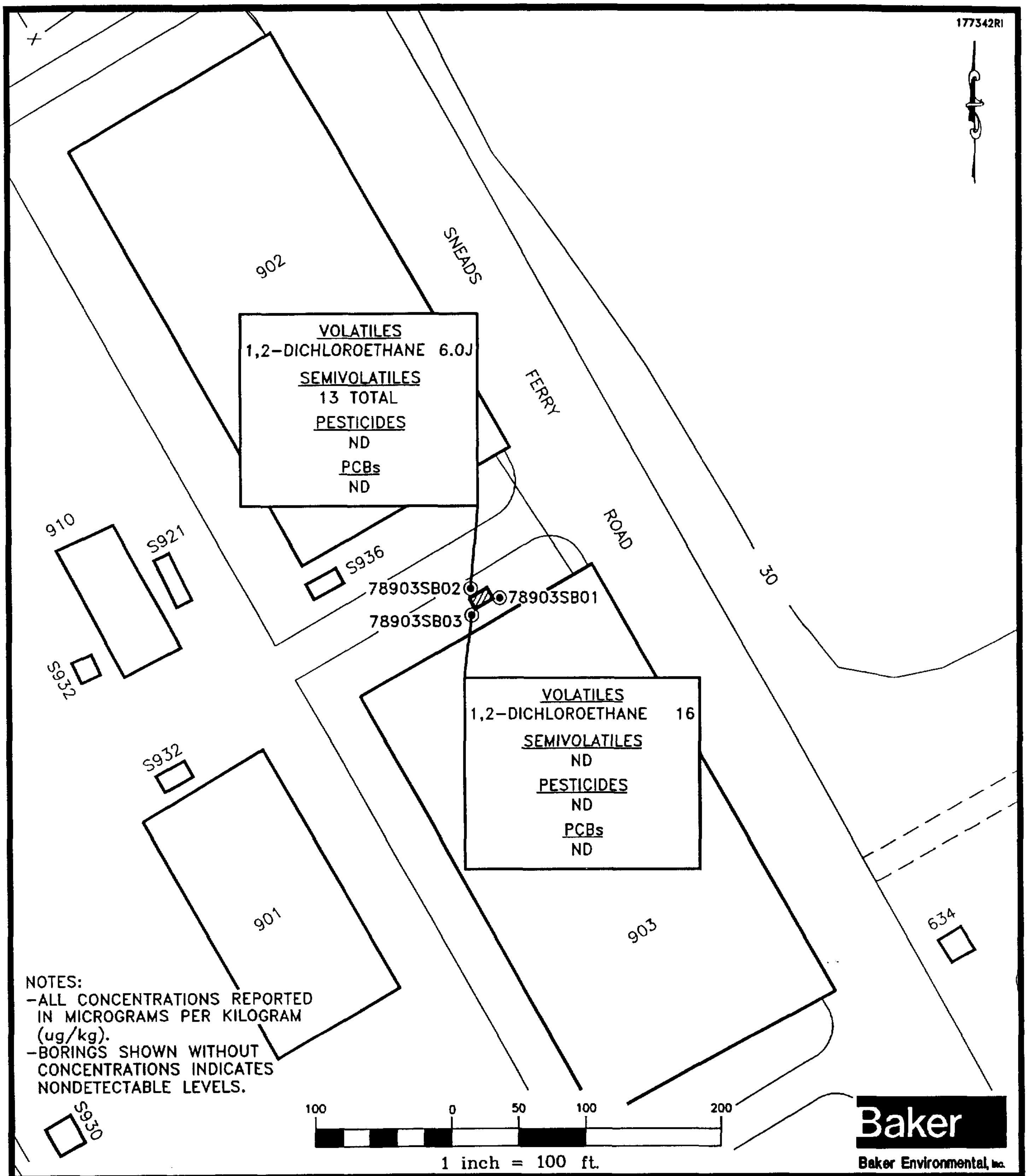
NOTE:
-ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER KILOGRAM (ug/kg).

LEGEND

| | |
|---|---|
| ▨ | SUSPECTED TANK AREA |
| 78903SB01 ◉ | SOIL BORING |
| ND | NOT DETECTED |

SOURCE: LANTDIV, FEB. 1992

FIGURE 4-11
POSITIVE DETECTIONS OF ORGANIC COMPOUNDS IN SURFACE SOILS
BUILDING 903
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



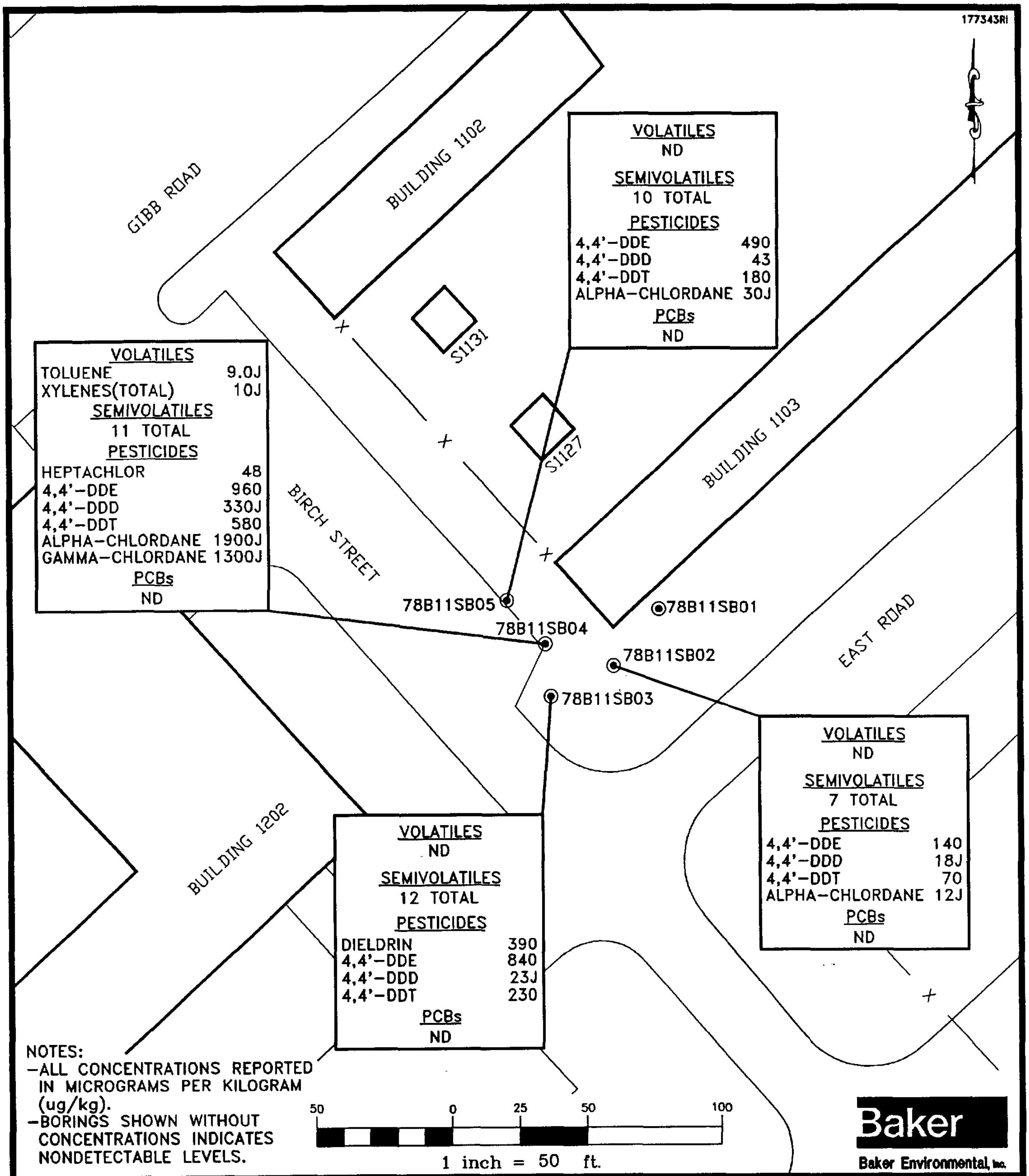
NOTES:
- ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER KILOGRAM (ug/kg).
- BORINGS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS.

LEGEND

| | |
|---|---|
| ▨ | SUSPECTED TANK AREA |
| 78903SB01 ◉ | SOIL BORING |
| ND | NOT DETECTED |

SOURCE: LANTDIV, FEB. 1992

FIGURE 4-12
POSITIVE DETECTIONS OF ORGANIC COMPOUNDS IN SUBSURFACE SOILS
BUILDING 903
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



78B11SB05

VOLATILES
ND

SEMIVOLATILES
10 TOTAL

| PESTICIDES | |
|---|---|
| 4,4'-DDE | 490 |
| 4,4'-DDD | 43 |
| 4,4'-DDT | 180 |
| ALPHA-CHLORDANE | 30J |

PCBs
ND

78B11SB04

| VOLATILES | |
|---|---|
| TOLUENE | 9.0J |
| XYLENES(TOTAL) | 10J |

SEMIVOLATILES
11 TOTAL

| PESTICIDES | |
|---|---|
| HEPTACHLOR | 48 |
| 4,4'-DDE | 960 |
| 4,4'-DDD | 330J |
| 4,4'-DDT | 580 |
| ALPHA-CHLORDANE | 1900J |
| GAMMA-CHLORDANE | 1300J |

PCBs
ND

78B11SB02

VOLATILES
ND

SEMIVOLATILES
7 TOTAL

| PESTICIDES | |
|---|---|
| 4,4'-DDE | 140 |
| 4,4'-DDD | 18J |
| 4,4'-DDT | 70 |
| ALPHA-CHLORDANE | 12J |

PCBs
ND

78B11SB03

VOLATILES
ND

SEMIVOLATILES
12 TOTAL

| PESTICIDES | |
|---|---|
| DIELDRIN | 390 |
| 4,4'-DDE | 840 |
| 4,4'-DDD | 23J |
| 4,4'-DDT | 230 |

PCBs
ND

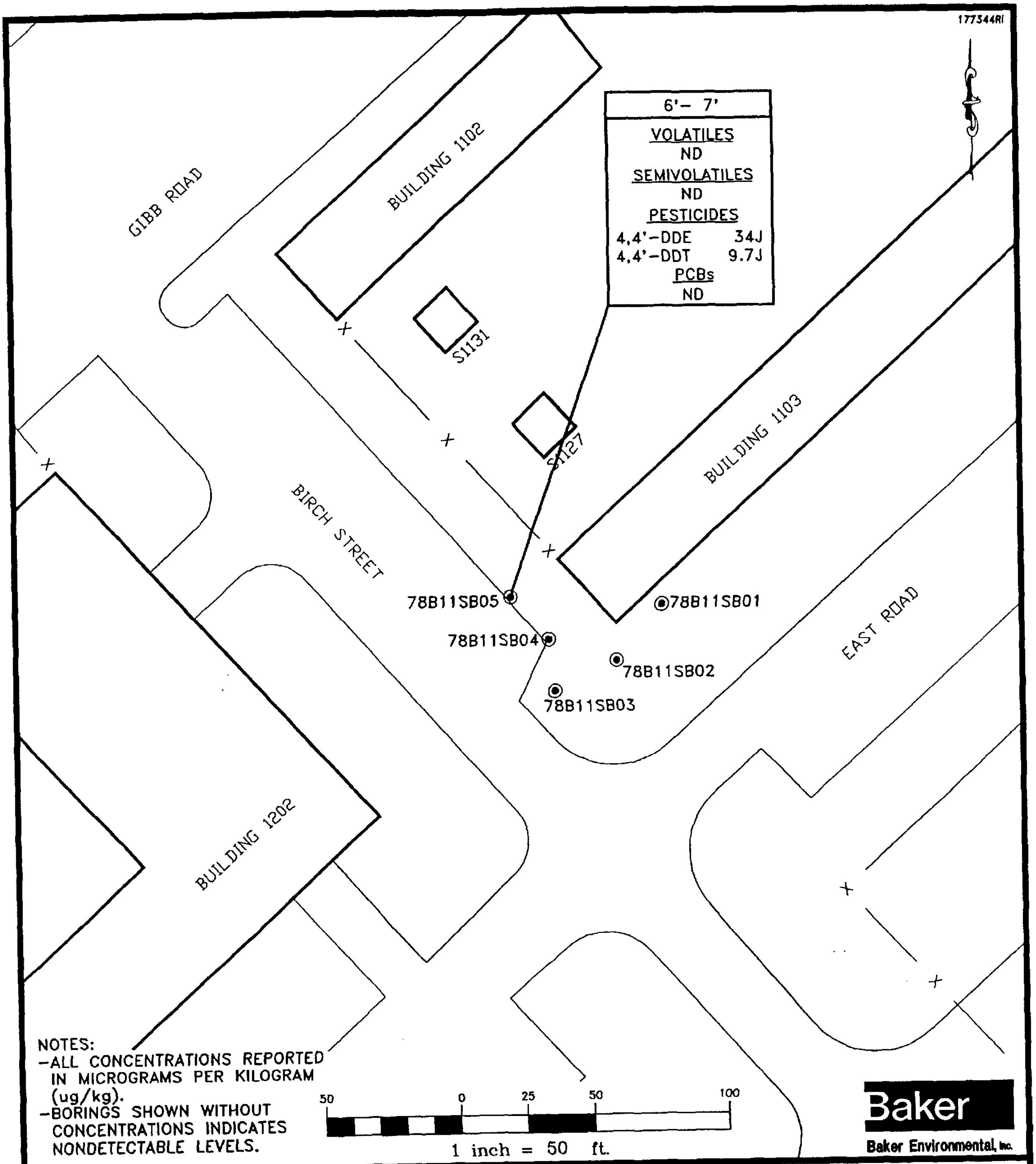
NOTES:
- ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER KILOGRAM (ug/kg).
- BORINGS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS.

LEGEND

| | |
|---|---|
| 78B11SB01 ◉ | SOIL BORING |
| ND | NOT DETECTED |

SOURCE: LANTDIV, FEB. 1992

FIGURE 4-13
POSITIVE DETECTIONS OF ORGANIC COMPOUNDS IN SURFACE SOILS
BUILDING 1103
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



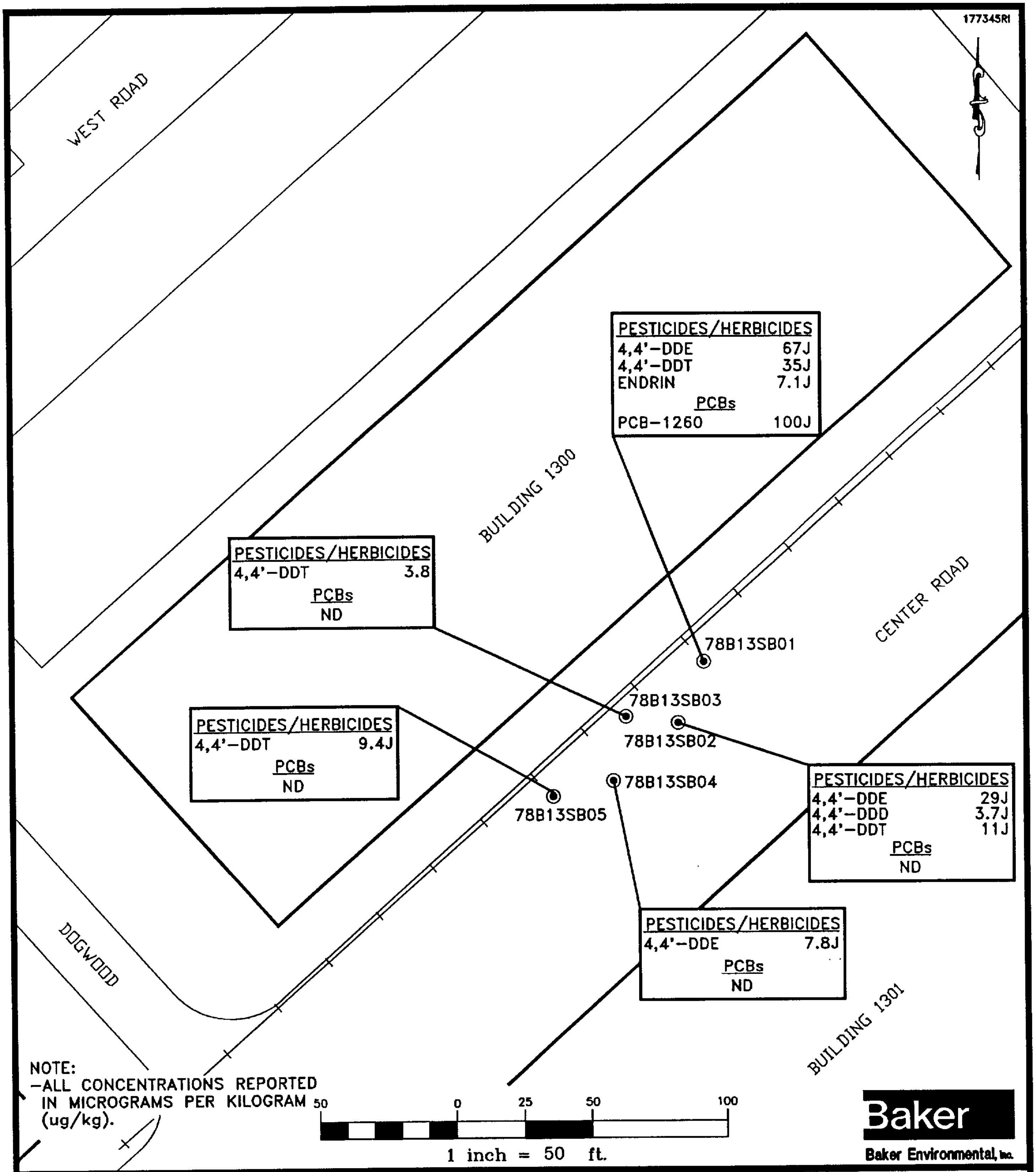
NOTES:
- ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER KILOGRAM (ug/kg).
- BORINGS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS.

LEGEND

| | |
|---|---|
| 78B11SB01 ● | SOIL BORING |
| ND | NOT DETECTED |

SOURCE: LANTDIV, FEB. 1992

FIGURE 4-14
POSITIVE DETECTIONS OF ORGANIC COMPOUNDS IN SUBSURFACE SOILS
BUILDING 1103
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

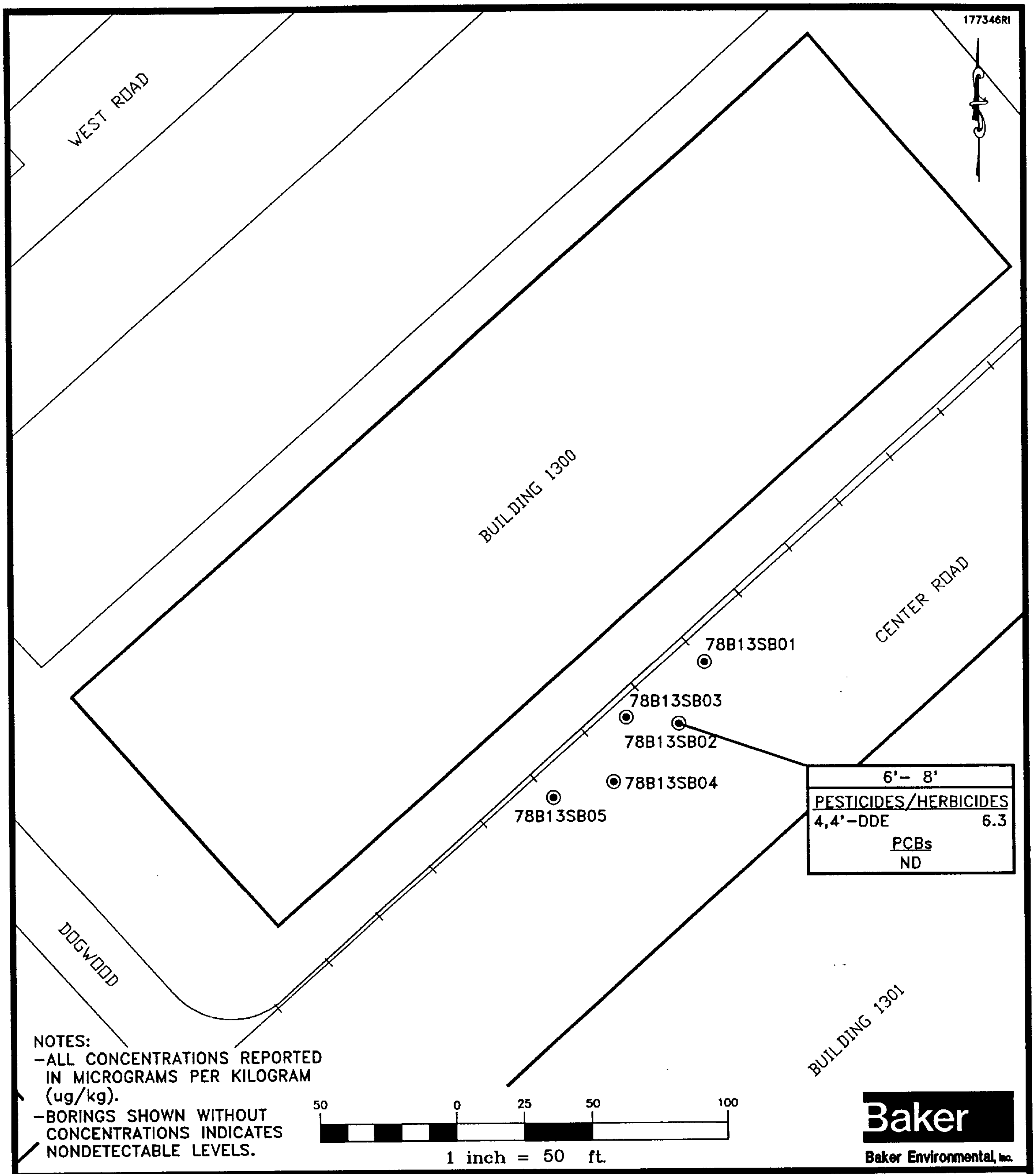


LEGEND

| | |
|---|---|
| 78B13SB01 ● | SOIL BORING |
| ND | NOT DETECTED |

SOURCE: LANTDIV, FEB. 1992

FIGURE 4-15
POSITIVE DETECTIONS OF ORGANIC COMPOUNDS IN SURFACE SOILS
BUILDING 1300
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTES:
- ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER KILOGRAM (ug/kg).
- BORINGS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS.

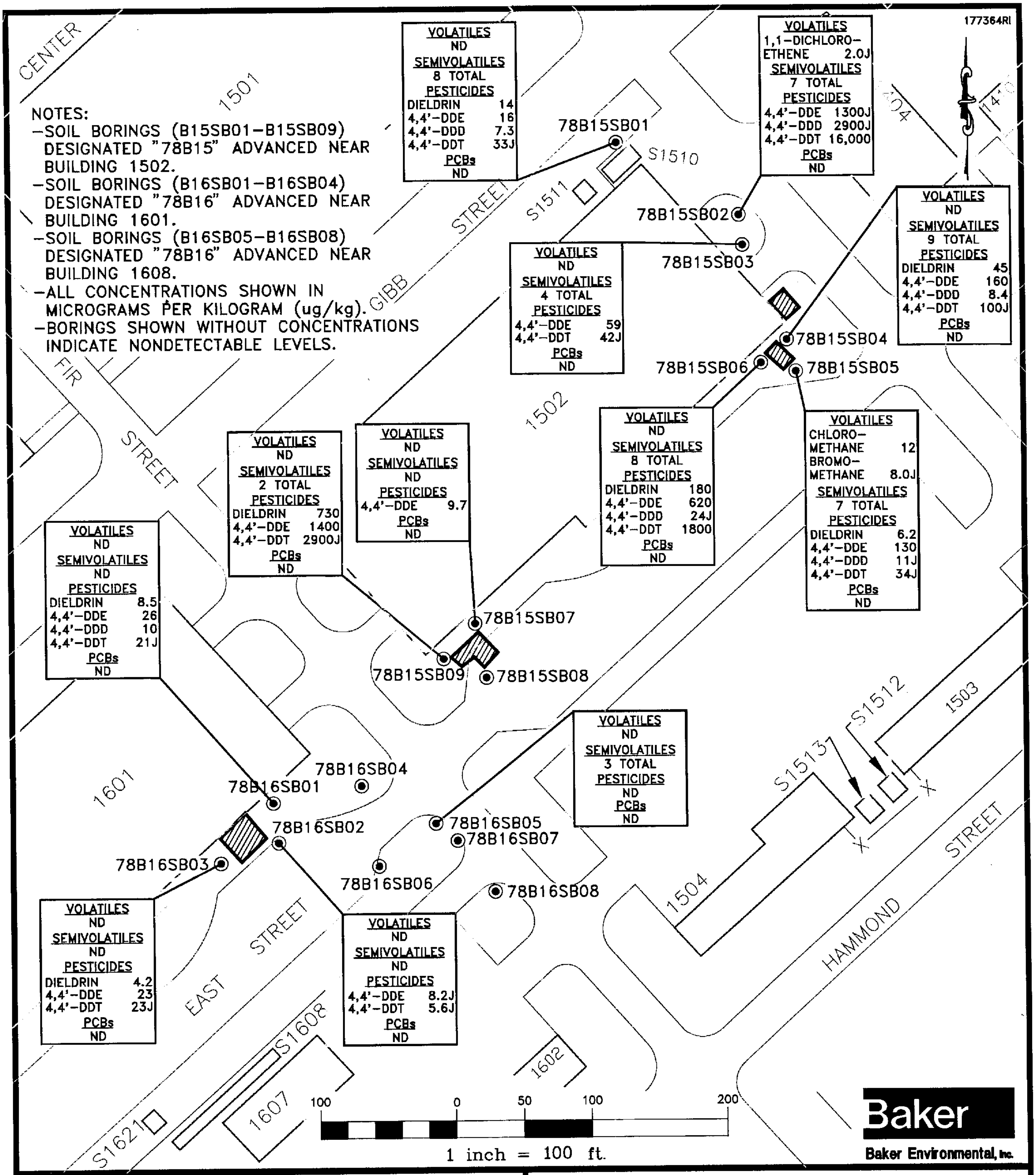
LEGEND

78B13SB01 ◉ SOIL BORING

ND NOT DETECTED

SOURCE: LANTDIV, FEB. 1992

FIGURE 4–16
POSITIVE DETECTIONS OF ORGANIC COMPOUNDS IN SUBSURFACE SOILS
BUILDING 1300
SITE 78
REMEDIAL INVESTIGATION CTO–0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

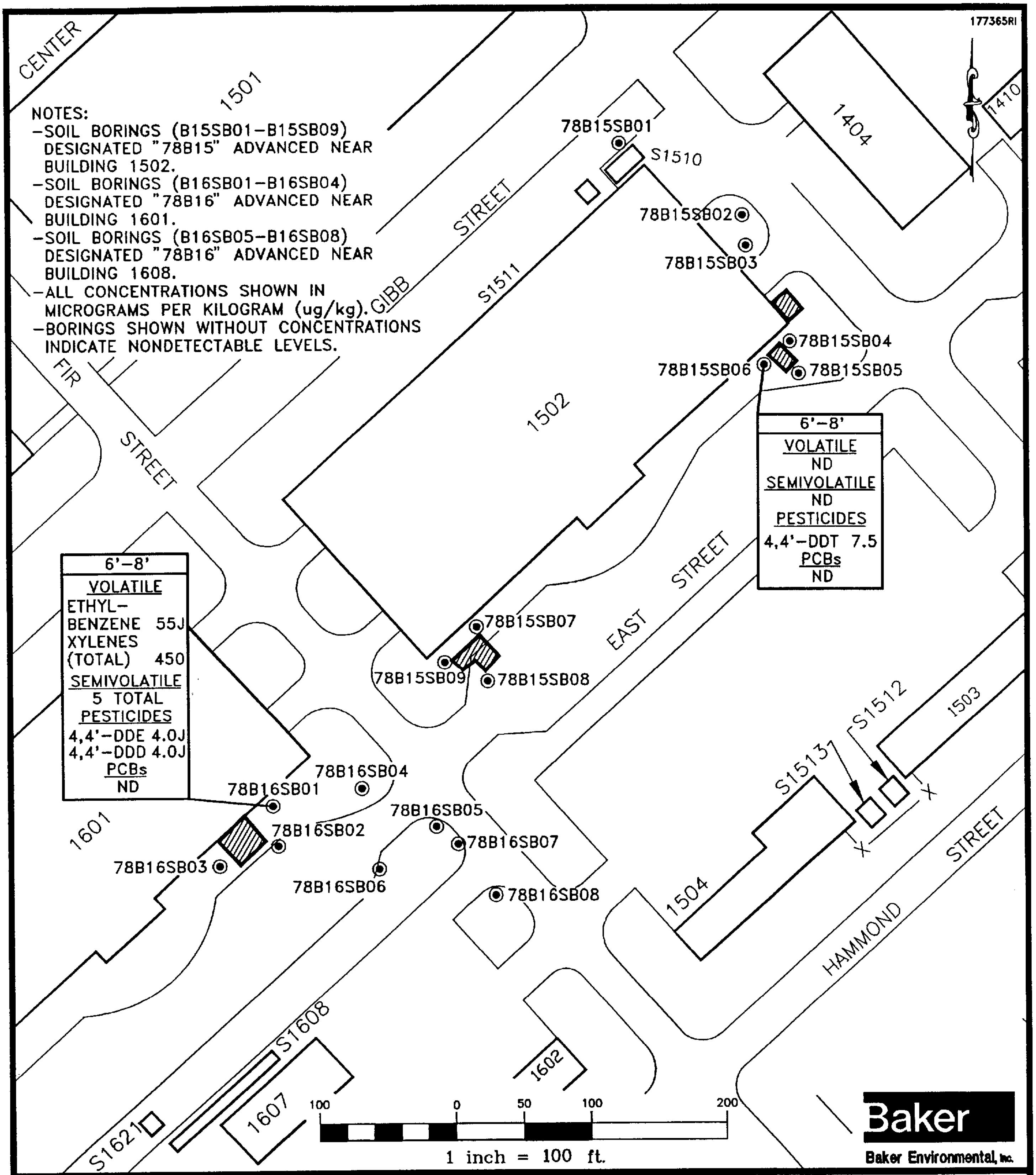


## LEGEND

| | |
|---|---|
| ▨ | SUSPECTED UST AREA |
| 78B15SB01 ● | SOIL BORING |
| ND | NOT DETECTED |

SOURCE: LANTDIV, FEB. 1992

FIGURE 4-17
POSITIVE DETECTIONS OF ORGANIC COMPOUNDS IN SURFACE SOILS
BUILDINGS 1502, 1601 AND 1608
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTES:
- SOIL BORINGS (B15SB01–B15SB09) DESIGNATED "78B15" ADVANCED NEAR BUILDING 1502.
- SOIL BORINGS (B16SB01–B16SB04) DESIGNATED "78B16" ADVANCED NEAR BUILDING 1601.
- SOIL BORINGS (B16SB05–B16SB08) DESIGNATED "78B16" ADVANCED NEAR BUILDING 1608.
- ALL CONCENTRATIONS SHOWN IN MICROGRAMS PER KILOGRAM (ug/kg).
- BORINGS SHOWN WITHOUT CONCENTRATIONS INDICATE NONDETECTABLE LEVELS.

6'–8'
VOLATILE
ND
SEMIVOLATILE
ND
PESTICIDES
4,4'-DDT 7.5
PCBs
ND

6'–8'
VOLATILE
ETHYL-BENZENE 55J
XYLENES (TOTAL) 450
SEMIVOLATILE
5 TOTAL
PESTICIDES
4,4'-DDE 4.0J
4,4'-DDD 4.0J
PCBs
ND

1 inch = 100 ft.

## LEGEND

| | |
|---|---|
| ▨ | SUSPECTED UST AREA |
| 78B15SB01 ● | SOIL BORING |
| ND | NOT DETECTED |

SOURCE: LANTDIV, FEB. 1992

# FIGURE 4–18
# POSITIVE DETECTIONS OF ORGANIC COMPOUNDS IN SUBSURFACE SOILS BUILDINGS 1502, 1601 AND 1608
SITE 78
REMEDIAL INVESTIGATION CTO–0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

*Semivolatiles*

SVOCs were detected in all three surface samples collected around the UST area but in only one of the subsurface samples. Borings 78B903SB01 and 78B903SB03 exhibited the most detections of SVOCs. The concentration ranges of a few SVOCs detected in the surface soils included: naphthalene (81 J to 1,400 µg/kg); phenanthrene (770 to 9,000 µg/kg); fluoranthene (2,100 to 8,800 µg/kg); and pyrene (1,500 to 7,600 µg/kg). Subsurface soils indicated significantly lower SVOC (Table 4-26) concentrations with few detections compared to surface soils. A sample collected from 4 to 5 feet at 78B903SB02 was the only boring which exhibited SVOCs (concentrations ranged from 74 to 590 µg/kg). The potential source of the SVOCs may be related to releases of fuel in the area.

*Pesticides*

Pesticides were detected in all three surface soil samples collected at Building 903. No pesticides were detected in the subsurface soil samples. The overall pesticide concentrations ranged from 5.4 J µg/kg to 37 J µg/kg. As shown on Figure 4-11, boring 78B903SB02 had the most frequent detections of pesticides which included dieldrin, 4,4'-DDE, 4,4'-DDD, and 4,4'-DDT. Based on the relatively low concentrations present, it appears that the pesticides may be the result of spraying activities instead of direct disposal.

### *Building 1103*

Analytical data indicated that organic compounds (i.e., VOCs, SVOCs and pesticides) and a few metals (barium, lead, and zinc) are the predominant contaminants impacting soils at Building 1103. Accordingly, only the extent of these contaminants will be discussed for this site.

*Volatiles*

VOCs were detected in only one surface sample which was collected from boring 78B11SB04. Concentrations of toluene and total xylenes were detected at 9.0 J and 10 J µg/kg, respectively. As depicted on Figure 4-13, the extent of VOC impacted soil appears to be limited to the immediate area (surface soils only) of boring 78B11SB04 since adjacent borings did not exhibit VOCs. Further, note that VOCs were not detected in the subsurface soil samples (Figure 4-14).

*Semivolatiles*

Concentrations of SVOCs were detected in surface soil samples collected from four of the five borings (excluding 78B11SB01). The most frequent detections (12) and the highest concentrations [ranging from 60 J (carbazole) to 710 µg/kg (fluoranthene)] were found at boring 78B11SB03. This boring is located southwest of Building 1103 as shown on Figure 4-13. None of the subsurface soils exhibited concentrations of SVOCs.

*Pesticides*

Pesticides were detected in four of the five surface samples (excluding 78B11SB01) collected near Building 1103. The highest pesticide concentrations [(heptachlor (48 µg/kg), 4,4'-DDE (960 µg/kg), 4,4'-DDD (330 J µg/kg), 4,4'-DDT (580 µg/kg), alpha chlordane (1,900 J µg/kg), and gamma chlordane (1,300 J µg/kg)] were detected in boring 78B11SB04 which is located along the southwestern side of the building (Figure 4-13). Borings 78B11SB03 and 78B11SB05, which are located adjacent to 78B11SB04, also exhibited pesticides (as high as 840 µg/kg). Although some of these concentrations appear relatively high, there is no record of pesticide usage (other than routine spraying) or storage at Building 1103. At Building 1105, which is located approximately 300 feet north of Building 1103, pesticides were reportedly stored and mixed from 1958 to 1977. It is unknown whether pesticides stored at Building 1105 were ever used or temporarily stored at Building 1103.

Boring 78B11SB05 is the only one which had detections of pesticides in subsurface soils (Figure 4-14). A sample collected from 6 to 7 feet tested positive for 4,4'-DDE (34 J µg/kg) and 4,4'-DDT (9.7 J µg/kg).

*Inorganics*

Barium, lead, and zinc exhibited elevated concentrations in soil an order of one magnitude or higher above base-specific background levels. The results indicated that the elevated levels were only detected in surface soils. Overall, borings 78B11SB02 (barium) and 78B11SB05 (lead and zinc) exhibited the highest concentrations above background. The source of these elevated metals is unknown since this the potential concern at this building are oil/grease racks.

### *Building 1300*

Pesticides/herbicides and PCBs were the only compounds analyzed for in soils at Building 1300. Subsequently, only the extent of contamination for these compounds at Building 1300 will be addressed.

#### *Pesticides/Herbicides*

Low concentrations (67 µg/kg or less) of pesticides were found in all five surface samples. Only one subsurface sample had detectable levels of pesticides. Boring 78B13SB01, which is the northern most boring adjacent to Building 1300, had the highest concentrations (ranging between 7.1 J to 67 J µg/kg) of pesticides among surface soils (Figure 4-15). Further, a subsurface sample collected from 6 to 8 feet at 78B13SB02 exhibited a detection of 4,4'-DDD at 6.3 µg/kg as shown on Figure 4-16. The source of the pesticides appear to be related to spraying activities instead of direct disposal due to the relatively low concentrations, and since there is no previous history of pesticide disposal or mixing in the area. Herbicides were not detected in any of the surface or subsurface soil samples.

#### *Polychlorinated Biphenyls*

As shown on Figure 4-15, PCBs were only detected in one soil sample collected at Building 1300. PCB-1260 was detected in the surface soil sample collected at boring 78B13SB01 at a concentration of 100 J µg/kg. None of subsurface soil samples indicated levels of PCBs. The potential source of the PCBs in the soils is unknown. The building is reportedly used for refrigeration equipment repair.

### *Building 1502*

Analytical data indicated that organic compounds (i.e., VOCs, SVOCs and pesticides) and a few metals (barium, lead, mercury, and zinc) are the predominant contaminants of concern in soils at Building 1502. Accordingly, the extent of PCBs at this site will not be discussed.

#### *Volatiles*

Soils in the vicinity of Building 1502 were not significantly impacted by VOCs. As shown on Figure 4-17, surface sample collected from boring 78B15SB02 exhibited a concentration of

1,1,-DCE at 2.0 J µg/kg. Note that VOCs (other than chloromentane and bromomethane) were not detected in samples collected in the vicinity of the suspected USTs which reportedly contained No. 2 fuel oil, gasoline, and/or used waste oil. Moreover, VOCs were not detected in any of the subsurface soil samples (Figure 4-18).

*Semivolatiles*

SVOCs were detected at seven of the nine boring locations in surface soils only (Figure 4-17). The highest concentrations were detected at borings 78B15SB01 (ranging from 65 J to 240 J µg/kg), 78B15SB04 (ranging from 66 J to 230 J µg/kg), and 78B15SB06 (ranging from 62 J to 220 J µg/kg). Boring 78B15SB01 is located on the northern corner of Building 1502, and borings 78B15SB04 and 78B15SB06 are located near the suspected UST located at the northeastern corner of building. The apparent sources of the SVOCs in the soils may be attributed to fuel oil No. 2 and/or used waste oils which were reportedly stored in the suspected USTs.

*Pesticides*

All nine borings in the vicinity of Building 1502 showed detections of pesticides in surface soils. Of the nine borings, 78B15SB02 had the highest concentrations of pesticides (ranging from 1,300 J to 16,000 µg/kg). This boring is located on the northeastern side of Building 1502 as shown on Figure 4-17. Several other borings (78B15SB04 and 78B15SB06) located near the eastern corner of the building also exhibited somewhat elevated concentrations of pesticides (8.4 to 1,800 µg/kg).

Pesticide levels significantly decreased in subsurface soils at Building 1502. As shown on Figure 4-18, 78B15SB06 (6 to 8 feet) was the only boring with detected pesticides [4,4'-DDT (7.5 µg/kg)].

Although a few of the samples exhibited somewhat elevated pesticide concentrations. The source of pesticides in soils a Building 1502 is unknown. According to base records, there is no prior history of pesticide disposal or mixing at the building. The building is reportedly a base vehicle repair shop.

#### *Inorganics*

Four metals including barium, lead, mercury, and zinc were detected in soils an order of one magnitude or higher (i.e., elevated) above base-specific background levels at Building 1502. The results indicated that these analytes were only elevated in surface soils. Overall, the highest elevated concentrations of these analytes were detected at borings 78B15SB01 (barium), 78B15SB02 (lead and zinc), and 78B15SB09 (mercury). The source of the metals (i.e., lead, mercury, and zinc) may be related battery disposal in the area since the facility is used for to vehicle maintenance.

### Building 1601

Analytical data indicated that pesticides are the predominant contaminants of concern in soils at Building 1601. Accordingly, only the extent of pesticides at this site will be discussed.

#### *Pesticides*

Low levels of pesticides (26 J µg/kg or less) were present in the vicinity of Building 1601. The highest concentrations were detected in surface soils from boring 78B16SB01 (8.5 to 26 µg/kg). As shown on Figure 4-17, this boring is located northeast of the suspected UST area. Further, this boring also exhibited low levels of pesticides (4.0 J µg/kg) in a subsurface soil sample (Figure 4-18) at a depth between 6 and 7 feet. Two other borings in the area, 78B16SB02 and 78B16SB03, also had detections of pesticides in surface soils but at lower levels.

### Building 1608

Analytical data indicated that SVOCs are the only contaminants detected in soils at Building 1608. Accordingly, the only extent of SVOCs at this site will be discussed.

#### *Semivolatiles*

SVOCs were only detected in one surface sample from Building 1608. Boring 78B16SB05, which is located northeast of Building 1608 at the intersection of East Street and Fir Street (Figure 4-17), had detections of three SVOCs at concentrations less than 67 J µg/kg. Other borings adjacent to 78B16SB05 did not indicate SVOCs. Further, levels of SVOCs were not detected in any subsurface samples (Figure 4-18).

### 4.3.3.2 Extent of Groundwater Contamination at Site 78

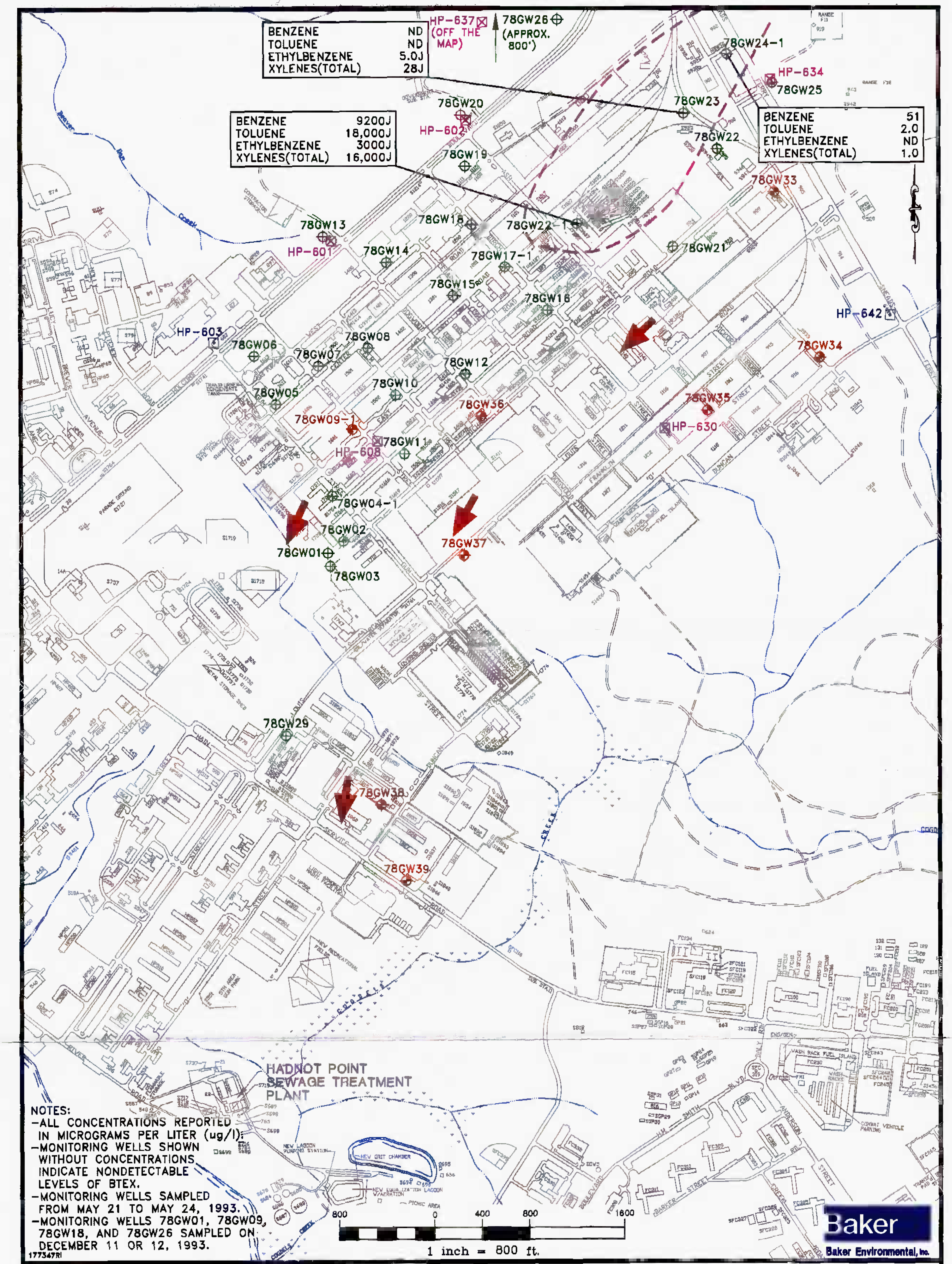
The following subsections summarize the extent of organic and inorganic contamination in the shallow, intermediate, and deep groundwater for Site 78. As mentioned previously in Section 3.4.2, the shallow (surficial water table aquifer) and deeper aquifers (Castle Hayne aquifer) in the vicinity of Site 78 are, at least partially, hydraulically interconnected since there is not a laterally continuous confining layer (i.e., layer characterized by a low enough hydraulic conductivity which could impede the vertical migration of groundwater) separating them. Subsequently, "shallow", "intermediate", and "deep" are relative terms used to describe sample depth and are not intended to describe discrete water-bearing zones.

#### *Shallow Groundwater*

VOCs, both nonhalogenated (e.g., BTEX) and halogenated (e.g., TCE) compounds, were detected in shallow groundwater at Site 78. As shown on Figure 4-19, detections of BTEX were detected in wells 78GW22-1, 78GW23, and 78GW24-1. These wells are situated within the northeastern portion of Site 78. Of the three wells, 78GW22-1 exhibited the highest level of total BTEX at 46,200 µg/l. This well also exhibited elevated BTEX levels in the past (1984 and 1987) as shown on Table 4-29. The two other wells, 78GW23 and 78GW24-1, also exhibited concentrations of BTEX but at significantly lower concentrations (total BTEX of 33 and 54 µg/l, respectively). These wells also indicated BTEX levels in the past (1987 and 1991).

The BTEX plume is centered in the vicinity of well 78GW22-1 and extends outward primarily toward the northeast as depicted on Figure 4-19. The plume is bounded on the west by well 78GW19, on the south by well 78GW17-1, and on the east by well 78GW21. In general, the concentration levels decreased in the northeast direction (considered upgradient) away from well 78GW22-1. The likely source of the BTEX in this area appears to be the Hadnot Point Fuel Farm (also referred as Site 22) which is located immediately east of well 78GW22-1. Other potential sources in the area include Buildings 901, 903, and 907 where USTs or suspected USTs may contain or previously contained various types of fuels.

Halogenated compounds were also detected in the shallow wells at Site 78 as shown on Figure 4-20. Several compounds including 1,1-DCE (well 78GW24-1), cis-1,2-DCE (wells 78GW23 and 78GW24-1), trans-1,2-DCE (wells 78GW23 and 78GW24-1), 1,2-DCE-total (wells 78GW09-1 and 78GW01), 1,2-dichloropropane (well 78GW12) , dichlorodifluoromethane (well



NOTES:
- ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ug/l).
- MONITORING WELLS SHOWN WITHOUT CONCENTRATIONS INDICATE NONDETECTABLE LEVELS OF BTEX.
- MONITORING WELLS SAMPLED FROM MAY 21 TO MAY 24, 1993.
- MONITORING WELLS 78GW01, 78GW09, 78GW18, AND 78GW26 SAMPLED ON DECEMBER 11 OR 12, 1993.

177347RI

LEGEND

| | |
|---|---|
| 78GW02 ⊕ | EXISTING SHALLOW MONITORING WELL INSTALLED BY ESE, 1984-1991 |
| 78GW33 ⊕ | SHALLOW MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., 1993 |
| ➔ | APPROXIMATE DIRECTION OF GROUNDWATER FLOW |
| — — — | ESTIMATED EXTENT OF BTEX CONTAMINATION |
| HP-603 ☐ | WATER SUPPLY WELLS (ACTIVE)-NOT SAMPLED |
| HP-601 ☒ | WATER SUPPLY WELLLS (INACTIVE)-NOT SAMPLED |

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-19
POSITIVE DETECTIONS OF BENZENE, TOLUENE, ETHYLBENZENE AND XYLENES(BTEX)
IN SHALLOW WELLS
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

78GW08), dichloromethane (well 78GW08), TCE (wells 78GW23, 78GW09-1 and 78GW01), PCE (wells 78GW15, 78GW19, and 78GW39), and vinyl chloride (well 78GW24-1) were detected at concentration levels which exceeded the Federal MCLs and/or the NCWQS. As shown on Figure 4-20, the overall highest concentrations were detected in wells 78GW23 and 78GW24-1, with lower levels (2.0 µg/l or less) in wells 78GW02, 78GW04-1, 78GW05, 78GW08, 78GW12, 78GW14, 78GW15, 78GW19, 78GW21, and 78GW39.

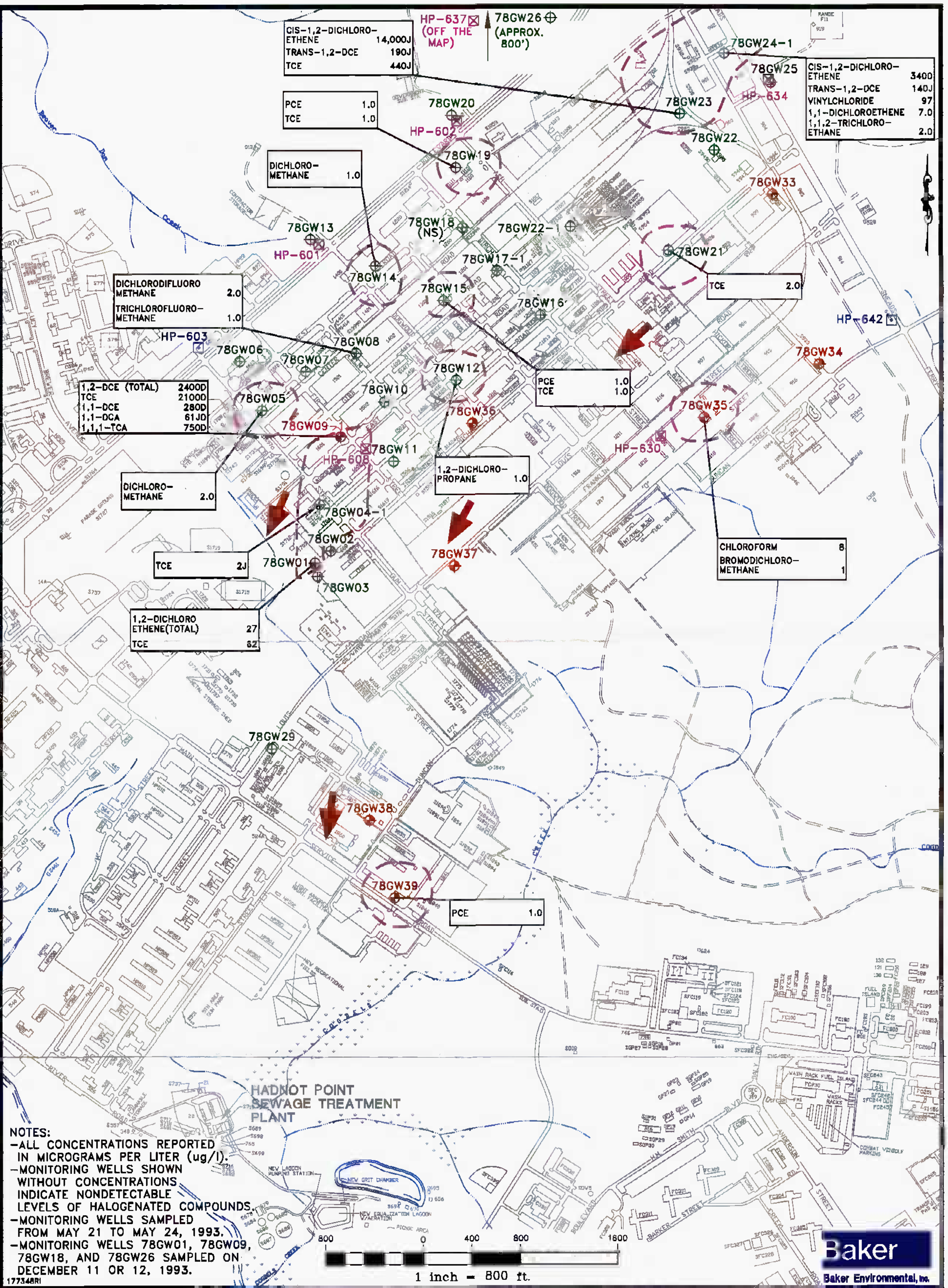
Two primary plumes of halogenated compounds were identified. The first plume is situated near wells 78GW23 and 78GW24-1 where contaminants (e.g., cis-1,2-DCE) were detected at levels as high as 14,000 J µg/l (78GW23). The plume appears to be limited to the immediate vicinity of these wells since surrounding wells indicated nondetectable levels. The source(s) of the contaminants may have originated from Buildings 902 or 903 which reportedly stored/used solvents. Because of the numerous industrial facilities in the area, however, it is difficult to locate the exact source of the contamination. The second plume is located near Building 1601 and extends southward towards Building 1709 (wells 78GW09-1, 78GW04-1, and 78GW01). The source(s) of the contaminants may have originated from Building 1502 and/or 1601 (suspected USTs) or from historical solvent usage/storage in this area.

Metals were detected extensively in groundwater throughout Site 78. Figure 2-21 identifies the selected metals which were detected at concentrations above the Federal MCLs and/or NCWQS. The metals which exceeded the standards included: arsenic (100 to 405 µg/l), beryllium (4.0 to 12 µg/l), barium (19 to 1,250 µg/l), chromium (55 to 858 µg/l), cadmium (8.0 to 12 µg/l), lead (19.6 to 462 µg/l), manganese (57 to 714 µg/l), mercury (1.1 to 1.3 µg/l), and nickel (108 to 136 µg/l). Since the distribution of the contaminants do not reflect a particular trend or pattern, it is difficult to assess the entire extent of metals contamination and identify specific source areas. The data suggests, therefore, that multiple metal sources (e.g., industrial processes, buried metals) at the site are impacting the entire Site 78 area.

*Intermediate Groundwater*

Low levels of benzene, TCE, and/or dichloromethane were detected in several intermediate wells as shown on Figures 4-22 and 4-23. Overall, the concentrations in the intermediate wells are significantly less compared to the shallow wells.

Benzene was detected at a concentration of 5.0 µg/l in well 78GW04-2 (screened from 65 to 78 feet). This concentration is equal to the Federal MCL but it exceeds the NCWQS. Well



NOTES:
- ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ug/l).
- MONITORING WELLS SHOWN WITHOUT CONCENTRATIONS INDICATE NONDETECTABLE LEVELS OF HALOGENATED COMPOUNDS.
- MONITORING WELLS SAMPLED FROM MAY 21 TO MAY 24, 1993.
- MONITORING WELLS 78GW01, 78GW09, 78GW18, AND 78GW26 SAMPLED ON DECEMBER 11 OR 12, 1993.

177348RI

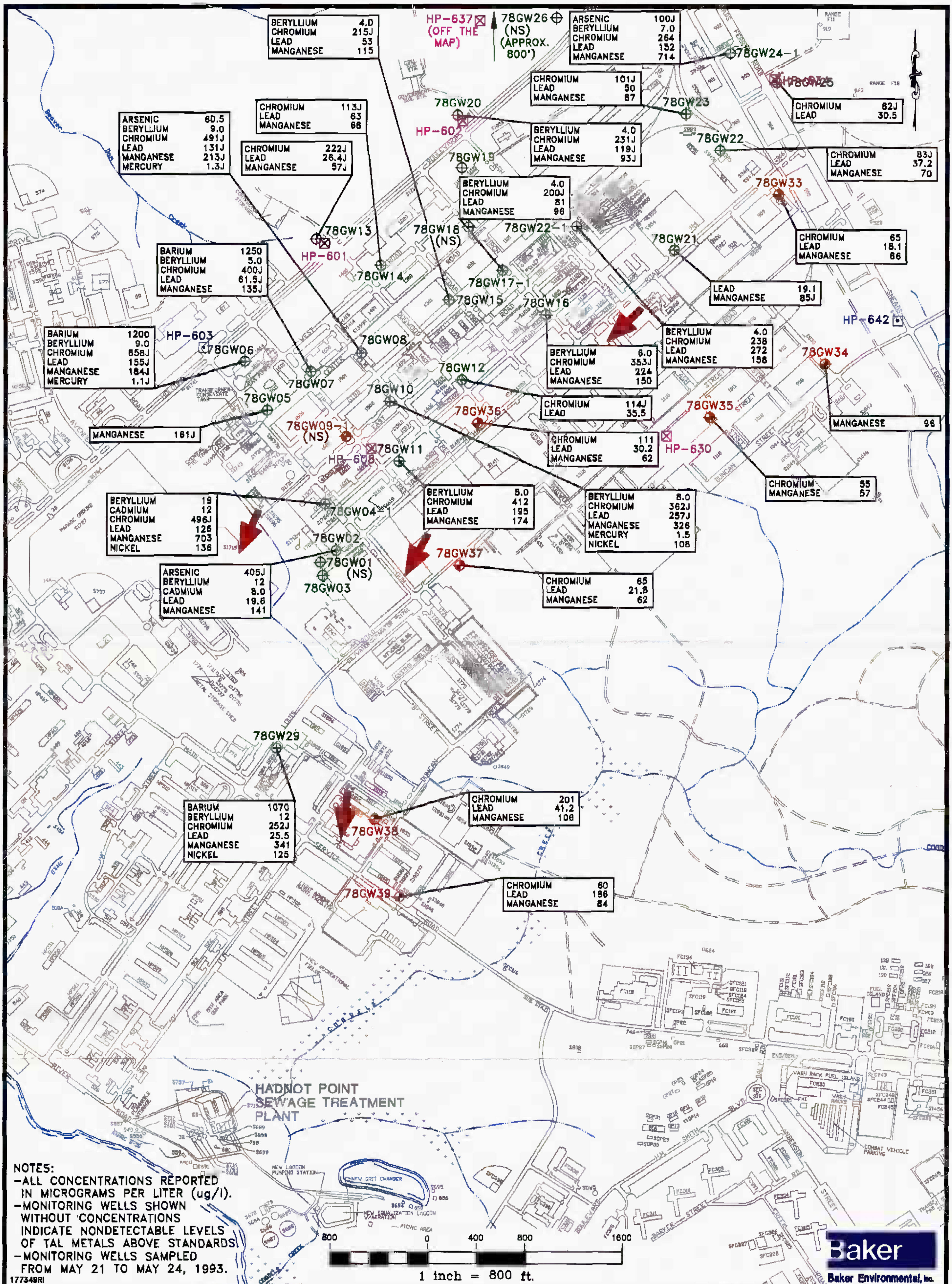
## LEGEND

| | |
|---|---|
| 78GW02 ⊕ | EXISTING SHALLOW MONITORING WELL INSTALLED BY ESE, 1984-1991. |
| 78GW33 ⊕ | SHALLOW MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., 1993 |
| ➡ | APPROXIMATE DIRECTION OF GROUNDWATER FLOW |
| — — — | ESTIMATED EXTENT OF HALOGENATED COMPOUND CONTAMINATION |
| HP-603 ☐ | WATER SUPPLY WELL (ACTIVE)-NOT SAMPLED |
| HP-601 ☒ | WATER SUPPLY WELL (INACTIVE)-NOT SAMPLED |

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-20
POSITIVE DETECTIONS OF HALOGENATED COMPOUNDS IN SHALLOW WELLS
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00522WB5Y



NOTES:
-ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ug/l).
-MONITORING WELLS SHOWN WITHOUT CONCENTRATIONS INDICATE NONDETECTABLE LEVELS OF TAL METALS ABOVE STANDARDS
-MONITORING WELLS SAMPLED FROM MAY 21 TO MAY 24, 1993.

177349RI

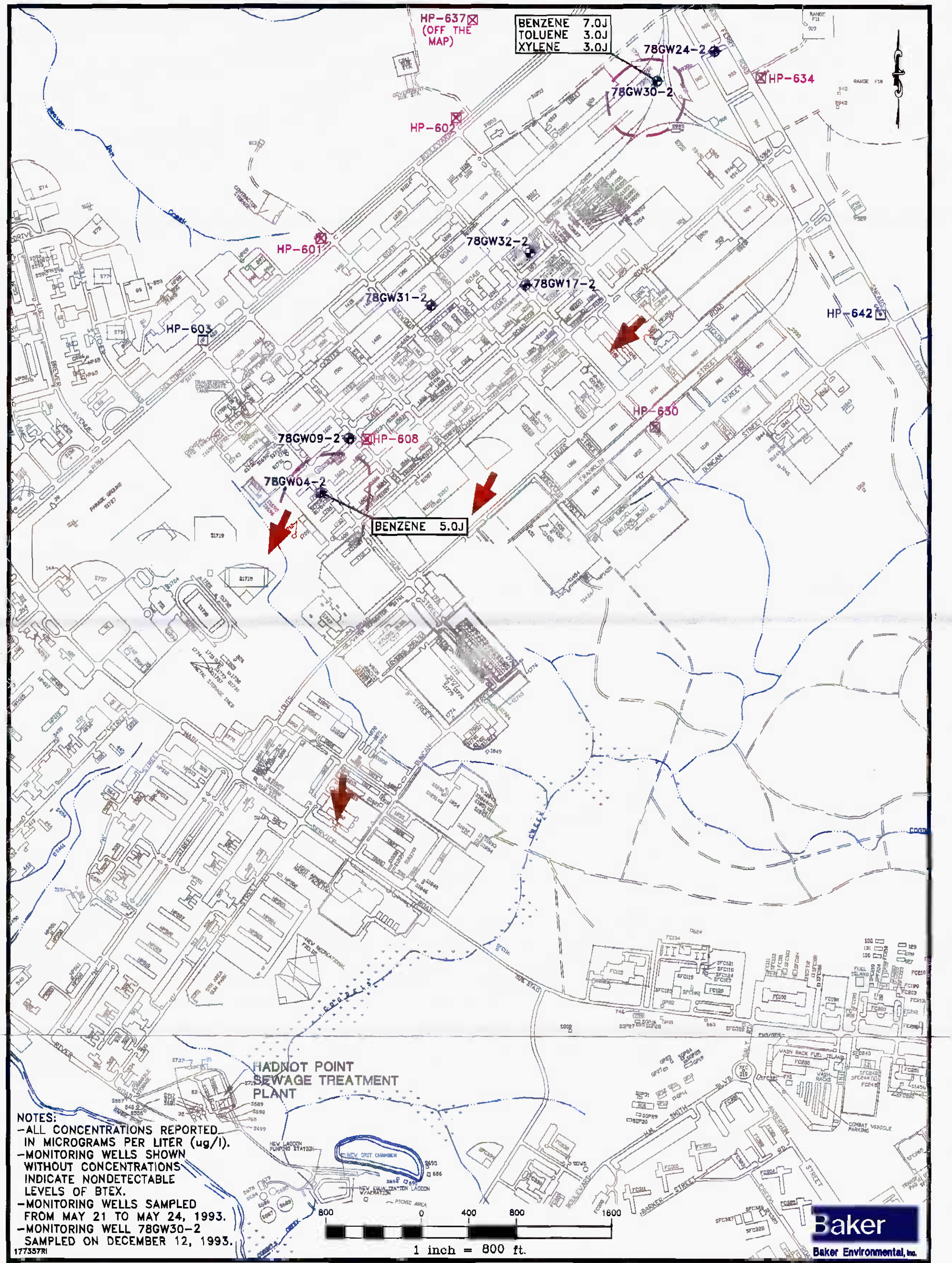
Baker
Baker Environmental, Inc.

LEGEND

| | |
|---|---|
| 78GW02 ⊕ | EXISTING SHALLOW MONITORING WELL INSTALLED BY ESE, 1984-1991 |
| 78GW33 ● | SHALLOW MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, INC., 1993 |
| ➔ | APPROXIMATE DIRECTION OF GROUNDWATER FLOW |
| (NS) | NOT SAMPLED FOR TAL METALS |
| HP-603 ⊡ | WATER SUPPLY WELL (ACTIVE)-NOT SAMPLED |
| HP-601 ☒ | WATER SUPPLY WELL (INACTIVE)-NOT SAMPLED |

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-21
POSITIVE DETECTIONS OF TAL METALS ABOVE FEDERAL MCLs AND/OR NCWQS IN SHALLOW WELLS
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



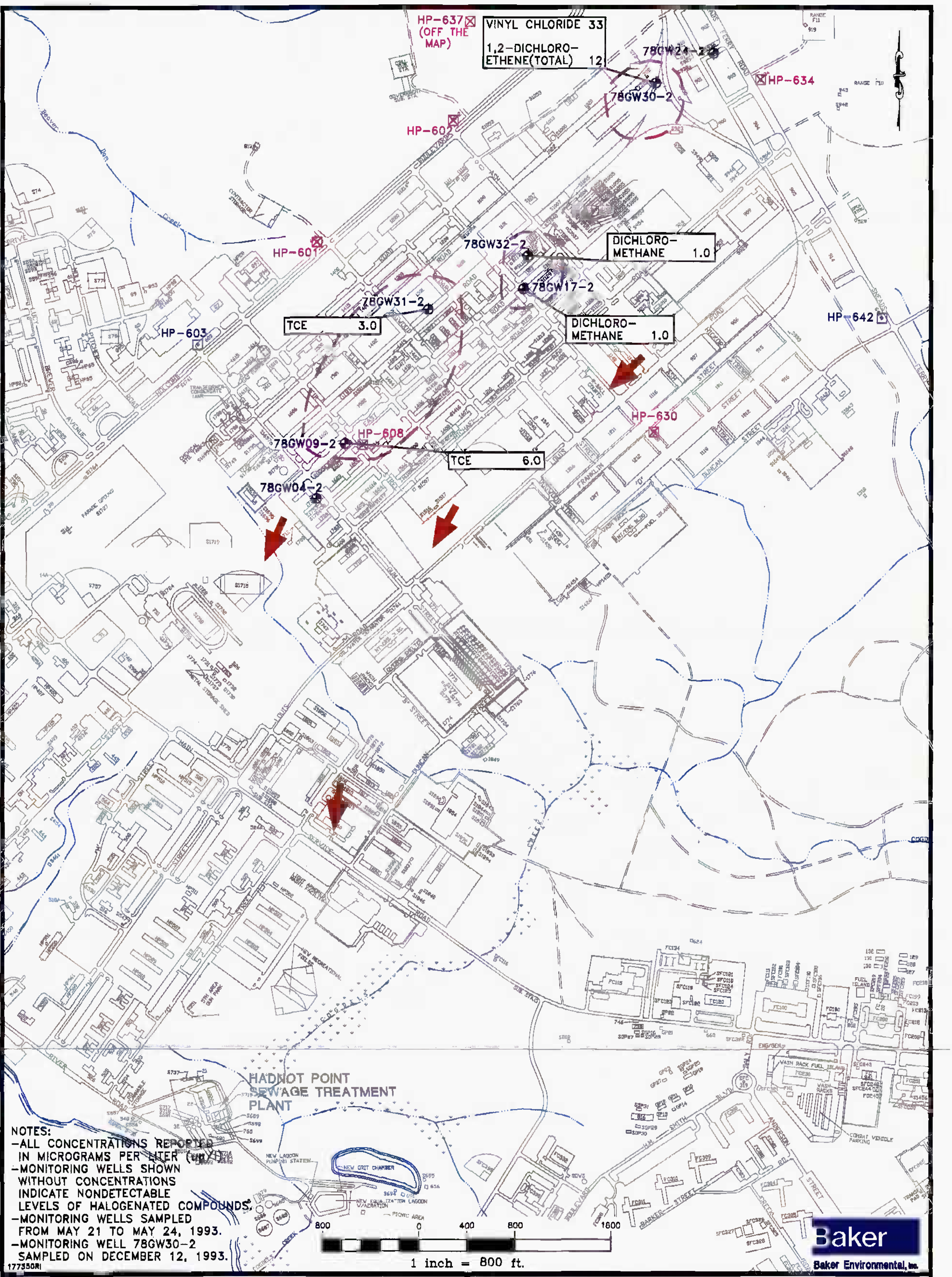
NOTES:
- ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ug/l).
- MONITORING WELLS SHOWN WITHOUT CONCENTRATIONS INDICATE NONDETECTABLE LEVELS OF BTEX.
- MONITORING WELLS SAMPLED FROM MAY 21 TO MAY 24, 1993.
- MONITORING WELL 78GW30-2 SAMPLED ON DECEMBER 12, 1993.

LEGEND

| | |
|---|---|
| 78GW04-2 ⊕ | EXISTING INTERMEDIATE MONITORING WELL INSTALLED BY ESE, 1991 |
| ➜ | APPROXIMATE DIRECTION OF GROUNDWATER FLOW |
| — — | ESTIMATED EXTENT OF BTEX CONTAMINATION |
| HP-603 ⊡ | WATER SUPPLY WELL (ACTIVE)-NOT SAMPLED |
| HP-601 ☒ | WATER SUPPLY WELL (INACTIVE)-NOT SAMPLED |

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-22
POSITIVE DETECTIONS OF BENZENE, TOLUENE, ETHYLBENZENE, AND XYLENES (BTEX) IN INTERMEDIATE WELLS
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTES:
- ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ug/l).
- MONITORING WELLS SHOWN WITHOUT CONCENTRATIONS INDICATE NONDETECTABLE LEVELS OF HALOGENATED COMPOUNDS.
- MONITORING WELLS SAMPLED FROM MAY 21 TO MAY 24, 1993.
- MONITORING WELL 78GW30-2 SAMPLED ON DECEMBER 12, 1993.

LEGEND

| | |
|---|---|
| 78GW04-2 ⊕ | EXISTING INTERMEDIATE MONITORING WELL INSTALLED BY ESE, 1991 |
| ➔ | APPROXIMATE DIRECTION OF GROUNDWATER FLOW |
| — — | ESTIMATED EXTENT OF HALOGENATED COMPOUND CONTAMINATION |
| HP-603 ⊡ | WATER SUPPLY WELL (ACTIVE)-NOT SAMPLED |
| HP-601 ☒ | WATER SUPPLY WELL (INACTIVE)-NOT SAMPLED |

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-23
POSITIVE DETECTIONS OF HALOGENATED COMPOUNDS IN INTERMEDIATE WELLS
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

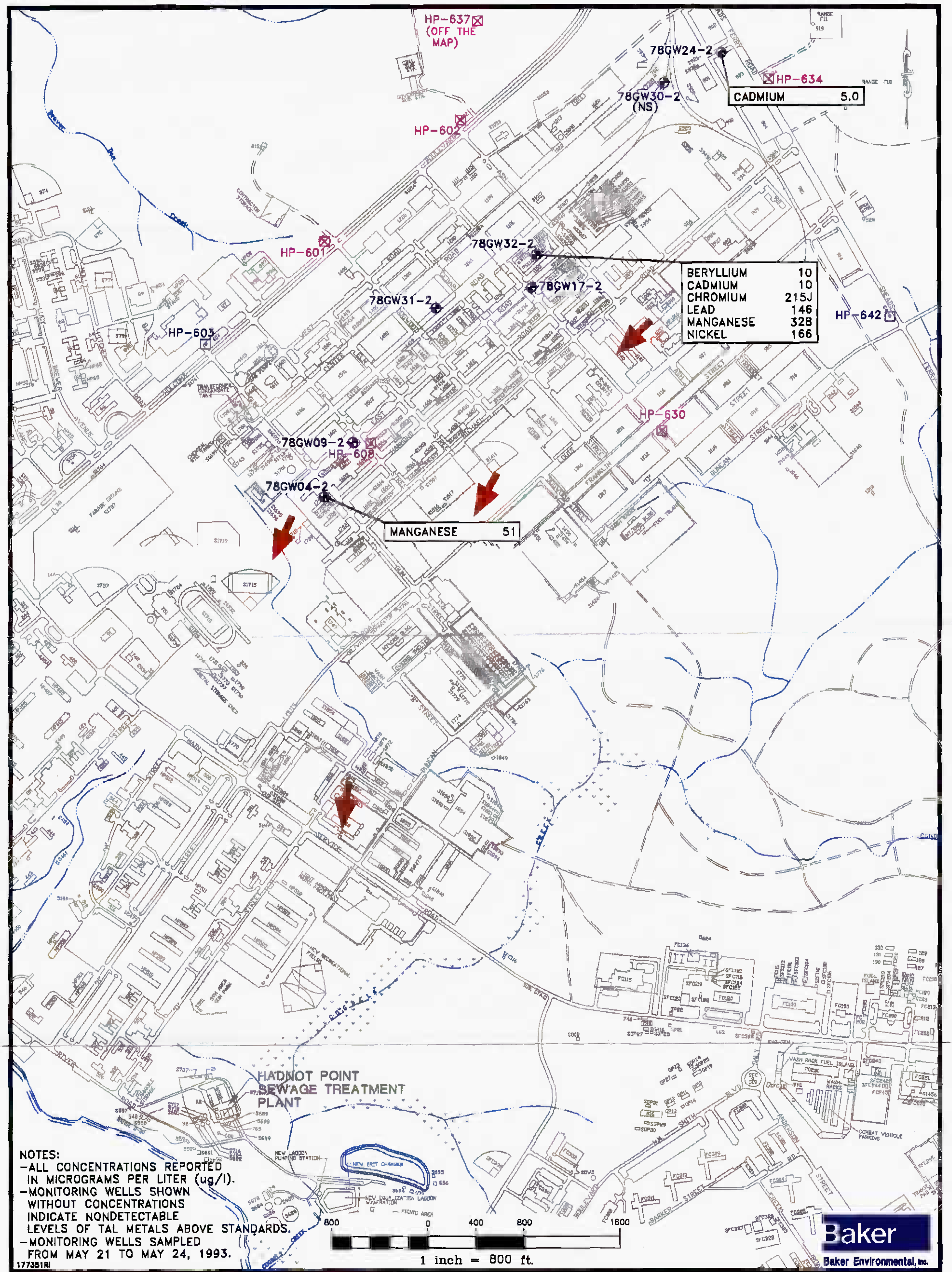
78GW04-2 is located near the southwestern portion of Site 78 where BTEX contamination was present in the adjacent paired shallow well (78GW04-1) in 1987 and 1991. The 1993 groundwater analytical data from this shallow well, however, indicated low levels of TCE (2.0 J µg/l J) but no detectable BTEX concentrations. Benzene, toluene, and xylenes were detected at well 78GW30-2 at concentrations of 7.0 J µg/l, 3.0 J µg/l, and 3.0 J µg/l respectively. The benzene concentration exceeds the MCL and NCWQS. Well 78GW30-2 is located in the northern corner of Site 78. BTEX contamination was present in this area during previous investigations.

In addition to BTEX compounds, TCE (6.0 µg/l or less), vinyl chloride (33 µg/l), 1,2-DCE (12 µg/l), and dichloromethane (1.0 µg/l) were detected in five of the intermediate wells at the site. As shown on Figure 4-23, a plume of TCE is present at intermediate depths (approximately 50 to 75 feet) in the vicinity of wells 78GW09-2 and 78GW31-2. TCE was detected in well 78GW09-2 (6.0 µg/l) at a concentration which slightly exceeds both standards. Note that the nearby shallow wells (78GW09-1, 78GW04-1, and 78GW01) had detected levels of TCE. Moreover, well 78GW31-2 (screened from 65 to 78 feet) indicated a TCE level of 3.0 µg/l which slightly exceeds the NCWQS. This well is located near the central portion of the site where past sampling events (1987 and 1991) did not indicate levels of contamination. Note that shallow well 78GW15, which is located approximately 100 feet upgradient from 78GW31-2, exhibited low levels of TCE (1.0 µg/l) and PCE (1.0 µg/l) in samples collected during this RI.

Another plume of halogenated compounds was identified in the northern section of Site 78, centered around well 78GW30-2. This well contained vinyl chloride (33 µg/l) and 1,2-DCE (12 µg/l). Shallow wells in this area had detectable concentrations of 1,2-DCE and other halogenated compounds.

A small plume of detected dichloromethane was identified near Building 1103, which is located southwest of Site 22 (Hadnot Point Fuel Farm). The source of this compound is unknown. The detected levels of dichloromethane (1.0 µg/l) do not appear to warrant concern.

As shown on Figure 4-24, metals concentrations, which exceeded the Federal MCLs and/or the NCWQS, were highest in well 78GW32-2. Several metals including beryllium (10 µg/l), cadmium (10 µg/l), chromium (215 µg/l), lead (146 µg/l), manganese (328 µg/l), and nickel (166 µg/l) were detected at elevated concentrations in this well. Shallow well 78GW17-1, which is located adjacent to 78GW32-2, also exhibited elevated levels of beryllium, chromium, lead, and manganese. The specific source of the lead contamination at some areas of Site 78 may be



NOTES:
- ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ug/l).
- MONITORING WELLS SHOWN WITHOUT CONCENTRATIONS INDICATE NONDETECTABLE LEVELS OF TAL METALS ABOVE STANDARDS.
- MONITORING WELLS SAMPLED FROM MAY 21 TO MAY 24, 1993.

LEGEND

| | |
|---|---|
| 78GW04-2 ⊕ | EXISTING INTERMEDIATE MONITORING WELL INSTALLED BY ESE, 1991 |
| ➡ | APPROXIMATE DIRECTION OF GROUNDWATER FLOW |
| (NS) | NOT SAMPLED FOR TAL METALS |
| HP-603 ▣ | WATER SUPPLY WELL (ACTIVE)-NOT SAMPLED |
| HP-601 ☒ | WATER SUPPLY WELL (INACTIVE)-NOT SAMPLED |

SOURCE: LANTDIV, FEBRUARY 1992

# FIGURE 4-24
# POSITIVE DETECTIONS OF TAL METALS ABOVE FEDERAL MCLs AND/OR NCWQS IN INTERMEDIATE WELLS
# SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00522W04V

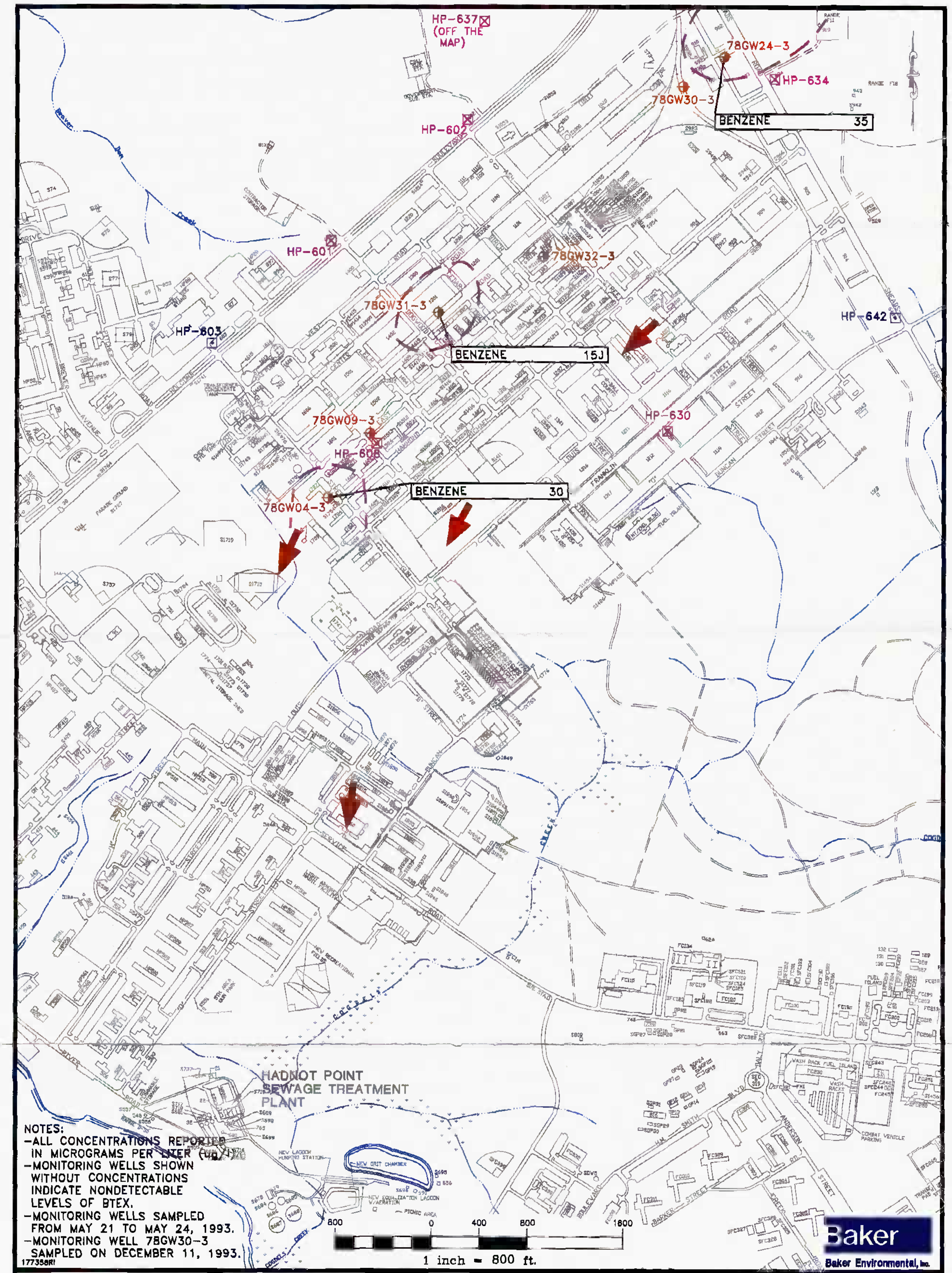
related to the Hadnot Point Fuel Farm. The specific source of the other metals is unknown since most of the activities in the area are related to solvent or petroleum storage and handling.

### *Deep Groundwater*

Four of the six deep monitoring wells sampled revealed concentrations of BTEX and halogenated compounds as depicted on Figures 4-25 and 4-26, respectively. Benzene was detected in deep wells 78GW04-3 (screened from 140 to 153 feet), 78GW31-3 (screened from 140 to 153 feet), and 78GW24-3 (screened from 128 to 148 feet) at concentrations which exceed both Federal and state standards. Well 78GW24-3, which exhibited the highest benzene level (35 µg/l), is located in an area where elevated BTEX concentrations are also present at shallow depth (78GW24-1) but were not detected at the intermediate depth (78GW24-2). Furthermore, deep well 78GW04-3 indicated a benzene level of 30 µg/l. Benzene was also detected in the paired adjacent intermediate well (78GW04-2) but at a lower concentration (5.0 µg/l). Note that the 1991 groundwater analytical results from deep wells 78GW04-3, 78GW24-3, 78GW31-3 did not indicate BTEX concentrations, which may suggest that the contaminants are migrating vertically into the deeper water-bearing zone.

Halogenated compounds including TCE, cis-1,2-DCE, trans-1,2-DCE, and/or 1,2-DCE were detected in the deeper water-bearing zone at relatively low concentrations (6.0 µg/l or less) as depicted on Figure 4-26. The highest concentration of TCE was detected in deep well 78GW32-3 (6.0 µg/l). TCE was not found, however, in nearby shallow wells or the adjacent paired intermediate well (78GW32-2). These findings, as described above, suggest that the contaminants may be migrating into the deeper water-bearing zone. The highest level of 1,2-DCE was detected in well 78GW24-3. This compound was also detected in the shallow and intermediate wells in this area (78GW24-1, 78GW23, 78GW30-2)..

Based on the analytical results, the vertical and horizontal extent of VOC contamination in the deeper water-bearing zone has not been fully evaluated. Benzene contamination above the standards is present at maximum depths ranging from 148 feet (78GW24-3) to 153 feet (78GW04-3). Elevated TCE above the standards is also present to a maximum depth of 153 feet (78GW32-3). Moreover, the horizontal extent of contamination has not been fully evaluated in the vicinities of wells 78GW24-3 or 78GW04-3. It should be noted, however, that the overall concentrations in the deeper water-bearing zone are not significantly elevated above the standards.



NOTES:
- ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ug/l).
- MONITORING WELLS SHOWN WITHOUT CONCENTRATIONS INDICATE NONDETECTABLE LEVELS OF BTEX.
- MONITORING WELLS SAMPLED FROM MAY 21 TO MAY 24, 1993.
- MONITORING WELL 78GW30-3 SAMPLED ON DECEMBER 11, 1993.

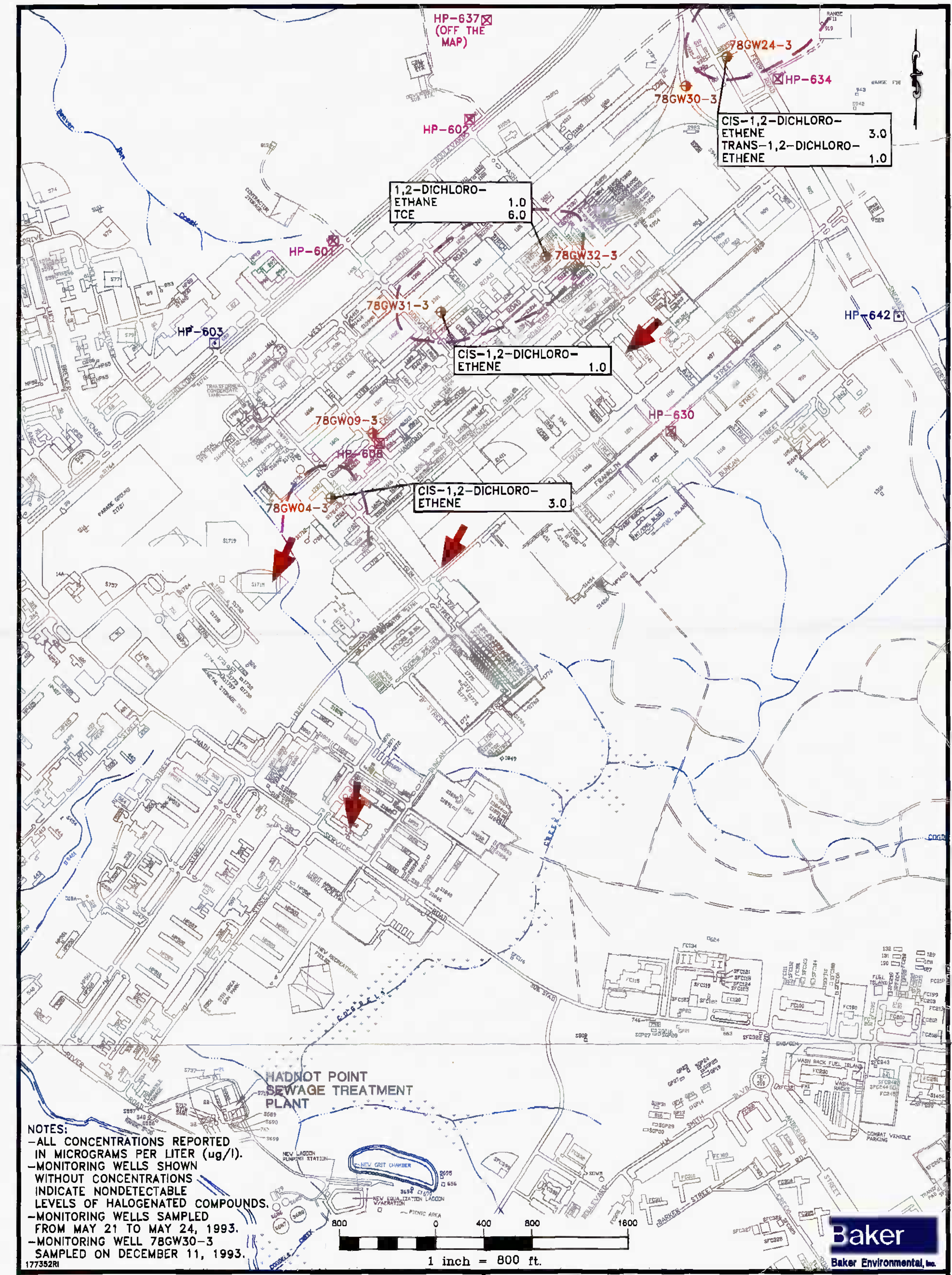
LEGEND

| | |
|---|---|
| 78GW04-3 ◐ | EXISTING DEEP MONITORING WELL INSTALLED BY ESE, 191 |
| ➔ | APPROXIMATE DIRECTION OF GROUNDWATER FLOW |
| — — | ESTIMATED EXTENT OF BTEX CONTAMINATION |
| HP-603 ⊡ | WATER SUPPLY WELL (ACTIVE)-NOT SAMPLED |
| HP-601 ☒ | WATER SUPPLY WELL (INACTIVE)-NOT SAMPLED |

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-25
POSITIVE DETECTIONS OF BENZENE, TOLUENE, ETHYLBENZENE, AND XYLENES (BTEX) IN DEEP WELLS
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00522WB6V



NOTES:
- ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ug/l).
- MONITORING WELLS SHOWN WITHOUT CONCENTRATIONS INDICATE NONDETECTABLE LEVELS OF HALOGENATED COMPOUNDS.
- MONITORING WELLS SAMPLED FROM MAY 21 TO MAY 24, 1993.
- MONITORING WELL 78GW30-3 SAMPLED ON DECEMBER 11, 1993.

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LEGEND

| | |
|---|---|
| 78GW04-3 ⊕ | EXISTING DEEP MONITORING WELL INSTALLED BY ESE, 1991. |
| ➔ | APPROXIMATE DIRECTION OF GROUNDWATER FLOW |
| — — | ESTIMATED EXTENT OF HALOGENATED COMPOUND CONTAMINATION |
| HP-603 ⊡ | WATER SUPPLY WELL (ACTIVE)-NOT SAMPLED |
| HP-601 ☒ | WATER SUPPLY WELL (INACTIVE)-NOT SAMPLED |

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-26
POSITIVE DETECTIONS OF HALOGENATED COMPOUNDS IN DEEP WELLS
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

In addition to the VOCs, alpha chlordane was detected in deep well 78GW09-3 (0.11 J µg/l) at a concentration which exceeded the NCWQS of 0.027 µg/l. Although pesticides are present in soils throughout the area, the source of this pesticide in groundwater is unknown since all other wells in the area (including shallow, intermediate, and deep) tested negative for all pesticides. Because pesticides are not extremely mobile in groundwater, it is unlikely that the alpha chlordane migrated vertically into the deeper groundwater.

Figure 4-27 shows the positive detections of TAL metals above the Federal MCLs and/or NCWQs in the deep wells sampled at Site 78. As shown on the figure, arsenic, cadmium, and/or manganese exceeded the standards at two well locations: 78GW24-3 and 78GW04-3. Cadmium also exceeded the standards in the intermediate well 78GW24-2. Cadmium and/or manganese exceeded the standards in the intermediate well 78GW04-2 and the shallow well 78GW04-1.

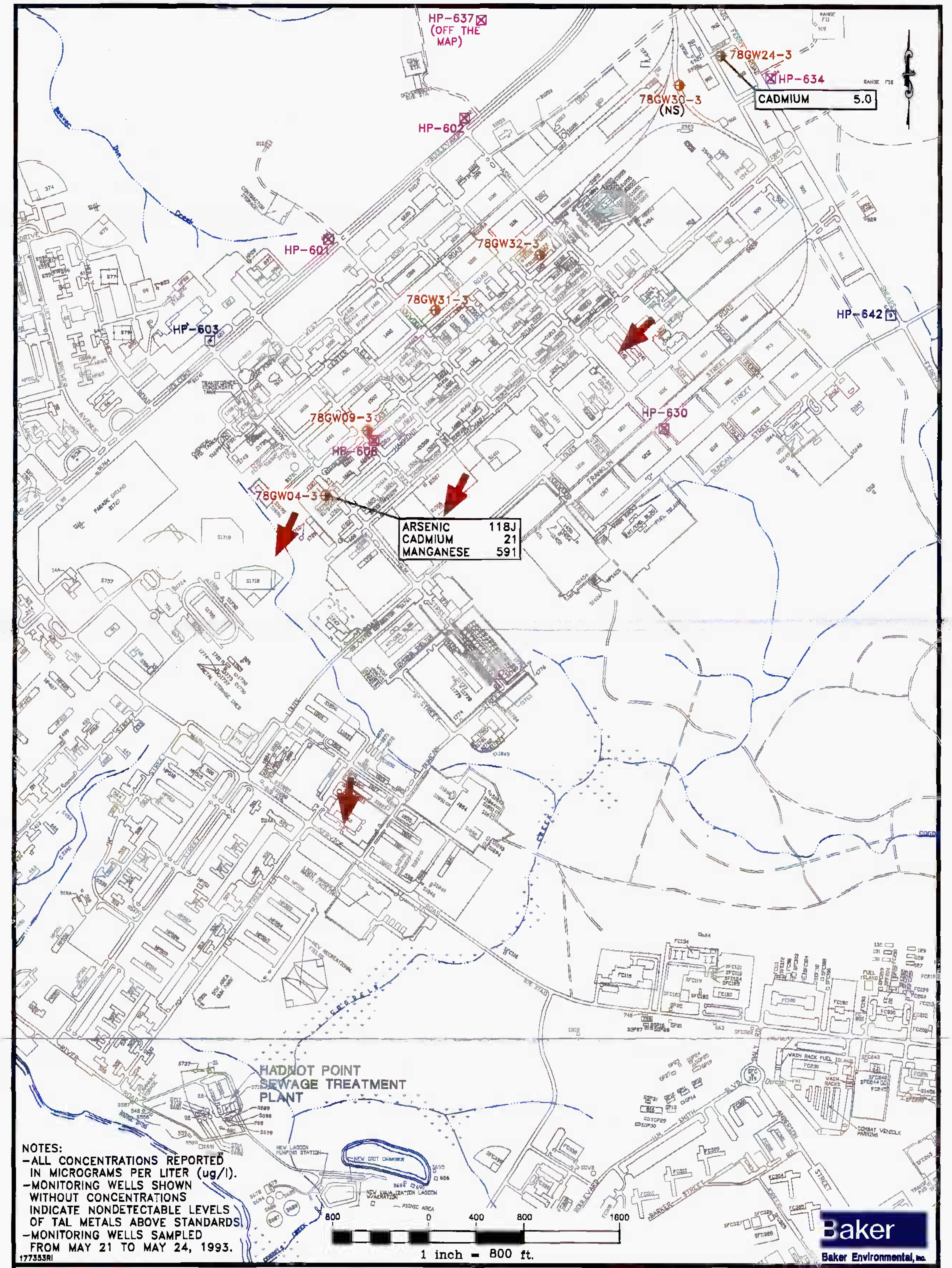
In summary, the shallow wells at Site 78 exhibited higher overall contaminant levels, for both metals and organic compounds, compared to the intermediate and deep wells. BTEX and a few halogenated compounds are the primary organic contaminants present in groundwater. A number of metals including: arsenic, beryllium, barium, cadmium, chromium, lead, manganese, and nickel are also prevalent in the shallow groundwater at the site. The analytical results suggest that he contaminants may be migrating vertically into the deeper groundwater based on the fact that the concentration levels have increased in the deep wells over the past several years. Additional rounds of samples, however, may be required to confirm this trend.

### 4.3.3.3 Extent of Surface Water and Sediment Contamination

Surface water and sediments sampled within Site 78 are divided into two areas: Cogdels Creek and The New River, and Beaver Dam Creek.

#### *Cogdels Creek and The New River*

VOCs, SVOCs, pesticides, and inorganics were all detected in Cogdels Creek surface water and/or sediments.



NOTES:
- ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ug/l).
- MONITORING WELLS SHOWN WITHOUT CONCENTRATIONS INDICATE NONDETECTABLE LEVELS OF TAL METALS ABOVE STANDARDS.
- MONITORING WELLS SAMPLED FROM MAY 21 TO MAY 24, 1993.

177353RI

Baker Environmental, Inc.

**LEGEND**

| | |
|---|---|
| 78GW04-3 ⊕ | EXISTING DEEP MONITORING WELL INSTALLED BY ESE, 1991 |
| ➡ | APPROXIMATE DIRECTION OF GROUNDWATER FLOW |
| (NS) | NOT SAMPLED FOR TAL METALS |
| HP-603 ☐ | WATER SUPPLY WELL (ACTIVE)-NOT SAMPLED |
| HP-601 ☒ | WATER SUPPLY WELL (INACTIVE)-NOT SAMPLED |

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-27
POSITIVE DETECTIONS OF TAL METALS ABOVE FEDERAL MCLs AND/OR NCWQS IN DEEP WELLS
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

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Positive detections of organic compounds in surface water and sediments in Cogdels Creek and The New River are depicted on Figure 4-27. Positive detections of TAL metals above Federal Screening Values and/or NCWQS.

*Volatiles*

As depicted in Figure 4-28, the presence of VOCs in both surface water and sediments in Cogdels Creek and The New River is not limited to any specific areas. TCE, toluene, and 1,2-DCE were all detected in surface water samples at low concentrations (maximum of 47 µg/l), while ethylbenzene and 2-butanone were detected in sediment samples, also at relatively low concentrations (maximum of 60 J µg/l).

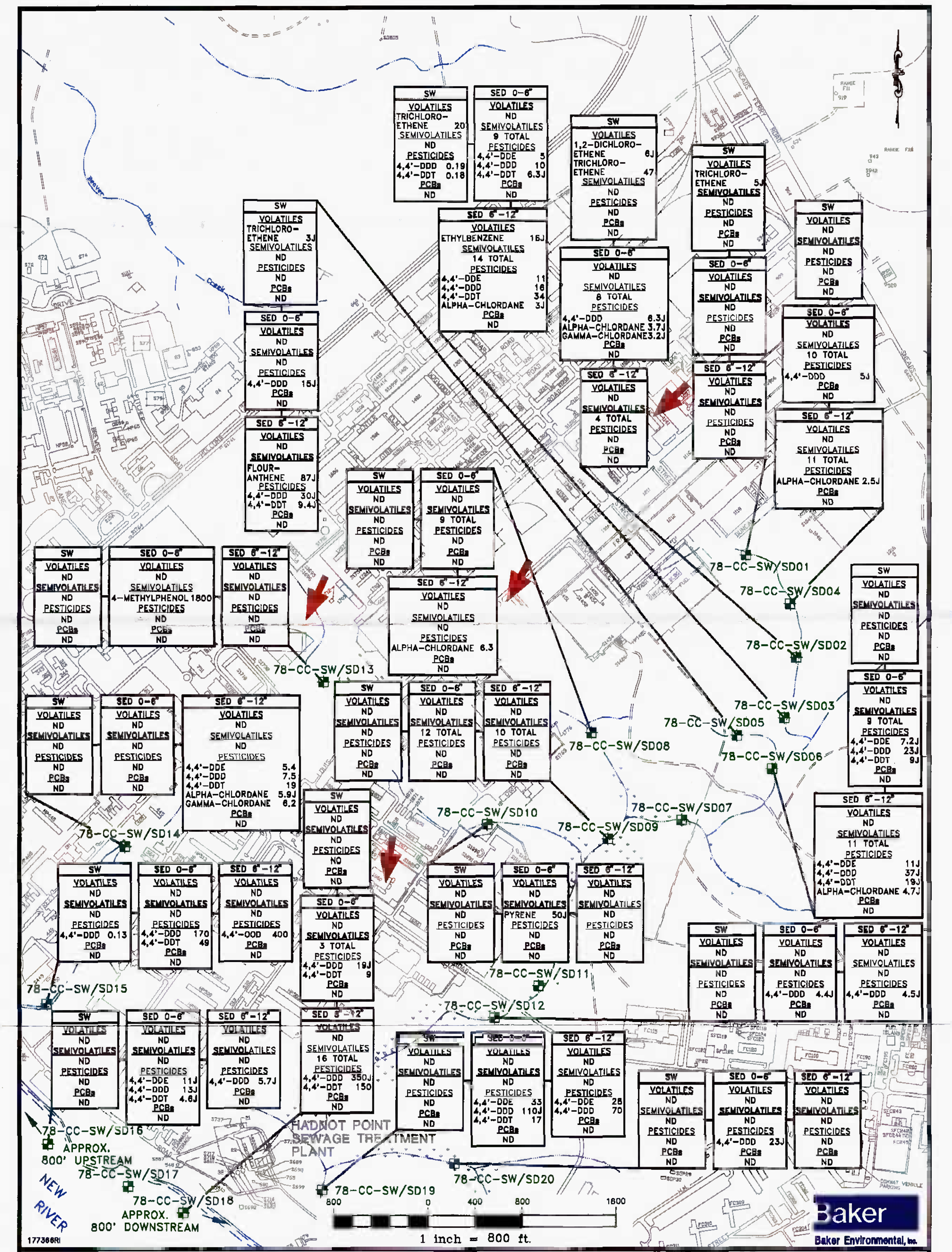
*Semivolatiles*

Although no SVOCs were detected in Cogdels Creek and New River surface water samples, a number of SVOCs were detected in sediments collected from these same locations. Eighteen different SVOCs, primarily PAH compounds, were detected in Cogdels Creek and New River sediments. As depicted in Figure 4-28, detected PAHs were greatest at sample locations along the eastern portion of the site (78-CC-SW/SD02, 78-CC-SW/SD03, 78-CC-SW/SD06, 78-CC-SW/SD08) and at sample location 78-CC-SW/SD18, at the extreme southern end of the site. Due to the limitations on the figures, only the total number of SVOCs positive detections at each sample location is listed.

The most frequently detected SVOCs in Cogdels Creek and New River sediments were fluoranthene and pyrene (14 samples each), chrysene (13 samples), benzo(b)fluoranthene (12 samples), benzo(a)pyrene and indeno(1,2,3-cd)pyrene (11 samples each), phenanthrene and benzo(a)anthracene (10 samples each), and benzo(g, h, i)perylene (eight samples).

*Pesticides*

Pesticides were detected in only two of twenty surface water samples collected from Cogdels Creek and The New River (at relatively low concentrations), but were detected in 22 of 20 sediment samples. The most prevalent pesticide was 4,4'-DDD, detected in two surface water samples and 20 sediment samples. Other pesticides detected include 4,4'-DDT, detected in one surface water sample and 11 sediment samples, 4,4'-DDE, detected in eight sediment samples,



## LEGEND

78-CC-SW/SD01 SURFACE WATER(SW)/SEDIMENT(SD) SAMPLE STATION

→ APPROXIMATE GROUNDWATER FLOW DIRECTION

ND NOT DETECTED

NOTES:
- TYPICALLY 2 SEDIMENT SAMPLES (0-6" AND 6"-12") WERE COLLECTED AT EACH STATION.
- SAMPLE STATIONS 16, 17 AND 18 ARE LOCATED WITHIN THE NEW RIVER.
- SAMPLE LOCATIONS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS OF ORGANIC COMPOUNDS IN EITHER THE SURFACE WATER OR SEDIMENTS.
- ALL SURFACE WATER CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ug/l).
- ALL SEDIMENT CONCENTRATIONS REPORTED IN MICROGRAMS PER KILOGRAM (ug/kg).

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-28
POSITIVE DETECTIONS OF ORGANIC COMPOUNDS IN SURFACE WATER AND SEDIMENTS ABOVE FEDERAL SCREENING VALUES AND/OR NCWQS IN COGDELS CREEK AND THE NEW RIVER
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

alpha-chlordane, detected in five sediment samples, and gamma-chlordane, detected in three samples.

As depicted in Figure 4-28, pesticides were detected throughout the site, at generally low concentrations, including the following sediment concentrations: 4,4'-DDE (5 - 33 µg/kg), 4,4'-DDD (4.4 J - 400 µg/kg), 4,4'-DDT (4.6 J - 150 µg/kg), alpha-chlordane (2.5 J - 5.9 J µg/kg), and gamma-chlordane (3.2 J - 6.3 µg/kg). Surface water concentrations of pesticides were all less than 0.2 µg/l.

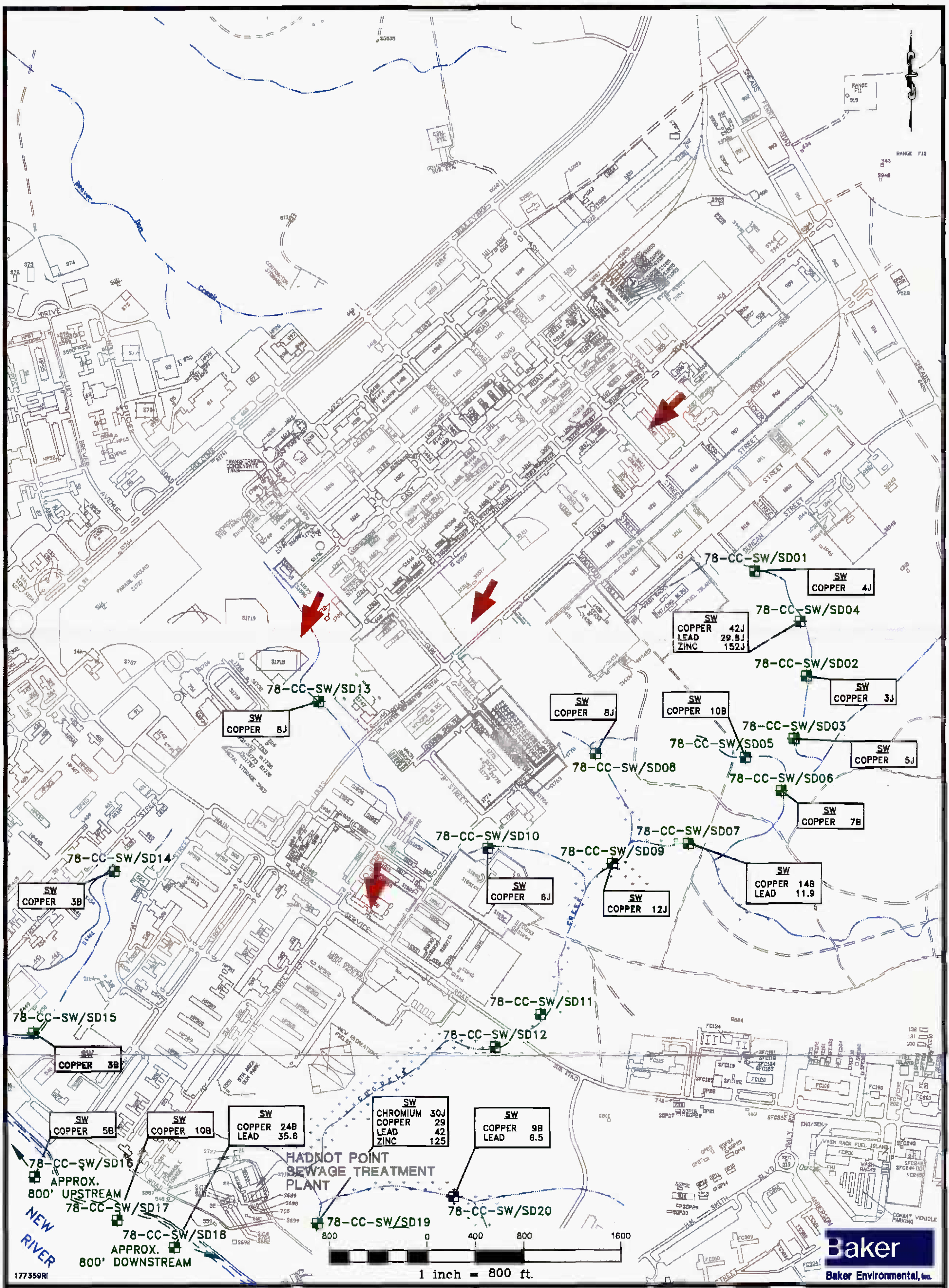
The prevalence of pesticides throughout the Cogdels Creek and New River area of the site indicates that pesticide contamination may be the result of spraying practices, rather than disposal practices or spill incidents.

*Inorganics*

As depicted in Figure 4-29, positive detections of TAL metals above Federal Screening Values (WQSVs, NOAA standards) and/or NCWQSs are present in five surface water samples and twelve sediment samples, located primarily at eastern and extreme southern areas (adjacent to the Hadnot Point STP) of Site 78. The most prevalent inorganic to exceed WQS and/or WQSV standards is lead, (17 samples overall), followed by zinc (eight samples overall), cadmium (three sediment samples), copper and silver (two sediment samples each), and chromium (one surface water sample. The greatest concentration of lead was found in sediment sample 78-CC-SD18-612 (359 mg/kg), which also exhibited the maximum concentration of copper (116 mg/kg) and zinc (363 mg/kg). Sediment sample 78-CC-SD08-06 exhibited the maximum concentration of cadmium (11.9 mg/kg) and chromium (42 mg/kg). Finally, sediment sample 78-CC-SD20-06 contained the maximum concentration of silver (3.9B mg/kg).

*<u>Beaver Dam Creek</u>*

SVOCs, pesticides, PCBs, and inorganics were all detected in Beaver Dam Creek sediments, while only inorganics were detected in Beaver Dam Creek surface water. No VOCs were detected in any Beaver Dam Creek samples.



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LEGEND

78-CC-SW/SD01 SURFACE WATER(SW)/SEDIMENT(SD) SAMPLE STATION

➡ APPROXIMATE GROUNDWATER FLOW DIRECTION

NOTES:
-SAMPLE STATIONS 16, 17 AND 18 ARE LOCATED WITHIN THE NEW RIVER.
-SURFACE WATER SAMPLE LOCATIONS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS OF TAL METALS.
-ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER(ug/l).

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-29
POSITIVE DETECTIONS OF TAL METALS IN SURFACE WATER ABOVE FEDERAL WQSVs AND/OR NCWQS IN COGDELS CREEK AND THE NEW RIVER
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00522W074

*Semivolatiles*

SVOCs were detected in six of fourteen sediment samples from Beaver Dam Creek. As indicated by Figure 4-30, the vast majority of SVOCs detected were from two sample locations (78-BD-SD02-06 and 78-BD-SD03-06) and consist primarily of PAH compounds. Due to the limitations on the figures, only the total number of SVOC positive detections at each sample location is listed. The extent of these compounds appears to be limited to this portion of Beaver Dam Creek.

Likely sources of PAH contamination are spills or leaks from petroleum fuels stored throughout the site or from stormwater runoff which contained petroleum fuels.

*Pesticides*

Pesticides were detected in eight of 14 sediment samples from Beaver Dam Creek. The most prevalent pesticide was 4,4-DDE, and gamma-chlordane, both of which were detected in six samples. Other detected pesticides include alpha-chlordane (four samples), 4,4'-DDT (three samples) and 4,4'-DDD (two samples). Sediments collected from 78-BD-SD07-06 and 78-BD-SD07-612 were the only sample locations to exhibit detectable amounts of all five pesticides detected at the site. Sample 78-BD-SD07-612 exhibited the maximum concentration of 4,4'-DDD (39 J µg/kg), while sample 78-BD-SD07-06 exhibited maximum concentrations of 4,4'-DDE (93 J µg/kg), 4,4'-DDT (47 µg/kg), alpha-chlordane (7.3 J µg/kg), and gamma-chlordane (5.6 J µg/kg).

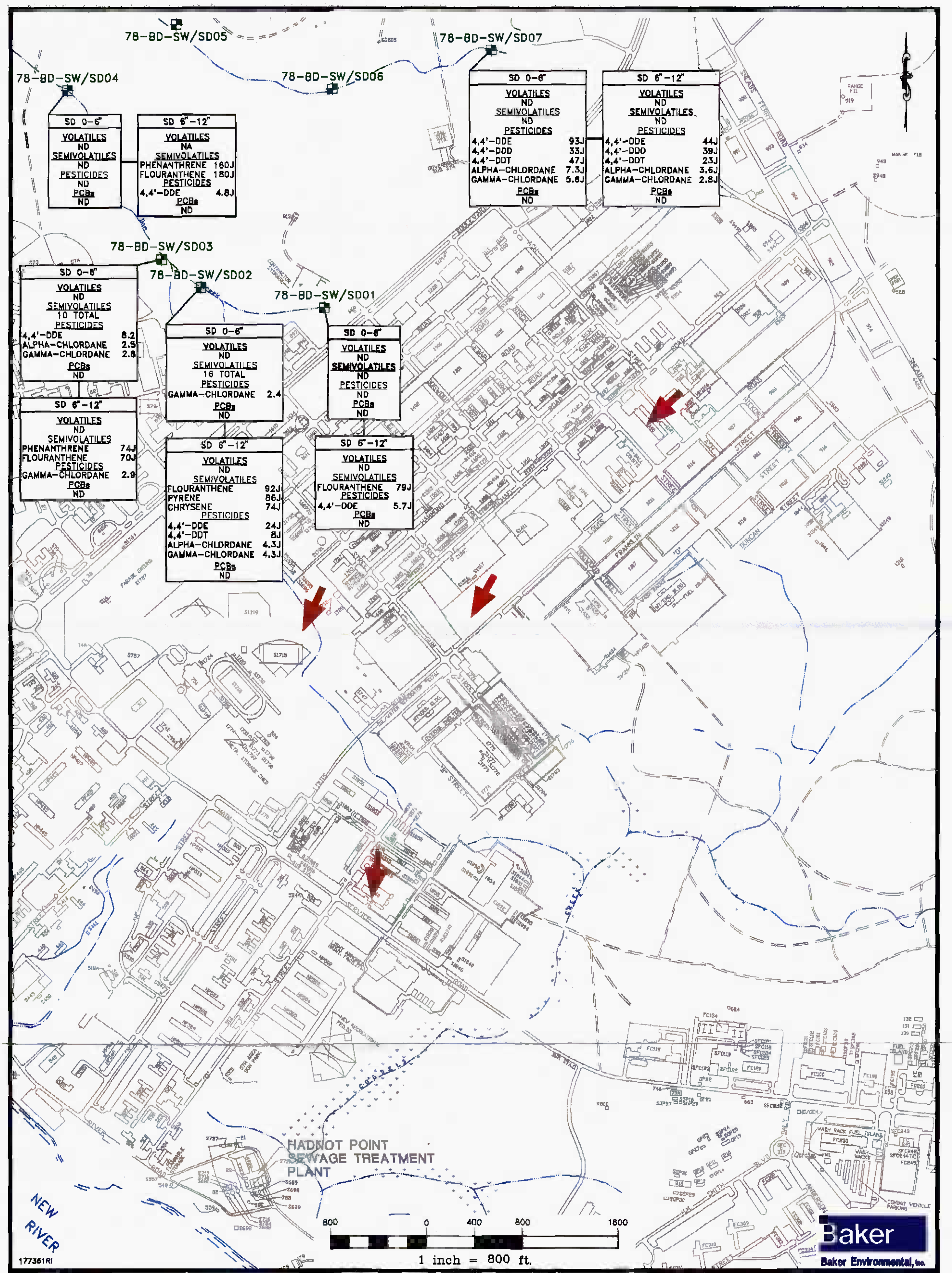
Pesticide contamination is believed to be caused by spraying practices, rather than disposal or spill incidents, due to the prevalence of pesticides and their relatively low concentrations.

*Polychlorinated Biphenyls*

The only PCB detected in Beaver Dam Creek sediments was PCB-1260, which was detected in sample 78-BD-SD02-612 (70 µg/kg).

*Inorganics*

As depicted in Figure 4-31, the only inorganics from Beaver Dam Creek to exceed Federal Screening Values (WQSVs, NOAA standards) and/or NCWQSs were copper (in all seven



## LEGEND

78-BD-SW/SD01 ▣ SURFACE WATER(SW)/SEDIMENT(SD) SAMPLE STATION

➡ APPROXIMATE GROUNDWATER FLOW DIRECTION

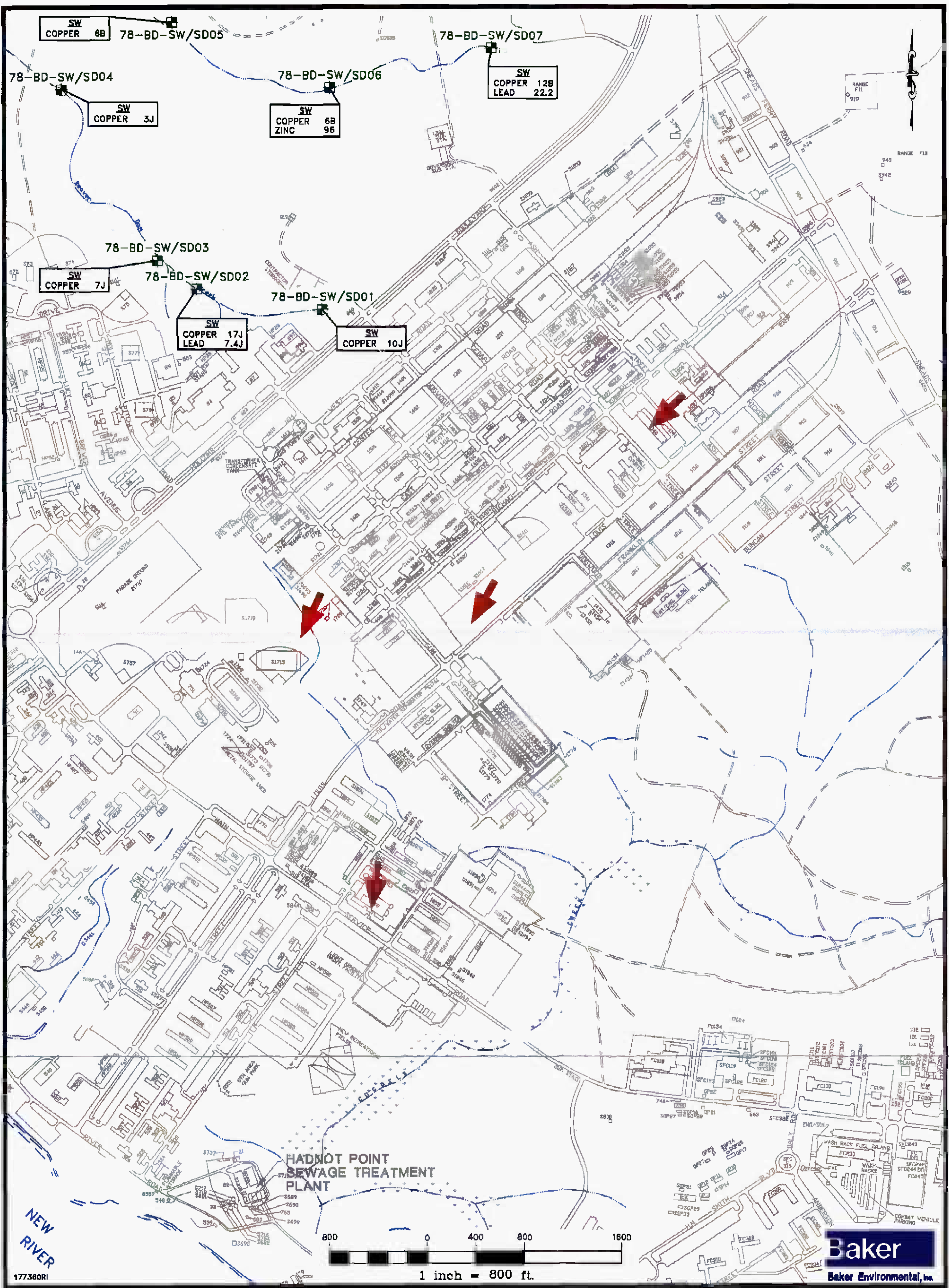
ND-NOT DETECTED NA-NOT ANALYZED

NOTES:
- -TYPICALLY 2 SEDIMENT SAMPLES (0-6" AND 6"-12") WERE COLLECTED AT EACH STATION.
- -SURFACE WATER SAMPLE LOCATIONS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS OF ORGANIC COMPOUNDS.
- -ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER KILOGRAM(ug/kg).

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-30
POSITIVE DETECTIONS OF ORGANIC COMPOUNDS IN SEDIMENTS ABOVE FEDERAL SCREENING VALUES IN BEAVER DAM CREEK
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00522WB7V



LEGEND

78-BD-SW/SD01 ■ SURFACE WATER(SW)/SEDIMENT(SD) SAMPLE STATION

➔ APPROXIMATE GROUNDWATER FLOW DIRECTION

NOTES:
-SURFACE WATER SAMPLE LOCATIONS SHOWN WITHOUT CONCENTRATIONS INDICATES NONDETECTABLE LEVELS OF TAL METALS.
-ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER(ug/l).

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-31
POSITIVE DETECTIONS OF TAL METALS IN SURFACE WATER ABOVE FEDERAL WQSVs AND/OR NCWQS IN BEAVER DAM CREEK
SITE 78
REMEDIAL INVESTIGATION CTO-0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

surface water samples), lead (in two surface water samples and four sediment samples), and zinc (in one surface water sample). Among surface water samples, the maximum copper concentration was detected in sample 78-BD-SW02 (17 J µg/l), the maximum lead concentration was detected in sample 78-BD-SW07, and the maximum zinc concentration was detected in sample 78-BD-SW06 (96 µg/l). In sediments, the maximum lead concentration was detected in sample 78-BD-SD01-612.

While elevated inorganic concentrations are present throughout much of the Beaver Dam Creek area of the site, maximum concentrations of inorganics are primarily found in the narrower reaches of Beaver Dam Creek, which are situated adjacent to roadways and developed areas.

## 4.4 Summary of Nature and Extent of Contamination at OU No. 1

This section summarizes the nature and extent of contamination at OU No. 1 (Sites 21, 24, and 78).

### 4.4.1 Site 21

Site 21 investigation results indicate that soils, surface water and sediment within portions of the site are impacted by organic compounds, predominantly pesticides and PCBs. Pesticides were detected in soil (detection range from 4.6 µg/kg to 34,000 µg/kg), surface water (detected in one sample only at 0.24 µg/l), and sediment (detection range from 3.7 µg/kg to 3,500 µg/kg) samples, but were not detected in groundwater samples. Although pesticides were found throughout the site in both soils and sediment, the analytical data indicated that the most significant concentrations were detected in samples collected in the vicinity of the Former Pesticide Mixing/Disposal Area. Accordingly, the source of the pesticides at the site appears to be related to the previous mixing and disposal activities.

PCB-1260 was also detected in soil and sediment samples collected at Site 21. The PCBs were only detected in the surface samples collected from these two media. The overall highest concentrations detected in the soils and sediment were 4,600 µg/kg and 120 µg/kg, respectively. Both of these samples were collected in the vicinity of the Former PCB Transformer Oil Disposal Area. Subsequently, the source of the PCBs at the site appears to be related to the disposal of transformer oils.

VOCs and SVOCs were not extensively found within the various media sampled at Site 21. Limited VOC and SVOC contamination were present in soils. Further, neither contaminant group was detected in surface water or sediment samples. A groundwater sample collected from well 21GW02, however, exhibited elevated levels of VOCs including BTEX and TCE. These compounds were detected at concentrations which exceeded drinking water standards. The VOCs impacting this well appear to be have migrated from an off site source, most likely from facilities located within Site 78 (possibly Site 22, Hadnot Point Fuel Farm or the 900 Building area). This conclusion is supported by the fact that VOCs were not extensively found in other site media (e.g., soils, sediment, or surface water). In addition, there is no history of solvent disposal/usage or fuel storage/dispensing at Site 21.

### 4.4.2 Site 24

Site 24 investigation results indicated that soils and groundwater within portions of the site are impacted by organic compounds (i.e., specifically pesticides), and metals. Pesticides were detected in soil samples (predominantly surface soils) throughout the site but at relatively low concentrations (highest concentration of 350 µg/kg). Low concentrations of heptachlor epoxide (concentration ranged from 0.078 µg/l to 0.13 µg/l) were also detected in three wells at levels which exceeded the NCWQS. Moreover, note that surface water and sediment samples collected in Cogdels Creek at stations located adjacent to Site 24 did not contain any organic contamination, including pesticides. Based on the relatively low concentrations and widespread detections of pesticides found in the soil and groundwater at Site 24, it appears that the pesticides have resulted from routine spraying activities, not direct disposal. This conclusion is supported by the fact that there is no history of pesticide disposal at Site 24.

TAL metals are also prevalent in site soils and groundwater. Arsenic, cadmium, chromium, lead, manganese, mercury, and nickel were detected at relatively high concentrations (i.e., compared to base-specific background levels) in both soils and groundwater. The detection of these metals in both media was common throughout the site; however, the highest concentrations were detected near the Buried Metal Disposal Area. Note that surface water samples collected in Cogdels Creek at stations located adjacent to Site 24 exhibited copper, lead, and zinc concentrations above the Federal WQSVs and/or the NCWQSs. The source of the metals detected at Site 24 appears to be the buried metal debris and fly ash materials which were reportedly disposed of at the site.

### 4.4.3 Site 78

Site 78 investigation results indicated that soil, groundwater, surface water, and sediment within portions of the site have been impacted by organic compounds and metals. In general, pesticides were the predominant contaminants impacting site soil and sediment. In groundwater (i.e., shallow, intermediate, and deep) and surface water, VOCs and metals were the predominant contaminants of concern.

Pesticides were detected throughout Site 78 in soil and sediment samples. In soils, the concentrations (which included 4,4'-DDE, 4,4'-DDD, 4,4'-DDE, dieldrin, alpha chlordane, and/or gamma chlordane) were generally below 500 µg/kg, with the exception of a few samples which exhibited levels above 1,000 µg/kg at Buildings 1103 and 1502. Pesticides were also detected in sediment samples collected from Cogdels Creek (highest concentration of 400 µg/kg), the New River (highest concentration of 150 µg/kg), and Beaver Dam Creek (highest concentration of 93 µg/kg). Note that no pesticides were detected in groundwater (shallow and intermediate) or surface water samples collected at Site 78. A low concentration of alpha chlordane (0.11 µg/l), however, was detected in one of the deep wells (78GW09-3). The source of this contaminant is not known. This is the first and only time the pesticide was detected. Based on the widespread detections of the pesticides, and the relatively low concentration levels observed, it appears that the pesticides present in soil and sediment are the result of routine spraying activities at the Base and do not reflect disposal activities.

Groundwater samples collected from Site 78 indicated elevated levels of VOCs and several TAL metals (including: arsenic, beryllium, barium, cadmium, chromium, lead, manganese, mercury, and nickel) above drinking water standards. The shallow groundwater appears to be most severely impacted by these contaminants. Concentrations of both halogenated and nonhalogenated VOCs were detected primarily in several shallow wells located near the northeastern portion of the site and in the area near Building 1601. TAL metals were detected throughout the site in the shallow groundwater and did not indicate a particular contaminant or pattern trend. Although the shallow water-bearing zone appears to be the most impacted, it should be noted that the deeper water-bearing zone also exhibited elevated VOC contamination. Moreover, groundwater data obtained over the past three years at this site suggests that the contaminant levels in the deep water-bearing zone are increasing with time, which may indicate that the VOC contamination is migrating vertically.

In addition to the groundwater, surface water samples collected from Site 78 also indicated levels of VOCs and TAL metals. Toluene, TCE, and 1,2-DCE were the most frequently detected VOCs in the surface water (Cogdels Creek only). In terms of TAL metals, aluminum, barium, calcium, chromium, copper, iron, lead, potassium, sodium, vanadium, and zinc were the most frequently detected above the standards in Beaver Dam Creek, Cogdels Creek, and/or the New River. Note that barium, cadmium, chromium, and lead were found at elevated levels in both the groundwater water and surface water at Site 78.

A number of potential contaminant sources exist within Site 78 which may be contributing to the elevated VOCs and metals. The primary sources of the VOCs include the numerous confirmed and/or suspected USTs and aboveground storage tanks, maintenance and repair facilities, the Hadnot Point Fuel Farm (Site 22), and waste storage areas. Many of these sources were identified and discussed in Section 1.0 in this report. Identifying specific sources of the metals contamination at Site 78, however, is somewhat more difficult, given the fact that metals are present throughout the site and that they exhibit no particular trend. Some of the potential sources may include buried metal, fly ash debris, and wastes generated by industrial processes.

# Section 4.0 Tables

### TABLE 4 - 1
### OPERABLE UNIT NO. 1 - SITE 21
### TRANSFORMER STORAGE LOT 140
### SURFACE SOIL POSITIVE DETECTION SUMMARY
### REMEDIAL INVESTIGATION CTO - 19177
### MCB CAMP LEJEUNE, NORTH CAROLINA
### ORGANIC CHEMICALS

| SAMPLE NO. | 21-PCB-SB01-00 | 21-PCB-SB02-00 | 21-PCB-SB03-00 | 21-PCB-SB04-00 | 21-PCB-SB05-00 | 21-PCB-SB07-00 | 21-PCB-SB08-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| **VOLATILES** | | | | | | | |
| ACETONE | | | | | | | |
| XYLENES (total) | | | | | | | |
| **SEMIVOLATILES** | | | | | | | |
| NAPHTHALENE | | | | | | | |
| 2-METHYLNAPHTHALENE | | | | | | | |
| FLUORENE | | | | | | | |
| PHENANTHRENE | | | 120 J | 46 J | | 67 J | |
| ANTHRACENE | | | | | | | |
| FLUORANTHENE | | 51 J | 300 J | 67 J | | 150 J | |
| PYRENE | | 69 J | 200 J | 170 J | | 110 J | |
| 3,3'-DICHLOROBENZIDINE | | | | 82 J | | | |
| BENZO(A)ANTHRACENE | | | 150 J | 73 J | | 95 J | |
| CHRYSENE | | 46 J | 160 J | 100 J | 95 J | 93 J | |
| BIS(2-ETHYLHEXYL)PHTHALATE | 51 J | | | | | | |
| BENZO(B)FLUORANTHENE | | 80 J | 250 J | 170 J | | 140 J | |
| BENZO(K)FLUORANTHENE | | 48 J | 69 J | 58 J | | 76 J | |
| BENZO(A)PYRENE | | 60 J | 140 J | 130 J | | 94 J | |
| INDENO(1,2,3-CD)PYRENE | | 40 J | 73 J | 98 J | | 58 J | |
| DIBENZ(A,H)ANTHRACENE | | | | | | | |
| BENZO(GHI)PERYLENE | | 44 J | 68 J | 110 J | | 56 J | |
| **PESTICIDES/PCBS** | | | | | | | |
| 4,4'-DDE | | | 7.1 J | | | | 24 |
| 4,4'-DDD | 8.9 | 3.6 | 8.7 | | | | |
| 4,4'-DDT | | | | | | | 15 |
| ALPHA-CHLORDANE | | | | | | | |
| GAMMA-CHLORDANE | | | | | | | |
| AROCLOR-1260 | | | 290 | 2100 | 34 J | 310 J | |

ug/kg - microgram per kilogram
J - value is estimated

## TABLE 4 - 1
## OPERABLE UNIT NO. 1 - SITE 21
## TRANSFORMER STORAGE LOT 140
## SURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO.<br>DEPTH<br>UNITS | 21-PCB-SB10-00<br>0-6"<br>UG/KG | 21-PCB-SB11-00<br>0-6"<br>UG/KG | 21-PCB-SB13-00<br>0-6"<br>UG/KG | 21-PCB-SB17-00<br>0-6"<br>UG/KG | 21-PCB-SB18-00<br>0-6"<br>UG/KG | 21-PCB-SB19-00<br>0-6"<br>UG/KG | 21-PST-SB01-00<br>0-6"<br>UG/KG |
|---|---|---|---|---|---|---|---|
| **VOLATILES** | | | | | | | |
| ACETONE | | | | | | | |
| XYLENES (total) | | | | | | | |
| **SEMIVOLATILES** | | | | | | | |
| NAPHTHALENE | | | | | | | |
| 2-METHYLNAPHTHALENE | | | | | | | |
| FLUORENE | | | | | | | |
| PHENANTHRENE | | 41 J | | | | | |
| ANTHRACENE | | 47 J | | | | | |
| FLUORANTHENE | | 560 | | | | | |
| PYRENE | | 520 | | | | | |
| 3,3'-DICHLOROBENZIDINE | | | | | | | |
| BENZO(A)ANTHRACENE | | 510 | | | | | |
| CHRYSENE | | 450 | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | 650 J | | | | | |
| BENZO(B)FLUORANTHENE | | 560 | | | | | |
| BENZO(K)FLUORANTHENE | | 320 J | | | | | |
| BENZO(A)PYRENE | | 310 J | | | | | |
| INDENO(1,2,3-CD)PYRENE | | 180 J | | | | | |
| DIBENZ(A,H)ANTHRACENE | | 62 J | | | | | |
| BENZO(GHI)PERYLENE | | 160 J | | | | | |
| **PESTICIDES/PCBS** | | | | | | | |
| 4,4'-DDE | 160 | 16 | 4.5 J | | | | 150 |
| 4,4'-DDD | 14 | 4.9 | | | | | 310 J |
| 4,4'-DDT | 99 | 16 | | | | | |
| ALPHA-CHLORDANE | | | | | | | |
| GAMMA-CHLORDANE | | | | | | | |
| AROCLOR-1260 | 67 | | | 4300 | 3700 | 4600 | 2200 |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 1
# OPERABLE UNIT NO. 1 - SITE 21
# TRANSFORMER STORAGE LOT 140
# SURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO. | 21-PST-SB02-00 | 21-PST-SB03-00 | 21-PST-SB04-00 | 21-PST-SB05-00 | 21-PST-SB06-00 | 21-PST-SB07-00 | 21-PST-SB08-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| **VOLATILES** | | | | | | | |
| ACETONE | | | 300 J | | | | |
| XYLENES (total) | | | 1100 | | | | |
| **SEMIVOLATILES** | | | | | | | |
| NAPHTHALENE | | | 3200 J | | | | |
| 2-METHYLNAPHTHALENE | | | 13000 | | | | |
| FLUORENE | | | 1300 J | | | | |
| PHENANTHRENE | | | 1800 J | | | | |
| ANTHRACENE | | | | | | | |
| FLUORANTHENE | | | | | | | |
| PYRENE | | | | | | | |
| 3,3'-DICHLOROBENZIDINE | | | | | | | |
| BENZO(A)ANTHRACENE | | | | | | | |
| CHRYSENE | | | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | | | | |
| BENZO(B)FLUORANTHENE | | | | | | | |
| BENZO(K)FLUORANTHENE | | | | | | | |
| BENZO(A)PYRENE | | | | | | | |
| INDENO(1,2,3-CD)PYRENE | | | | | | | |
| DIBENZ(A,H)ANTHRACENE | | | | | | | |
| BENZO(GHI)PERYLENE | | | | | | | |
| **PESTICIDES/PCBS** | | | | | | | |
| 4,4'-DDE | | | | | 81 J | 59 J | 84 J |
| 4,4'-DDD | 15 J | 34000 J | 26000 J | 260 J | | 40 J | 13 J |
| 4,4'-DDT | 33 J | | | 960 J | 590 J | 3100 J | 300 J |
| ALPHA-CHLORDANE | | 1800 J | | 20 J | 25 J | | 6.2 J |
| GAMMA-CHLORDANE | 4.6 J | 2200 J | 1700 | 19 | 26 J | | 6.8 J |
| AROCLOR-1260 | 940 J | | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

## TABLE 4 - 1
## OPERABLE UNIT NO. 1 - SITE 21
## TRANSFORMER STORAGE LOT 140
## SURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO. | 21-PST-SB09-00 | 21-PST-SB10-00 | 21-PST-SB11-00 |
|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" |
| UNITS | UG/KG | UG/KG | UG/KG |
| **VOLATILES** | | | |
| ACETONE | | | |
| XYLENES (total) | | | |
| **SEMIVOLATILES** | | | |
| NAPHTHALENE | | | |
| 2-METHYLNAPHTHALENE | | | |
| FLUORENE | | | |
| PHENANTHRENE | | | |
| ANTHRACENE | | | |
| FLUORANTHENE | | | |
| PYRENE | | | |
| 3,3'-DICHLOROBENZIDINE | | | |
| BENZO(A)ANTHRACENE | | | |
| CHRYSENE | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | |
| BENZO(B)FLUORANTHENE | | | |
| BENZO(K)FLUORANTHENE | | | |
| BENZO(A)PYRENE | | | |
| INDENO(1,2,3-CD)PYRENE | | | |
| DIBENZ(A,H)ANTHRACENE | | | |
| BENZO(GHI)PERYLENE | | | |
| **PESTICIDES/PCBS** | | | |
| 4,4'-DDE | 7.8 J | 120 J | 110 J |
| 4,4'-DDD | | 13 J | 81 |
| 4,4'-DDT | 19 J | 260 J | 4100 J |
| ALPHA-CHLORDANE | | | |
| GAMMA-CHLORDANE | | | |
| AROCLOR-1260 | | | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 2
# OPERABLE UNIT NO. 1 - SITE 21
# TRANSFORMER STORAGE LOT 140
# SURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO. | 21-PCB-SB01-00 | 21-PCB-SB02-00 | 21-PCB-SB03-00 | 21-PCB-SB04-00 | 21-PCB-SB05-00 | 21-PCB-SB07-00 |
|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 7320 | 4830 | 3080 | 2820 | 2740 | 6160 |
| ARSENIC | 0.93 B | 1 B | 0.97 B | 1.4 B | 0.76 B | 1.3 B |
| BARIUM | 15.7 B | 15.8 B | 31.6 B | 13.4 B | 9.1 B | 13.5 B |
| BERYLLIUM | | | 0.22 B | 0.21 B | | 0.21 B |
| CADMIUM | | | | | | |
| CALCIUM | 70600 | 14000 | 28500 | 101000 | 15900 | 136000 |
| CHROMIUM | 11.9 J | 5.8 J | 8.6 J | 9.4 J | 6.1 J | 15.2 J |
| COBALT | 2.4 B | | | 2.1 B | | |
| COPPER | 4.3 B | 3.1 B | 5.6 | 11.1 | 3.2 B | 4 B |
| IRON | 3700 J | 2860 J | 3650 J | 3220 | 2030 | 3510 |
| LEAD | 13.6 J | 21.8 J | 24.9 J | 12.6 J | 26 J | 10.9 J |
| MAGNESIUM | 1140 | 519 B | 634 B | 1680 | 344 B | 2190 |
| MANGANESE | 48.1 J | 28.2 J | 25.2 J | 40.1 J | 14.2 J | 29.5 J |
| MERCURY | | | 0.54 | | | |
| NICKEL | | | 6 B | | | 4.8 B |
| POTASSIUM | 414 B | 281 B | 196 B | 320 B | 151 B | 451 B |
| SELENIUM | | 0.46 J | 0.37 J | 0.44 J | 0.49 J | 0.32 J |
| SODIUM | 136 B | 67.8 B | 80.2 B | 226 B | 96.2 B | 429 B |
| VANADIUM | 16 | 8.1 B | 15.9 | 17.4 | 4.2 B | 11.8 |
| ZINC | 18.8 | 14.5 | 21.1 | 32.1 | 17.3 | 15.4 |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 2
# OPERABLE UNIT NO. 1 - SITE 21
# TRANSFORMER STORAGE LOT 140
# SURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO. | 21-PCB-SB11-00 | 21-PST-SB04-00 | 21-PST-SB08-00 |
|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" |
| UNITS | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 2840 | 2710 J | 1120 |
| ARSENIC | 3.9 J | 0.97 B | 1.3 B |
| BARIUM | 22.6 B | 15.7 B | 9.3 B |
| BERYLLIUM | | | 0.21 B |
| CADMIUM | | | 1 |
| CALCIUM | 111000 | 53600 | 183000 |
| CHROMIUM | 17.1 J | 7.6 J | 19.9 J |
| COBALT | | | |
| COPPER | 16.3 J | 5.2 B | 4.4 B |
| IRON | 6730 | 2280 J | 2970 J |
| LEAD | 252 J | 54.4 | 44.4 |
| MAGNESIUM | 1820 | 847 B | 2700 |
| MANGANESE | 70 J | 13.8 | 66.2 J |
| MERCURY | | | |
| NICKEL | | | |
| POTASSIUM | 239 B | 121 B | 369 B |
| SELENIUM | 0.59 J | | |
| SODIUM | 218 B | 122 B | 380 J |
| VANADIUM | 8.6 B | 6.3 B | 7.5 B |
| ZINC | 67.7 J | 44.7 | 25.5 |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

## TABLE 4 - 3
## OPERABLE UNIT NO. 1 - SITE 21
## TRANSFORMER STORAGE LOT 140
## SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO. | 21-PCB-SB01-02 | 21-PCB-SB08-03 | 21-PCB-SB12-03 | 21-PST-SB03-02 | 21-PST-SB04-01 | 21-PST-SB07-01 | 21-GW02-04 | 21-GW03-03 |
|---|---|---|---|---|---|---|---|---|
| DEPTH | 4-6' | 6-8' | 6-8' | 4-6' | 2-4' | 2-4' | 10-12' | 10-12' |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| **VOLATILES** | | | | | | | | |
| METHYLENE CHLORIDE | 12 J | | | | | | | |
| ACETONE | | | | | 470 J | | | |
| TOLUENE | | | | | 37 J | | | |
| ETHYLBENZENE | | | | | 570 | | | |
| XYLENES (total) | | | | | 3400 | | | |
| **SEMIVOLATILES** | | | | | | | | |
| NAPHTHALENE | | | | | 2100 | | | |
| 2-METHYLNAPHTHALENE | | | | | 10000 | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | 57 J | | | | 190 J | | | 71 J |
| **PESTICIDES/PCBS** | | | | | | | | |
| 4,4'-DDD | | | | 47.0 J | 2800 J | | 5.7 | |
| 4,4'-DDT | | 4.6 J | 12.0 | | | 6.7 J | | |
| ALPHA-CHLORDANE | | | | | 59 J | | | |
| GAMMA-CHLORDANE | | | | | 90 | | | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 4
# OPERABLE UNIT NO. 1 - SITE 21
# TRANSFORMER STORAGE LOT 140
# SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO. | 21-PCB-SB01-02 | 21-PCB-SB02-05 | 21-PCB-SB03-04 | 21-PCB-SB04-04 | 21-PCB-SB05-03 | 21-PCB-SB07-03 |
|---|---|---|---|---|---|---|
| DEPTH | 4-6' | 10-12' | 8-10' | 8-10' | 6-8' | 6-8' |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 8130 | 4650 | 7210 | 6980 | 10200 | 14500 |
| ARSENIC | 1.1 B | 5.2 | 1.2 B | 0.48 B | 1.4 B | 1.4 J |
| BARIUM | 12.2 B | 5.1 B | 9.4 B | 8.8 B | 13.7 B | 12 B |
| BERYLLIUM | | | | | 0.24 B | 0.24 B |
| CADMIUM | | | | | | |
| CALCIUM | 37200 | 44.6 B | 110 B | 12000 | 17100 | 2190 |
| CHROMIUM | 13.3 J | 6.5 J | 12 J | 10.6 J | 16.8 J | 19.7 J |
| COBALT | 1.8 B | | 2.2 B | | 1.9 B | |
| COPPER | 2.1 B | 1.2 B | 1.9 B | 1.2 B | 2.4 B | 0.96 B |
| IRON | 4450 J | 6200 J | 2110 J | 2320 | 9720 | 6860 |
| LEAD | 12.3 J | 3.8 J | 5.2 J | 6.2 J | 24.8 J | 7 J |
| MAGNESIUM | 926 B | 190 B | 311 B | 490 B | 634 B | 631 B |
| MANGANESE | 40.6 J | 3.3 J | 5.8 J | 8.8 J | 14.4 J | 8.4 J |
| NICKEL | 4.6 B | | | | 5.8 B | |
| POTASSIUM | 384 B | 196 B | 439 B | 369 B | 355 B | 574 B |
| SELENIUM | 0.25 J | 0.23 J | 0.34 J | 0.39 J | 0.31 J | 0.46 J |
| SODIUM | 86.6 B | 51.6 B | 55.8 B | 62.1 B | 108 B | 62.6 B |
| THALLIUM | | | | | | |
| VANADIUM | 14.9 | 13.8 | 10.6 B | 12.2 | 15.6 | 22.4 |
| ZINC | 11.7 | 4.2 B | 5.1 | 5.8 | 18.1 | 7.5 |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit(CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 4
# OPERABLE UNIT NO. 1 - SITE 21
# TRANSFORMER STORAGE LOT 140
# SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO. | 21-PCB-SB11-02 | 21-PST-SB04-01 | 21-PST-SB08-03 | 21-GW02-04 | 21-GW02-05 | 21-GW03-03 |
|---|---|---|---|---|---|---|
| DEPTH | 4-6' | 2-4' | 6-8' | 10-12' | 10-12' | 10-12' |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 6720 | 3510 J | 10500 | 3130 | 1150 | 9410 |
| ARSENIC | 1.4 J | 0.85 B | 0.77 B | 0.55 J | 0.93 J | 2.2 B |
| BARIUM | 8.8 B | 14 B | 15.6 B | 4.4 J | 2.1 J | 11 B |
| BERYLLIUM | 0.24 B | | 0.26 B | 0.23 B | 0.24 J | 0.24 B |
| CADMIUM | 1.5 | | | | | |
| CALCIUM | 479 B | 12900 | 57.4 B | 295 J | | 3830 J |
| CHROMIUM | 8.3 J | 5.7 J | 14.3 J | 3.2 J | 2.6 J | 15.2 |
| COBALT | | | | | | |
| COPPER | 3.4 J | 3.2 B | 1.3 B | 1.1 B | 1.7 J | 1.4 B |
| IRON | 3250 | 2290 J | 2640 J | 791 J | 940 J | 3510 |
| LEAD | 5.8 | 23.1 J | 7.7 | 6.9 J | 2.6 J | 7.1 |
| MAGNESIUM | 285 B | 316 B | 349 B | 127 B | 33.3 B | 478 B |
| MANGANESE | 3.9 J | 7.8 | 4.3 J | 3.4 J | 2.9 J | 9.8 |
| NICKEL | | | | | | |
| POTASSIUM | 329 B | 102 B | 369 B | 159 B | 49.2 B | 507 B |
| SELENIUM | | 0.23 B | | | 0.36 J | 0.33 J |
| SODIUM | 50.1 B | 46.7 B | 51 J | 41.4 | 48.8 B | 72.4 B |
| THALLIUM | | | | 0.23 | | |
| VANADIUM | 13.4 | 5.7 B | 13.5 | 4.4 J | 3.6 J | 15.5 |
| ZINC | 4.9 J | 15.1 | 4.3 B | 3 J | 9.8 J | 5.7 |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit(CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 4
# OPERABLE UNIT NO. 1 - SITE 21
# TRANSFORMER STORAGE LOT 140
# SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO. | 21-GW03-05 | 21-GW04-03 | 21-GW04-04 |
|---|---|---|---|
| DEPTH | 10-12' | 8-10' | 8-10' |
| UNITS | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 6030 | 5060 | 5410 |
| ARSENIC | 1.8 B | 3.3 J | 1.4 J |
| BARIUM | 8.8 B | 9.1 B | 10.7 B |
| BERYLLIUM | | 0.25 B | |
| CADMIUM | | | |
| CALCIUM | 110 B | 127 B | 77.9 B |
| CHROMIUM | 8.8 J | 7.3 J | 12.2 J |
| COBALT | 2 B | | |
| COPPER | 1.8 B | 1.3 J | 2 J |
| IRON | 2540 J | 2610 | 1810 |
| LEAD | 5 J | 5.5 | 6.6 |
| MAGNESIUM | 273 B | 306 B | 319 B |
| MANGANESE | 6 J | 4 J | 4.3 J |
| NICKEL | | | |
| POTASSIUM | 405 B | 338 B | 402 B |
| SELENIUM | | 0.38 J | 0.46 J |
| SODIUM | 73 B | | |
| THALLIUM | | | |
| VANADIUM | 10.3 B | 9.6 B | 18.3 |
| ZINC | 6.5 | 2.5 J | 2.8 J |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit(CRDL), but greater than Instrument Detection Limit (IDL)

TABLE 4-5

# INORGANIC BASE-SPECIFIC BACKGROUND CONCENTRATIONS FOR SURFACE AND SUBSURFACE SOILS REMEDIAL INVESTIGATION CTO-0177 MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Surface Soil(1) Base-Specific Background Concentration Range | Subsurface Soil(2) Base-Specific Background Concentration Range |
|---|---|---|
| Aluminum | <90.5 - 1490 | 672 - 10,200 |
| Antimony | <0.66 - 9.6 | 0.71 - <9.7 |
| Arsenic | <0.44 - 0.91 | <0.47 - <0.65 |
| Barium | 3.6 - 16.5 | <4.0 - 10.9 |
| Beryllium | <0.06 - <0.22 | <0.05 - <0.23 |
| Cadmium | <0.35 - <1.1 | <0.34 - <1.2 |
| Calcium | 108 - 10,700 | <10.7 - 81.3 |
| Chromium | <0.06 - <3.2 | <3.2 - 8.7 |
| Cobolt | <0.37 - <1.8 | <0.35 - <1.9 |
| Copper | <1.1 - 3.1 | <0.47 - 1.2 |
| Iron | 160 - 1020 | 126 - 2840 |
| Lead | 2.0 - 20.4 | 1.2 - 6.1 |
| Magnesium | <20.2 - 200 | <25.4 - 260 |
| Manganese | <2.0 - 11.1 | 1.2 - 5.2 |
| Mercury | <0.02 - <0.12 | <0.02 - <0.11 |
| Nickel | <1.5 - <4.4 | <1.4 - <4.8 |
| Potassium | 54.5 - 102 | <81.6 - 187 |
| Selenium | <0.31 - <1.0 | 0.23 - <1.0 |
| Silver | <0.37 - 62.0 | 0.35 - <2.0 |
| Sodium | <9.4 - 67.5 | <14.5 - <44.9 |
| Thallium | <0.22 - <0.41 | <0.23 - <0.44 |
| Vanadium | <2.1 - 5.3 | <1.5 - 13.4 |
| Zinc | <1.1 - 28.3 | <0.19 - 11.6 |

Notes:

(1) A total of five surface soil samples were collected from various locations throughout the base for background samples.

(2) A total of six subsurface soil samples were collected from various location throughout the base for background samples. Concentrations expressed in milligram per kilogram (mg/kg).

## TABLE 4 - 6
## OPERABLE UNIT NO. 1 - SITES 21, 24, 78
## GROUNDWATER POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO. | 21-GW02-01 | 21-GW03-01 | 24-GW08-01 | 24-GW09-01 | 24-GW10-01 | 78-GW02-01 | 78-GW04-1-01 |
|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| **VOLATILES** | | | | | | | |
| Vinyl Chloride | | | | | | | |
| Dichlorodifluoromethane | | | | | | | |
| Trichlorofluoromethane | | | | | | | |
| Dichloromethane | | 2 | | | | 1 | |
| 1,1-Dichloroethene | | | | | | | |
| cis-1,2-Dichloroethene | | | | | | | |
| trans-1,2-Dichloroethene | | | | | | | |
| Chloroform | | | | | | | |
| 1,2-Dichloroethane | | | | | | | |
| Bromodichloromethane | | | | | | | |
| 1,2-Dichloropropane | | | | | | | |
| Trichloroethene | 41 J | | | | | | 2 J |
| Benzene | 77 J | | | | | | |
| 1,1,2-Trichloroethane | | | | | | | |
| Tetrachloroethene | | | | | | | |
| Toluene | 210 J | | | | | | |
| Ethylbenzene | 540 J | | | | | | |
| Xylenes (total) | 1300 J | | | | | | |
| **SEMIVOLATILES** | | | | | | | |
| PHENOL | | | | | | | |
| 2-METHYLPHENOL | | | | | | | |
| 4-METHYLPHENOL | 2 J | | | | | | |
| 2,4-DIMETHYLPHENOL | 6 J | | | | | | |
| NAPHTHALENE | 51 | | | | | | |
| 2-METHYLNAPHTHALENE | 20 | | | | | | |
| ACENAPHTHENE | | | | | | | |
| PHENANTHRENE | | | | | | | |
| CARBAZOLE | | | | | | | |
| FLUORANTHENE | | | | | | | |
| BUTYL BENZYL PHTHALATE | | | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | | | | |
| DI-N-OCTYL PHTHALATE | | | | | | | |
| BENZO(B)FLUORANTHENE | | | | | | | |
| **PESTICIDES/PCBS** | | | | | | | |
| HEPTACHLOR EPOXIDE | | | 0.083 J | 0.13 J | 0.078 J | | |
| DIELDRIN | | | | | | | |
| ALPHA-CHLORDANE | | | | | | | |

# TABLE 4 - 6
# OPERABLE UNIT NO. 1 - SITES 21, 24, 78
# GROUNDWATER POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO. | 78-GW04-2-01 | 78-GW04-3-01 | 78-GW05-01 | 78-GW08-01 | 78-GW09-2-01 | 78-GW09-3-01 | 78-GW12-01 |
|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| **VOLATILES** | | | | | | | |
| Vinyl Chloride | | | | | | | |
| Dichlorodifluoromethane | | | | 2 | | | |
| Trichlorofluoromethane | | | | 1 | | | |
| Dichloromethane | | | 2 | | | | |
| 1,1-Dichloroethene | | | | | | | |
| cis-1,2-Dichloroethene | | 3 | | | | | |
| trans-1,2-Dichloroethene | | | | | | | |
| Chloroform | | | | | | | |
| 1,2-Dichloroethane | | | | | | | |
| Bromodichloromethane | | | | | | | |
| 1,2-Dichloropropane | | | | | | | 1 |
| Trichloroethene | | | | | 6 | | |
| Benzene | 5 J | 30 | | | | | |
| 1,1,2-Trichloroethane | | | | | | | |
| Tetrachloroethene | | | | | | | |
| Toluene | | | | | | | |
| Ethylbenzene | | | | | | | |
| Xylenes (total) | | | | | | | |
| **SEMIVOLATILES** | | | | | | | |
| PHENOL | 8 J | 5 J | | | 4 J | 8 J | |
| 2-METHYLPHENOL | | | | | | | |
| 4-METHYLPHENOL | | | | | | | |
| 2,4-DIMETHYLPHENOL | | | | | | | |
| NAPHTHALENE | | | | | | | |
| 2-METHYLNAPHTHALENE | | | | | | | |
| ACENAPHTHENE | | | | | | | |
| PHENANTHRENE | | | | | | | |
| CARBAZOLE | | | | | | | |
| FLUORANTHENE | | | | | | | |
| BUTYL BENZYL PHTHALATE | | | 3 J | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | 5 J | | 4 J | 18 J | |
| DI-N-OCTYL PHTHALATE | | | | | | 2 J | |
| BENZO(B)FLUORANTHENE | | | | | | | |
| **PESTICIDES/PCBS** | | | | | | | |
| HEPTACHLOR EPOXIDE | | | | | | | |
| DIELDRIN | | | | | | | |
| ALPHA-CHLORDANE | | | | | | 0.11 J | |

## TABLE 4 - 6
## OPERABLE UNIT NO. 1 - SITES 21, 24, 78
## GROUNDWATER POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | 78-GW14-01<br>UG/L | 78-GW15-01<br>UG/L | 78-GW17-1-01<br>UG/L | 78-GW17-2-01<br>UG/L | 78-GW19-01<br>UG/L | 78-GW21-01<br>UG/L | 78-GW22-1-01<br>UG/L |
|---|---|---|---|---|---|---|---|
| **VOLATILES** | | | | | | | |
| Vinyl Chloride | | | | | | | |
| Dichlorodifluoromethane | | | | | | | |
| Trichlorofluoromethane | | | | | | | |
| Dichloromethane | 1 | | | 1 | | | |
| 1,1-Dichloroethene | | | | | | | |
| cis-1,2-Dichloroethene | | | | | | | |
| trans-1,2-Dichloroethene | | | | | | | |
| Chloroform | | | | | | | |
| 1,2-Dichloroethane | | | | | | | |
| Bromodichloromethane | | | | | | | |
| 1,2-Dichloropropane | | | | | | | |
| Trichloroethene | | 1 | | | 1 | 2 | |
| Benzene | | | | | | | 9200 J |
| 1,1,2-Trichloroethane | | | | | | | |
| Tetrachloroethene | | 1 | | | 1 | | |
| Toluene | | | | | | | 18000 J |
| Ethylbenzene | | | | | | | 3000 J |
| Xylenes (total) | | | | | | | 16000 J |
| **SEMIVOLATILES** | | | | | | | |
| PHENOL | | | | | | | |
| 2-METHYLPHENOL | | | | | | | |
| 4-METHYLPHENOL | | | | | | | |
| 2,4-DIMETHYLPHENOL | | | | | | | |
| NAPHTHALENE | | | | | | | 260 |
| 2-METHYLNAPHTHALENE | | | | | | | 36 |
| ACENAPHTHENE | | | | | | | |
| PHENANTHRENE | | | | | | | 2 J |
| CARBAZOLE | | | | | | | 12 |
| FLUORANTHENE | | | | | | | 2 J |
| BUTYL BENZYL PHTHALATE | | | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | | | | |
| DI-N-OCTYL PHTHALATE | | | | | | | |
| BENZO(B)FLUORANTHENE | | | | | | | |
| **PESTICIDES/PCBS** | | | | | | | |
| HEPTACHLOR EPOXIDE | | | | | | | |
| DIELDRIN | | | 0.2 | | | | |
| ALPHA-CHLORDANE | | | | | | | |

## TABLE 4 - 6
## OPERABLE UNIT NO. 1 - SITES 21, 24, 78
## GROUNDWATER POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO. | 78-GW23-01 | 78-GW24-1-01 | 78-GW24-2-01 | 78-GW24-3-01 | 78-GW31-2-01 | 78-GW31-3-01 | 78-GW32-2-01 |
|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| **VOLATILES** | | | | | | | |
| Vinyl Chloride | | 97 | | | | | |
| Dichlorodifluoromethane | | | | | | | |
| Trichlorofluoromethane | | | | | | | |
| Dichloromethane | | | | | | | 1 |
| 1,1-Dichloroethene | | 7 | | | | | |
| cis-1,2-Dichloroethene | 14000 J | 3400 | | 3 | | 1 J | |
| trans-1,2-Dichloroethene | 190 J | 140 | | 1 | | | |
| Chloroform | | | | | | | |
| 1,2-Dichloroethane | | | | | | | |
| Bromodichloromethane | | | | | | | |
| 1,2-Dichloropropane | | | | | | | |
| Trichloroethene | 440 J | | | | 3 | | |
| Benzene | | 51 | | 35 | | 15 J | |
| 1,1,2-Trichloroethane | | 2 | | | | | |
| Tetrachloroethene | | | | | | | |
| Toluene | | 2 | | | | | |
| Ethylbenzene | 5 J | | | | | | |
| Xylenes (total) | 28 J | 1 | | | | | |
| **SEMIVOLATILES** | | | | | | | |
| PHENOL | | | | 5 J | 3 J | 4 J | |
| 2-METHYLPHENOL | | | | | | | |
| 4-METHYLPHENOL | | | | | | | |
| 2,4-DIMETHYLPHENOL | | | | | | | |
| NAPHTHALENE | 2 J | 22 | 8 J | 2 J | | | |
| 2-METHYLNAPHTHALENE | | | | | | | |
| ACENAPHTHENE | | | 3 J | | | | |
| PHENANTHRENE | | | | | | | |
| CARBAZOLE | | | 3 J | | | | |
| FLUORANTHENE | | | | | | | |
| BUTYL BENZYL PHTHALATE | | | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | 7 J | | | |
| DI-N-OCTYL PHTHALATE | | | | | | | |
| BENZO(B)FLUORANTHENE | | | | | | | |
| **PESTICIDES/PCBS** | | | | | | | |
| HEPTACHLOR EPOXIDE | | | | | | | |
| DIELDRIN | | | | | | | |
| ALPHA-CHLORDANE | | | | | | | |

# TABLE 4 - 6
## OPERABLE UNIT NO. 1 - SITES 21, 24, 78
## GROUNDWATER POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO. | 78-GW32-3-01 | 78-GW35-01 | 78-GW37-01 | 78-GW38-01 | 78-GW39-01 |
|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L |
| **VOLATILES** | | | | | |
| Vinyl Chloride | | | | | |
| Dichlorodifluoromethane | | | | | |
| Trichlorofluoromethane | | | | | |
| Dichloromethane | | | | | |
| 1,1-Dichloroethene | | | | | |
| cis-1,2-Dichloroethene | | | | | |
| trans-1,2-Dichloroethene | | | | | |
| Chloroform | | 8 | | 1 | |
| 1,2-Dichloroethane | 1 | | | | |
| Bromodichloromethane | | 1 | | | |
| 1,2-Dichloropropane | | | | | |
| Trichloroethene | 6 | | | | |
| Benzene | | | | | |
| 1,1,2-Trichloroethane | | | | | |
| Tetrachloroethene | | | | | 1 |
| Toluene | | | | | |
| Ethylbenzene | | | | | |
| Xylenes (total) | | | | | |
| **SEMIVOLATILES** | | | | | |
| PHENOL | 2 J | | | | |
| 2-METHYLPHENOL | 2 J | | | | |
| 4-METHYLPHENOL | | | | | |
| 2,4-DIMETHYLPHENOL | | | | | |
| NAPHTHALENE | | | | | |
| 2-METHYLNAPHTHALENE | | | | | |
| ACENAPHTHENE | | | | | |
| PHENANTHRENE | | | | | |
| CARBAZOLE | | | | | |
| FLUORANTHENE | | | | | |
| BUTYL BENZYL PHTHALATE | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | 2 J | | | | |
| DI-N-OCTYL PHTHALATE | | | | | |
| BENZO(B)FLUORANTHENE | | | 2 J | | |
| **PESTICIDES/PCBS** | | | | | |
| HEPTACHLOR EPOXIDE | | | | | |
| DIELDRIN | | | | | |
| ALPHA-CHLORDANE | | | | | |

# TABLE 4 - 7
# OPERABLE UNIT NO. 1 - SITES 21, 24, 78
# GROUNDWATER POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL TOTAL METALS AND CYANIDE

| SAMPLE NO. | 21-GW01-01 | 21-GW02-01 | 21-GW03-01 | 21-GW04-01 | 21-GW0A-01 | 21-GW0B-01 | 21-GW0C-01 |
|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| ALUMINUM | 4910 J | 319000 J | 4820 J | 20100 J | 16900 J | 118000 J | 209000 J |
| ANTIMONY | | | | | | | |
| ARSENIC | 15 | 10 | | 11.8 | 45.2 J | 30.4 | 101 |
| BARIUM | 32 B | 647 | 51 B | 119 B | 100 B | 386 | 467 |
| BERYLLIUM | 1 B | 5 | 1 B | 1 B | 1 B | 6 | 8 |
| CADMIUM | | | | | | | |
| CALCIUM | 63000 J | 24100 J | 6130 J | 21700 J | 23800 | 6250 J | 35200 J |
| CHROMIUM | | 348 J | | 33 J | 21 J | 192 J | 291 J |
| COBALT | | 18 B | | 10 B | | 36 B | 60 |
| COPPER | 4 B | 79 | 7 B | 28 | 24 B | 38 | 84 |
| IRON | 9920 J | 122000 J | 13400 J | 24900 J | 38900 J | 72900 J | 106000 J |
| LEAD | | 214 J | | 33 J | 29 | 2000 J | 92.5 J |
| MAGNESIUM | 5070 | 15400 | 4550 B | 5490 | 4850 B | 11600 | 16300 |
| MANGANESE | 64 J | 179 J | 134 J | 193 J | 59 | 276 J | 273 J |
| MERCURY | | 2.4 J | | | | | 0.23 J |
| NICKEL | | 86 | | | | 60 | 123 |
| POTASSIUM | 2390 B | 10500 | 2240 B | 3800 B | 2360 B | 9520 | 11800 |
| SELENIUM | | 11 J | | | | 3.7 J | 4.3 B |
| SILVER | | | | | | | |
| SODIUM | 15700 | 12600 | 7950 | 14400 | 12600 | 14400 | 15200 |
| THALLIUM | | | | | | | |
| VANADIUM | 30 B | 281 | 11 B | 42 B | 48 B | 243 | 419 |
| ZINC | 65 J | 136 J | 27 J | 57 J | 41 J | 175 J | 487 J |

ug/L - microgram per liter
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 7
# OPERABLE UNIT NO. 1 - SITES 21, 24, 78
# GROUNDWATER POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL TOTAL METALS AND CYANIDE

| SAMPLE NO. | 24-GW01-01 | 24-GW02-01 | 24-GW03-01 | 24-GW04-01 | 24-GW06-01 | 24-GW07-01 | 24-GW08-01 |
|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| ALUMINUM | 262000 | 93700 | 50200 | 58900 | 19800 | 36000 | 61100 |
| ANTIMONY | | | | 4.6 B | 3.5 B | | |
| ARSENIC | | 2.3 J | 4.7 J | 116 J | 10.1 J | 3.7 J | 8 J |
| BARIUM | 380 | 1120 | 480 | 290 | 159 B | 85 B | 112 B |
| BERYLLIUM | 3 B | 19 | 5 | 2 B | 9 | 1 B | 2 B |
| CADMIUM | | 12 | | | 5 | | |
| CALCIUM | 4120 B | 2420 B | 124000 | 65600 | 151000 | 4960 B | 27000 |
| CHROMIUM | 296 | 316 | 110 | 153 | 78 | 37 | 85 |
| COBALT | | 41 B | 66 | | 35 B | | |
| COPPER | 49 | 52 | 22 B | 31 | 15 B | 19 B | 24 B |
| IRON | 58600 | 395000 | 16300 | 70500 | 69500 | 13700 | 27500 |
| LEAD | 89 | 17.9 | 21.6 | 23.6 | 7.4 | 11.4 | 23.8 |
| MAGNESIUM | 12200 | 7240 | 37100 | 7690 | 4320 B | 2670 B | 5050 |
| MANGANESE | 117 | 518 | 393 | 66 | 431 | 39 | 47 |
| MERCURY | 0.23 | 2.6 | | | 3.2 | | |
| NICKEL | 38 B | 140 | 85 | | 93 | | |
| POTASSIUM | 12000 | 7550 | 15400 | 6130 | 3370 B | 3870 B | 5580 |
| SELENIUM | 1.3 J | 1.1 J | 16.2 J | 4.3 J | | 2.1 J | 1.9 J |
| SILVER | | | | | | | |
| SODIUM | 6030 | 11600 | 19200 | 5230 | 7280 | 6520 | 6550 |
| THALLIUM | | | 2.4 B | | 1 B | | |
| VANADIUM | 304 | 408 | 92 | 202 | 83 | 64 | 129 |
| ZINC | 118 | 461 | 650 | 80 | 489 | 41 | 47 |

ug/L - microgram per liter
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 7
# OPERABLE UNIT NO. 1 - SITES 21, 24, 78
# GROUNDWATER POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL TOTAL METALS AND CYANIDE

| SAMPLE NO. | 24-GW09-01 | 24-GW10-01 | 78-GW02-01 | 78-GW03-01 | 78-GW04-1-01 | 78-GW04-2-01 | 78-GW04-3-01 |
|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| ALUMINUM | 12800 | 23300 | 29200 J | 23900 J | 297000 J | 286 | 115 B |
| ANTIMONY | 3.3 B | 5.7 B | 169 J | 38.5 J | | | |
| ARSENIC | 4.3 J | 2.5 J | 405 J | 5.7 J | 18.6 J | | 118 J |
| BARIUM | 164 B | 59 B | 109 B | 36 B | 728 | 519 | 547 |
| BERYLLIUM | 1 B | | 12 | 2 B | 19 | 1 B | 1 B |
| CADMIUM | | | 8 | | 12 | | 21 |
| CALCIUM | 9530 | 3820 B | 37000 | 32900 | 642000 | 170000 | 105000 |
| CHROMIUM | 19 | 21 | 18 J | | 496 J | | |
| COBALT | 11 B | | | | 28 B | | |
| COPPER | 11 B | 13 B | 20 B | 8 B | 87 | 4 B | 7 B |
| IRON | 13100 | 7010 | 427000 J | 5020 J | 267000 J | 32 B | 523000 |
| LEAD | 5.1 | 7.3 | 19.6 | 3.4 | 126 | | |
| MAGNESIUM | 7630 | 1760 B | 3650 B | 2210 B | 25500 | 88 B | 3210 B |
| MANGANESE | 180 | 29 | 141 | 27 | 703 | 51 | 591 |
| MERCURY | | | | | 0.75 | | 0.3 |
| NICKEL | | | | | 136 | 20 B | |
| POTASSIUM | 4280 B | 2620 B | 2770 B | 1320 B | 18800 | 21800 | 11300 |
| SELENIUM | 2.6 J | | 19.8 J | 2.4 J | 9 J | | |
| SILVER | | | | | | | |
| SODIUM | 6010 | 6650 | 5120 | 4270 B | 8870 | 11500 | 9290 |
| THALLIUM | | | | | 1.2 J | | |
| VANADIUM | 26 B | 34 B | 1660 | 50 | 591 | | 24 J |
| ZINC | 50 | 20 | 58 J | 12 J | 373 J | 7 J | 79 J |

ug/L - microgram per liter
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 7
# OPERABLE UNIT NO. 1 - SITES 21, 24, 78
# GROUNDWATER POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL TOTAL METALS AND CYANIDE

| SAMPLE NO. | 78-GW05-01 | 78-GW06-01 | 78-GW07-01 | 78-GW08-01 | 78-GW09-2-01 | 78-GW09-3-01 | 78-GW10-01 |
|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| ALUMINUM | 23000 J | 542000 J | 207000 J | 483000 J | 68 J | 2710 J | 404000 J |
| ANTIMONY | | | | | | | |
| ARSENIC | 5.2 J | 26 B | 16.2 | 60.5 | | | 43 J |
| BARIUM | 54 B | 1200 | 1250 | 740 | 27 B | 41 B | 582 |
| BERYLLIUM | 2 B | 9 | 5 | 9 | | 1 B | 8 |
| CADMIUM | | | | | | | |
| CALCIUM | 90200 J | 7180 J | 18700 J | 28200 J | 114000 | 99100 | 54400 |
| CHROMIUM | 17 J | 858 J | 400 J | 491 J | | | 362 J |
| COBALT | | 11 B | 20 B | 29 B | | | 31 B |
| COPPER | 8 B | 127 | 53 | 86 | 4 B | 4 B | 91 |
| IRON | 14900 J | 142000 J | 96700 J | 138000 J | 955 J | 99 J | 157000 J |
| LEAD | 13.1 J | 155 J | 61.5 J | 131 J | | | 257 |
| MAGNESIUM | 12700 | 24000 | 20000 | 18500 | 2550 B | 249 B | 17400 |
| MANGANESE | 161 J | 184 J | 135 J | 213 J | 19 | | 326 |
| MERCURY | | 1.1 J | 0.44 J | 1.3 J | | | 1.5 |
| NICKEL | | 86 | 54 | 89 | | | 108 |
| POTASSIUM | 4770 B | 25600 | 13200 | 14700 | 1220 B | 7820 | 15800 |
| SELENIUM | 6.4 | 5.5 B | 9.1 | 25.3 | | | 18 J |
| SILVER | | | | | | 5 J | |
| SODIUM | 23900 | 5090 | 9260 | 4710 B | 5820 | 7280 | 3340 B |
| THALLIUM | | 1.1 B | | 1.3 J | | | |
| VANADIUM | 28 B | 811 | 406 | 1700 | | 9 B | 499 |
| ZINC | 32 J | 223 J | 158 J | 200 J | 11 J | 181 J | 217 J |

ug/L - microgram per liter
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 7
# OPERABLE UNIT NO. 1 - SITES 21, 24, 78
# GROUNDWATER POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL TOTAL METALS AND CYANIDE

| SAMPLE NO. | 78-GW11-01 | 78-GW12-01 | 78-GW13-01 | 78-GW14-01 | 78-GW15-01 | 78-GW16-01 | 78-GW17-1-01 |
|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| ALUMINUM | 332000 | 108000 J | 61800 J | 103000 J | 205000 J | 341000 J | 168000 J |
| ANTIMONY | | | | | | | |
| ARSENIC | | 9.6 J | 38.3 | 18.4 J | | 19 J | 11.6 J |
| BARIUM | 631 | 155 B | 236 | 321 | 469 | 511 | 261 |
| BERYLLIUM | 5 | 2 B | 3 B | 1 B | 4 B | 6 | 4 B |
| CADMIUM | | | | | | | |
| CALCIUM | 9130 | 31200 | 4040 J | 5300 | 29100 | 62700 | 86900 |
| CHROMIUM | 412 | 114 J | 222 J | 113 J | 215 J | 353 J | 200 J |
| COBALT | | | 20 B | | 9 B | 13 B | 9 B |
| COPPER | 84 | 30 | 18 B | 33 | 49 | 80 | 40 |
| IRON | 120000 | 26400 J | 61800 J | 49600 J | 43300 J | 80900 J | 48700 J |
| LEAD | 195 | 35.5 | 26.4 J | 63 | 53 | 224 | 81 |
| MAGNESIUM | 15400 | 7220 | 11800 | 10600 | 13400 | 10800 | 9940 |
| MANGANESE | 174 | 47 | 57 J | 68 | 115 | 150 | 96 |
| MERCURY | 0.75 | | 0.3 J | 0.38 | | 0.38 | |
| NICKEL | 79 | | 40 | 34 B | 29 B | 61 | 30 B |
| POTASSIUM | 13000 | 6090 | 8210 | 6460 | 12000 | 14000 | 11600 |
| SELENIUM | 12 J | 3.6 J | 4.7 B | 12.4 J | 2.1 J | 14.5 J | |
| SILVER | | | | | | | |
| SODIUM | 3490 B | 5420 | 15000 | 15400 | 6410 | 4120 B | 3180 B |
| THALLIUM | | | | | 1 J | 1.4 J | 1 J |
| VANADIUM | 526 | 145 | 158 | 122 | 248 | 371 | 289 |
| ZINC | 120 J | 64 J | 96 J | 51 J | 116 J | 157 J | 98 J |

ug/L - microgram per liter
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# TABLE 4 - 7
# OPERABLE UNIT NO. 1 - SITES 21, 24, 78
# GROUNDWATER POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL TOTAL METALS AND CYANIDE

| SAMPLE NO. | 78-GW17-2-01 | 78-GW19-01 | 78-GW20-01 | 78-GW21-01 | 78-GW22-01 | 78-GW22-1-01 | 78-GW22-2-01 |
|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| ALUMINUM | 541 J | 4110 J | 149000 J | 23800 J | 78900 J | 257000 | 190000 J |
| ANTIMONY | | | | | 14 J | | |
| ARSENIC | | 3.1 J | 30.3 | 6.3 J | 10 J | 59.5 J | 75.6 |
| BARIUM | 57 B | 101 B | 430 | 382 | 107 B | 411 | 471 |
| BERYLLIUM | 1 B | 1 B | 4 B | 2 B | 1 B | 4 B | 12 |
| CADMIUM | | | | | | | 6 |
| CALCIUM | 144000 | 3700 B | 5450 J | 32900 J | 90100 | 44500 | 118000 J |
| CHROMIUM | | | 231 J | 22 J | 83 J | 238 | 389 J |
| COBALT | | | 35 B | 10 B | | | 170 |
| COPPER | 5 B | 3 B | 61 | 11 B | 34 | 54 | 92 |
| IRON | 2120 J | 8500 J | 101000 J | 26400 J | 27600 J | 62300 | 140000 J |
| LEAD | 5.9 | 8.3 | 119 J | 19.1 J | 37.2 | 272 | 360 J |
| MAGNESIUM | 2570 B | 5740 | 13100 | 9110 | 5500 | 12000 | 13000 |
| MANGANESE | 33 | 26 | 93 J | 85 J | 70 | 158 | 348 J |
| MERCURY | | | 0.37 J | | 0.3 | 0.45 | |
| NICKEL | | | 75 | | 21 B | 99 | 234 |
| POTASSIUM | 1630 B | 2130 B | 9100 | 4100 B | 6180 | 12000 | 10200 |
| SELENIUM | | | 4.2 B | 1.1 B | 4.2 J | 7.5 J | 45 |
| SILVER | | | | | | | |
| SODIUM | 9480 | 24000 | 11900 | 9480 | 12100 | 9910 | 8230 |
| THALLIUM | | | 1.8 B | | 1.7 J | | 3 B |
| VANADIUM | | 9 B | 236 | 86 | 114 | 269 | 547 |
| ZINC | | 6 J | 250 J | 108 J | 50 J | 150 J | 967 J |

ug/L - microgram per liter
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# TABLE 4 - 7
# OPERABLE UNIT NO. 1 - SITES 21, 24, 78
# GROUNDWATER POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL TOTAL METALS AND CYANIDE

| SAMPLE NO.<br>UNITS | 78-GW23-01<br>UG/L | 78-GW24-1-01<br>UG/L | 78-GW24-2-01<br>UG/L | 78-GW24-3-01<br>UG/L | 78-GW25-01<br>UG/L | 78-GW29-01<br>UG/L | 78-GW31-2-01<br>UG/L |
|---|---|---|---|---|---|---|---|
| ALUMINUM | 111000 J | 160000 | 1340 | 304 | 101000 J | 78800 J | 110 B |
| ANTIMONY | | | | | | | |
| ARSENIC | 7.6 J | 100 J | | | 11.4 J | 19 J | |
| BARIUM | 230 | 396 | 34 B | 17 B | 119 B | 1070 | 17 B |
| BERYLLIUM | 2 B | 7 | 1 B | | 2 B | 12 | 1 B |
| CADMIUM | | | 5 | 5 | | | |
| CALCIUM | 10800 | 34400 | 107000 | 73400 | 37800 | 41600 | 77600 |
| CHROMIUM | 101 J | 264 | 10 | | 82 J | 252 J | |
| COBALT | 8 B | 39 B | | | | 17 B | |
| COPPER | 25 | 71 | 6 B | 5 B | 26 | 34 | 3 B |
| IRON | 30800 J | 159000 | 2320 | 2370 | 26300 J | 125000 J | 280 |
| LEAD | 50 | 152 | 3.3 | 2.9 B | 30.5 | 25.5 | |
| MAGNESIUM | 7110 | 11600 | 1740 B | 1500 B | 4500 B | 21900 | 2200 B |
| MANGANESE | 87 | 714 | 21 | 41 | 33 | 341 | 8 B |
| MERCURY | 0.3 | 0.75 | | | | | 0.3 |
| NICKEL | 42 | 91 | | | | 125 | |
| POTASSIUM | 5450 | 9090 | 1050 B | 982 B | 4950 B | 11600 | 1640 B |
| SELENIUM | 4.4 J | 17.6 J | | | 1.6 J | 2.5 J | |
| SILVER | | | | | | | |
| SODIUM | 7450 | 10800 | 8350 | 7050 | 16400 | 21200 | 10400 |
| THALLIUM | 1.7 J | 1.5 B | | | 1.3 J | | |
| VANADIUM | 108 | 436 | 4 J | | 144 | 183 | 4 J |
| ZINC | 67 J | 291 J | 11 J | 16 J | 34 J | 330 J | 23 J |

ug/L - microgram per liter
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# TABLE 4 - 7
# OPERABLE UNIT NO. 1 - SITES 21, 24, 78
# GROUNDWATER POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL TOTAL METALS AND CYANIDE

| SAMPLE NO.<br>UNITS | 78-GW31-3-01<br>UG/L | 78-GW32-2-01<br>UG/L | 78-GW32-3-01<br>UG/L | 78-GW33-01<br>UG/L | 78-GW34-01<br>UG/L | 78-GW35-01<br>UG/L | 78-GW36-01<br>UG/L |
|---|---|---|---|---|---|---|---|
| ALUMINUM | 1200 | 112000 J | 539 J | 78200 | 6870 | 47100 | 120000 |
| ANTIMONY | | | | | | | |
| ARSENIC | | 21.6 J | | 5.6 J | 4.4 J | | 3.1 J |
| BARIUM | 415 | 476 | 42 B | 162 B | 173 B | 261 | 152 B |
| BERYLLIUM | 1 B | 10 | 1 B | 1 B | | 1 B | |
| CADMIUM | | 10 | | | | | |
| CALCIUM | 308000 | 94600 | 5440 | 64800 | 10400 | 7480 | 35400 |
| CHROMIUM | 21 | 215 J | | 65 | | 55 | 111 |
| COBALT | | 84 | | | | | |
| COPPER | 5 B | 87 | | 20 B | 11 B | 15 B | 29 |
| IRON | 72 B | 98500 J | 112 J | 14900 | 7250 | 11800 | 21200 |
| LEAD | | 146 | | 18.1 | 5.5 | 13.2 | 30.2 |
| MAGNESIUM | 151 B | 13700 | 319 B | 7290 | 2880 B | 5680 | 5740 |
| MANGANESE | 2 B | 328 | | 86 | 96 | 57 | 62 |
| MERCURY | | 0.3 | | | | | 0.3 |
| NICKEL | | 166 | | 20 B | | | 24 B |
| POTASSIUM | 61600 | 8460 | 67300 | 6900 | 2620 B | 6150 | 5820 |
| SELENIUM | 1.7 J | 99.5 J | | 12.8 J | | 3.5 J | 1.7 J |
| SILVER | | | | | | | |
| SODIUM | 26100 | 7510 | 42500 | 7030 | 4070 B | 10300 | 2450 B |
| THALLIUM | | 7.3 J | 1.3 J | | | | |
| VANADIUM | 10 J | 462 | 5 B | 74 | 15 B | 59 | 98 |
| ZINC | 10 J | 826 J | | 37 | 59 | 30 | 57 |

ug/L - microgram per liter
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# TABLE 4 - 7
# OPERABLE UNIT NO. 1 - SITES 21, 24, 78
# GROUNDWATER POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL TOTAL METALS AND CYANIDE

| SAMPLE NO. | 78-GW37-01 | 78-GW38-01 | 78-GW39-01 |
|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L |
| ALUMINUM | 73500 | 102000 | 60000 |
| ANTIMONY | | | |
| ARSENIC | 4 J | 33.6 J | |
| BARIUM | 123 B | 420 | 256 |
| BERYLLIUM | 2 B | | |
| CADMIUM | | | |
| CALCIUM | 10100 | 62200 | 16800 |
| CHROMIUM | 65 | 201 | 60 |
| COBALT | | | 10 B |
| COPPER | 22 B | 110 | 699 |
| IRON | 18800 | 67500 | 28800 |
| LEAD | 21.8 | 41.2 | 186 |
| MAGNESIUM | 4600 B | 17500 | 14300 |
| MANGANESE | 62 | 106 | 84 |
| MERCURY | | | 0.52 |
| NICKEL | | 32 B | 32 B |
| POTASSIUM | 5990 | 8180 | 3840 B |
| SELENIUM | 1.1 J | 1.3 J | 4.3 J |
| SILVER | | | |
| SODIUM | 7270 | 10300 | 19500 |
| THALLIUM | | | |
| VANADIUM | 106 | 235 | 67 |
| ZINC | 58 | 134 | 138 |

ug/L - microgram per liter
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# TABLE 4 - 8
# OPERABLE UNIT NO. 1 - SITES 21, 24, 78
# GROUNDWATER POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL DISSOLVED METALS

| SAMPLE NO. | 21-GW01D-01 | 21-GW02D-01 | 21-GW03D-01 | 21-GW04D-01 | 21-GW0AD-01 | 21-GW0BD-01 | 21-GW0CD-01 | 24-GW01D-01 |
|---|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| ALUMINUM | 1460 | | 373 | 38 B | 34 B | 52 B | 383 | 55 B |
| ANTIMONY | | | | | 7.8 B | | | 7.7 B |
| ARSENIC | | | | | 10.6 | 2.3 B | 10.5 | |
| BARIUM | 31 B | 19 B | 36 B | 53 B | 57 B | 82 B | 51 B | 23 B |
| BERYLLIUM | 2 B | 1 B | 1 B | 1 B | | 1 B | 1 B | 1 B |
| CADMIUM | 5 | | | | | | | |
| CALCIUM | 66800 | 17900 | 6070 | 26200 | 24000 | 5000 B | 35900 | 1940 B |
| CHROMIUM | | | | | | | | |
| COBALT | | | | | | | | |
| COPPER | 9 B | 9 B | 7 B | 4 B | | 10 B | 7 B | |
| IRON | 5920 | 32800 | 10600 | 9040 | 24500 J | 16500 | 29900 | |
| LEAD | | | | | | 94 | | |
| MAGNESIUM | 5430 | 5770 | 4390 B | 4760 B | 4220 B | 4530 B | 9140 | 2350 B |
| MANGANESE | 70 | 40 | 134 | 119 | 46 | 124 | 116 | 3 B |
| MERCURY | | | | | | | | |
| NICKEL | | | | | | | | |
| POTASSIUM | 2420 B | 1010 B | 1890 B | 2560 B | 1600 B | 2550 B | 1770 B | 937 B |
| SELENIUM | | | | | | | | |
| SODIUM | 17500 | 12400 | 7700 | 15400 | 12200 | 14600 | 16200 | 5060 |
| THALLIUM | | | | | | | | |
| VANADIUM | | | | | | | | |
| ZINC | 50 | 7 B | 28 | 16 B | 7 B | 6 B | 18 B | |

ug/L - microgram per liter
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# TABLE 4 - 8
## OPERABLE UNIT NO. 1 - SITES 21, 24, 78
## GROUNDWATER POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## TAL DISSOLVED METALS

| SAMPLE NO. | 24-GW02D-01 | 24-GW03D-01 | 24-GW04D-01 | 24-GW06D-01 | 24-GW07D-01 | 24-GW08D-01 | 24-GW09D-01 | 24-GW10D-01 |
|---|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| ALUMINUM | 23 B | 401 | | | | | 108 B | 191 B |
| ANTIMONY | | 9.6 B | 4.1 B | | 5.6 B | 5.8 B | 3.1 B | 8.2 B |
| ARSENIC | | | 16.3 | | | | | |
| BARIUM | 17 B | 138 B | 37 B | 33 B | 14 B | 19 B | 123 B | 13 B |
| BERYLLIUM | | 1 B | 1 B | | | | 1 B | 1 B |
| CADMIUM | | | | | | | | |
| CALCIUM | 713 B | 113000 | 61500 | 88900 | 3500 B | 23000 | 9440 | 3160 B |
| CHROMIUM | | | | | | | | |
| COBALT | | 48 B | | | | | | |
| COPPER | | | | | | | | |
| IRON | 76 B | 958 | 1790 | 20 B | | 47 B | 314 | 282 |
| LEAD | | | | | | | | |
| MAGNESIUM | 1300 B | 31900 | 3320 B | 2100 B | 867 B | 2270 B | 6830 | 1450 B |
| MANGANESE | 8 B | 320 | 11 B | 137 | 11 B | 12 B | 151 | 16 |
| MERCURY | 0.5 | | | | | | | |
| NICKEL | | 57 | | | | | | |
| POTASSIUM | 956 B | 11900 | 879 B | 1100 B | 989 B | 909 B | 3210 B | 1040 B |
| SELENIUM | | 7.3 | | | | | 1.5 B | 1 B |
| SODIUM | 12100 | 18300 | 5360 | 7080 | 6420 | 6430 | 5850 | 6180 |
| THALLIUM | | 1.3 B | | | | | | |
| VANADIUM | | | | | | | | |
| ZINC | | 437 | | | 9 B | | 27 | 10 B |

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# TABLE 4 - 8
# OPERABLE UNIT NO. 1 - SITES 21, 24, 78
# GROUNDWATER POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL DISSOLVED METALS

| SAMPLE NO. | 78-GW02D-01 | 78-GW03D-01 | 78-GW04-1D-01 | 78-GW04-2D-01 | 78-GW04-3D-01 | 78-GW05D-01 | 78-GW06D-01 | 78-GW07D-01 |
|---|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| ALUMINUM | 20 B | 88 B | 20 B | 228 | | 61 B | 179 B | 94 B |
| ANTIMONY | 8.1 B | 13.6 B | | | | | 14.4 J | |
| ARSENIC | | 2 B | | | | | | |
| BARIUM | 17 B | 23 B | 42 B | 510 | 88 B | 34 B | 28 B | 43 B |
| BERYLLIUM | | | | | | 1 B | 1 B | |
| CADMIUM | | | | | | | | |
| CALCIUM | 29900 | 34300 | 76400 | 165000 | 93100 | 93000 | 3310 B | 13300 |
| CHROMIUM | | | | | | | | |
| COBALT | | | | | | | | |
| COPPER | | | | 12 B | 8 B | 8 B | 14 B | 8 B |
| IRON | 1790 J | 2620 J | 1060 J | | 174 J | 30 B | 41 B | 175 |
| LEAD | | | | | | | | |
| MAGNESIUM | 2340 B | 1810 B | 3040 B | 53 B | 3200 B | 12300 | 4380 B | 7380 |
| MANGANESE | 59 | 17 | 96 | | 44 | 152 | 8 B | 6 B |
| MERCURY | | | | | | | | |
| NICKEL | | | | 41 | | | | |
| POTASSIUM | 1220 B | 964 B | 2860 B | 22200 | 11700 | 3890 B | 1630 B | 625 B |
| SELENIUM | | | 2 J | | | 4.6 B | | 2.5 J |
| SODIUM | 4810 B | 4020 B | 8060 | 11800 | 9610 | 23400 | 4970 B | 9160 |
| THALLIUM | | 1 J | | | | | | 1 B |
| VANADIUM | | | | | | | | |
| ZINC | | | | | | 10 B | 7 B | |

ug/L - microgram per liter
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# TABLE 4 - 8
# OPERABLE UNIT NO. 1 - SITES 21, 24, 78
# GROUNDWATER POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL DISSOLVED METALS

| SAMPLE NO. | 78-GW08D-01 | 78-GW09-2D-01 | 78-GW09-3D-01 | 78-GW10D-01 | 78-GW11D-01 | 78-GW12D-01 | 78-GW13D-01 | 78-GW14D-01 |
|---|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| ALUMINUM | 97 B | 32 B | 2240 | 627 | 227 | | 228 | 829 |
| ANTIMONY | 8.3 J | 7.9 B | | 9.8 B | | 10.9 B | | |
| ARSENIC | | | | | | | | |
| BARIUM | 29 B | 23 B | 38 B | 10 B | 26 B | 16 B | 57 B | 99 B |
| BERYLLIUM | 1 B | | | | 1 B | | 1 B | |
| CADMIUM | | | | | | | | |
| CALCIUM | 14400 | 112000 | 88500 | 33800 | 5830 | 27500 | 3430 B | 5660 |
| CHROMIUM | | | | | | 59 | | |
| COBALT | | | | | | | | |
| COPPER | 9 B | | | | 11 B | 17 B | 13 B | |
| IRON | 207 | 36 J | 51 J | 396 J | 57 J | 316 J | 711 | 3480 J |
| LEAD | | | | | | | | |
| MAGNESIUM | 3250 B | 2510 B | 160 B | 1480 B | 4080 B | 3560 B | 5610 | 7880 |
| MANGANESE | 7 B | 13 B | | 9 B | 5 B | 5 B | 11 B | 28 |
| MERCURY | | | | | | | | |
| NICKEL | | | | | | 24 B | | |
| POTASSIUM | 841 B | 1130 B | 8320 | 938 B | 367 B | 581 B | 3100 B | 2060 B |
| SELENIUM | 1.6 J | | | 5.8 | 1.3 B | 5.2 | | |
| SODIUM | 4960 B | 5420 | 7370 | 2820 B | 3170 B | 5160 | 14700 | 15500 |
| THALLIUM | | | 1.9 B | | | | | |
| VANADIUM | 7 B | | 5 B | | | | | |
| ZINC | | | | | 8 B | | 18 B | |

ug/L - microgram per liter
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 8
# OPERABLE UNIT NO. 1 - SITES 21, 24, 78
# GROUNDWATER POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL DISSOLVED METALS

| SAMPLE NO.<br>UNITS | 78-GW15D-01<br>UG/L | 78-GW16D-01<br>UG/L | 78-GW17-1D-01<br>UG/L | 78-GW17-2D-01<br>UG/L | 78-GW19D-01<br>UG/L | 78-GW20D-01<br>UG/L | 78-GW21D-01<br>UG/L | 78-GW22D-1-01<br>UG/L |
|---|---|---|---|---|---|---|---|---|
| ALUMINUM | 37 B | 22 B | | 70 B | 405 | 151 B | 30 B | 231 |
| ANTIMONY | | 11.1 B | 7 B | 9.5 B | | | | |
| ARSENIC | | | | | | 8.5 B | | 21.6 |
| BARIUM | 46 B | 6 B | 29 B | 46 B | 87 B | 47 B | 41 B | 57 B |
| BERYLLIUM | | | | | | 1 B | 1 B | |
| CADMIUM | | | | | | | | |
| CALCIUM | 21700 | 43100 | 78300 | 116000 | 3940 B | 4720 B | 41600 | 32200 |
| CHROMIUM | | | | | | | | |
| COBALT | | | | | | | | |
| COPPER | | | | | | 5 B | 3 B | 17 B |
| IRON | | | 53 J | 1070 J | 693 J | 45200 | 160 | 15400 J |
| LEAD | | | | | | | | 17.2 |
| MAGNESIUM | 5560 | 1220 B | 3720 B | 2500 B | 5660 | 6090 | 7210 | 4880 B |
| MANGANESE | 5 B | | | 32 | 27 | 18 | 41 | 53 |
| MERCURY | | | | | | | | |
| NICKEL | | | | | | | | |
| POTASSIUM | 2080 B | 472 B | 1430 B | 1560 B | 1940 B | 1370 B | 2180 B | 5400 |
| SELENIUM | 1.5 J | 4.5 B | | | | | | 1.9 B |
| SODIUM | 5940 | 3610 B | 3040 B | 9070 | 24000 | 11900 | 8190 | 9890 |
| THALLIUM | | | | | | | | |
| VANADIUM | | | | | | 4 B | | |
| ZINC | 6 B | | | | 7 B | 25 | 17 B | 7 B |

ug/L - microgram per liter
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 8
# OPERABLE UNIT NO. 1 - SITES 21, 24, 78
# GROUNDWATER POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL DISSOLVED METALS

| SAMPLE NO. | 78-GW22D-2-01 | 78-GW22D-01 | 78-GW23D-01 | 78-GW24-1D-01 | 78-GW24-2D-01 | 78-GW24-3D-01 | 78-GW25D-01 | 78-GW29D-01 |
|---|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| ALUMINUM | 51 B | 71 B | 1570 | 77 B | | | 36 B | 93 B |
| ANTIMONY | | 10.2 B | | | | | 7.2 B | |
| ARSENIC | 6 B | 2.5 B | | 4.1 B | | | | |
| BARIUM | 54 B | 15 B | 81 B | 28 B | 26 B | 15 B | 21 B | 59 B |
| BERYLLIUM | 1 B | | | | 1 B | 1 B | | |
| CADMIUM | | | | | | | | |
| CALCIUM | 108000 | 88100 | 11100 | 15500 | 88400 | 68100 | 37100 | 33800 |
| CHROMIUM | | | | | | | | |
| COBALT | | | | | | | | |
| COPPER | 5 B | | | 5 B | 9 B | 8 B | | |
| IRON | 3880 | 305 J | 4070 J | 9190 J | 653 J | 31 J | 25 J | 23 J |
| LEAD | | | | | | | | |
| MAGNESIUM | 7520 | 2420 B | 4090 B | 1620 B | 1450 B | 1450 B | 2250 B | 17000 |
| MANGANESE | 47 | 32 | 20 | 24 | 13 B | 45 | 2 B | 47 |
| MERCURY | | | | 0.6 | | | | |
| NICKEL | | | | | | | | |
| POTASSIUM | 1910 B | 1840 | 1530 B | 835 B | 884 B | 1000 B | 427 B | 6550 |
| SELENIUM | | | | | | | | |
| SODIUM | 8870 | 12100 | 7450 | 10200 | 8090 | 7130 | 16000 | 21700 |
| THALLIUM | | | 1 B | | | | | |
| VANADIUM | | 6 B | | 4 B | | | | |
| ZINC | 9 B | | 8 B | | | | | 18 B |

ug/L - microgram per liter
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

## TABLE 4 - 8
## OPERABLE UNIT NO. 1 - SITES 21, 24, 78
## GROUNDWATER POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## TAL DISSOLVED METALS

| SAMPLE NO. | 78-GW31-2D-01 | 78-GW31-3D-01 | 78-GW32-2D-01 | 78-GW32-3D-01 | 78-GW33D-01 | 78-GW34D-01 | 78-GW35D-01 | 78-GW36D-01 |
|---|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| ALUMINUM | | 1010 | | 281 | 141 B | 163 B | 282 | 37 B |
| ANTIMONY | | | 9.1 B | | 7.7 B | 5.4 B | 7.7 B | |
| ARSENIC | | | | | | | | 2 B |
| BARIUM | 16 B | 405 | 125 B | 3 B | 72 B | 137 B | 189 B | 8 B |
| BERYLLIUM | | | | | | 1 B | 1 B | |
| CADMIUM | | | | | | | | |
| CALCIUM | 76500 | 296000 | 51700 | 377 B | 59500 | 10200 | 6460 | 29500 |
| CHROMIUM | | | | | | 10 | | |
| COBALT | | | | | | | | |
| COPPER | 6 B | 8 B | | | | | | 4 B |
| IRON | 27 J | | 6190 J | 21 J | | 492 | 31 B | 20 B |
| LEAD | | | | | | | | |
| MAGNESIUM | 2260 B | 58 B | 8400 | 37 B | 4760 B | 2280 B | 3630 B | 1770 B |
| MANGANESE | 2 B | | 95 | | 56 | 64 | 25 | 7 B |
| MERCURY | 0.23 | | | | | | | 0.3 |
| NICKEL | | | | | | | | |
| POTASSIUM | 1740 B | 63600 | 3080 B | 66300 | 3810 B | 1890 B | 3030 B | 861 B |
| SELENIUM | | 1.8 J | | 1.5 J | 9.9 | | 3.8 B | 1.7 B |
| SODIUM | 10600 | 26800 | 7780 | 42200 | 6570 | 4090 B | 9890 | 2170 B |
| THALLIUM | | | | | | | | |
| VANADIUM | | 5 B | 6 B | | | | | |
| ZINC | | | 7 B | | | 31 | 7 B | |

ug/L - microgram per liter
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 8
## OPERABLE UNIT NO. 1 - SITES 21, 24, 78
## GROUNDWATER POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## TAL DISSOLVED METALS

| SAMPLE NO. | 78-GW37D-01 | 78-GW38D-01 | 78-GW39D-01 |
|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L |
| ALUMINUM | 31 B | | 153 B |
| ANTIMONY | 5 B | | |
| ARSENIC | | | |
| BARIUM | 33 B | 28 B | 94 B |
| BERYLLIUM | | | |
| CADMIUM | | | |
| CALCIUM | 8130 | 51800 | 15500 |
| CHROMIUM | | | |
| COBALT | | | |
| COPPER | | 5 B | 121 |
| IRON | 162 | | 102 |
| LEAD | | | 4.7 |
| MAGNESIUM | 1880 B | 9310 | 12100 |
| MANGANESE | 15 | 28 | 50 |
| MERCURY | | 0.3 | |
| NICKEL | | | |
| POTASSIUM | 1510 B | 1710 B | 2160 B |
| SELENIUM | | | 3.3 B |
| SODIUM | 7100 | 9960 | 19800 |
| THALLIUM | | | |
| VANADIUM | | | |
| ZINC | 11 B | | 58 |

ug/L - microgram per liter
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4-9

## SUMMARY OF GROUNDWATER FIELD PARAMETERS
## SITE 21
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Well No. | | | Field Parameters | | | |
|---|---|---|---|---|---|---|
| Date of Measurement | Depth of Well (ft.) (1) | Purge Volume (gals.) | Well Volume | Specific Conductance at 25 deg. C (micromhos/cm) | Temperature (deg. C) | pH (S.U.) |
| 21GW01<br>5-20-93 | 25.36 | 7.8 | 1 | 519 | 19.2 | 5.58 |
| | | | 2 | 519 | 19.2 | 5.49 |
| | | | 3 | 519 | 17.9 | 5.35 |
| 21GW02<br>5-20-93 | 18.43 | 18.17 | 1 | 346 | 19.6 | 6.30 |
| | | | 2 | 335 | 18.2 | 6.29 |
| | | | 3 | 335 | 18.2 | 6.43 |
| 21GW0B<br>5-21-93 | 27.00 | 12.0 | 1 | 22 | 17.6 | 4.84 |
| | | | 2 | 23 | 17.4 | 5.15 |
| | | | 3 | 29 | 18.2 | 5.42 |
| | | | 4 | 35 | 18.1 | 5.24 |
| 21GW0C<br>5-21-93 | 23.60 | 7.74 | 1 | 169 | 17.5 | 5.20 |
| | | | 2 | 165 | 17.0 | 4.80 |
| | | | 3 | 159 | 17.1 | 4.90 |
| 21GW03<br>5-21-93 | 17.88 | 22.09 | 1 | 133 | 20.4 | 5.85 |
| | | | 2 | 169 | 17.5 | 5.01 |
| | | | 3 | 193 | 17.7 | 5.11 |
| 21GW0A<br>5-22-93 | 26.34 | 11.4 | 1 | 303 | 17.6 | 6.32 |
| | | | 2 | 325 | 18.7 | 6.79 |
| | | | 3 | 344 | 19.0 | 6.61 |
| 21GW04<br>5-22-93 | 14.48 | 21.42 | 1 | 799 | 18.5 | 7.00 |
| | | | 2 | 750 | 18.2 | 7.09 |
| | | | 3 | 439 | 18.4 | 6.98 |
| | | | 4 | 356 | 18.1 | 6.89 |

(1) Well depth taken from below ground surface (bgs)

### TABLE 4 - 10
### OPERABLE UNIT NO. 1 - SITE 21
### TRANSFORMER STORAGE LOT 140
### SURFACE WATER POSITIVE DETECTION SUMMARY
### REMEDIAL INVESTIGATION CTO - 19177
### MCB CAMP LEJEUNE, NORTH CAROLINA
### ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | 21-DD-SW14<br>UG/L | 21-DD-SW15<br>UG/L |
|---|---|---|
| **VOLATILES** | | |
| METHYLENE CHLORIDE | | 3 J |
| ACETONE | 13 J | 14 |
| **PESTICIDES/PCBS** | | |
| 4,4'-DDD | 0.24 | |

mg/kg - microgram per liter
J - value is estimated

# TABLE 4 - 11
# OPERABLE UNIT NO. 1 - SITE 21
# TRANSFORMER STORAGE LOT 140
# SURFACE WATER POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS

| SAMPLE NO. | 21-DD-SW14 | 21-DD-SW15 |
|---|---|---|
| UNITS | UG/L | UG/L |
| ALUMINUM | 324 | 621 |
| BARIUM | 24 B | 23 B |
| CALCIUM | 89500 | 74200 |
| COPPER | 5 B | 5 B |
| IRON | 244 | 237 |
| MAGNESIUM | 2050 B | 1810 B |
| MANGANESE | 10 B | 2 B |
| POTASSIUM | 3150 B | 3080 B |
| SELENIUM | 3.4 B | 2.6 J |
| SODIUM | 4060 B | 3520 B |
| THALLIUM | 1.1 B | |
| ZINC | | 7 B |

ug/L - microgram per liter
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 12
# OPERABLE UNIT NO. 1 - SITE 21
# TRANSFORMER STORAGE LOT 140
# SEDIMENT POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | 21-DD-SD01-06<br>UG/KG | 21-DD-SD01-612<br>UG/KG | 21-DD-SD02-06<br>UG/KG | 21-DD-SD02-612<br>UG/KG | 21-DD-SD03-06<br>UG/KG | 21-DD-SD03-612<br>UG/KG |
|---|---|---|---|---|---|---|
| **VOLATILES** | | | | | | |
| METHYLENE CHLORIDE | | | | | | |
| ACETONE | | | | | | |
| **SEMIVOLATILES** | | | | | | |
| DI-N-BUTYL PHTHALATE | | | | | | |
| BUTYL BENZYL PHTHALATE | | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | | | |
| DI-N-OCTYL PHTHALATE | | | | | | |
| **PESTICIDES/PCBS** | | | | | | |
| HEPTACHLOR EPOXIDE | | | | | | |
| 4,4'-DDE | | 9.4 | 4.7 | 6.9 | 16 | 22 |
| 4,4'-DDD | 12 | 35 | 7.5 | 9.9 | 21 | 63 |
| 4,4'-DDT | | | 7.2 | 6.7 | 14 | |
| ALPHA-CHLORDANE | | | 3.8 J | 5 J | 19 J | 9.4 J |
| GAMMA-CHLORDANE | | | 3.7 | 4.8 | 19 | 8.8 |
| AROCLOR-1260 | 120 | 110 | | | | |

mg/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 12
# OPERABLE UNIT NO. 1 - SITE 21
# TRANSFORMER STORAGE LOT 140
# SEDIMENT POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | 21-DD-SD04-06<br>UG/KG | 21-DD-SD04-612<br>UG/KG | 21-DD-SD05-06<br>UG/KG | 21-DD-SD05-612<br>UG/KG | 21-DD-SD06-06<br>UG/KG | 21-DD-SD06-612<br>UG/KG |
|---|---|---|---|---|---|---|
| **VOLATILES** | | | | | | |
| METHYLENE CHLORIDE | | | | | | |
| ACETONE | | | | | | |
| **SEMIVOLATILES** | | | | | | |
| DI-N-BUTYL PHTHALATE | | | 82 J | | | |
| BUTYL BENZYL PHTHALATE | | | 110 J | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | 820 | 170 J | | |
| DI-N-OCTYL PHTHALATE | | | 80 J | | | |
| **PESTICIDES/PCBS** | | | | | | |
| HEPTACHLOR EPOXIDE | 32 J | | | | | |
| 4,4'-DDE | 65 J | 100 J | 20 J | 130 | 230 | 56 |
| 4,4'-DDD | 490 J | 1100 | 64 J | 330 J | 220 J | 30 J |
| 4,4'-DDT | 58 | | 73 J | 97 | 3500 J | 150 J |
| ALPHA-CHLORDANE | 540 J | 860 J | 28 J | 53 J | 23 | |
| GAMMA-CHLORDANE | 570 J | 960 J | 28 | 56 | | |
| AROCLOR-1260 | | | | | | |

mg/kg - microgram per kilogram
J - value is estimated

## TABLE 4 - 12
## OPERABLE UNIT NO. 1 - SITE 21
## TRANSFORMER STORAGE LOT 140
## SEDIMENT POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | 21-DD-SD07-06<br>UG/KG | 21-DD-SD08-06<br>UG/KG | 21-DD-SD09-06<br>UG/KG | 21-DD-SD09-612<br>UG/KG | 21-DD-SD10-06<br>UG/KG | 21-DD-SD10-612<br>UG/KG |
|---|---|---|---|---|---|---|
| **VOLATILES** | | | | | | |
| METHYLENE CHLORIDE | | | | | | |
| ACETONE | | | | | | |
| **SEMIVOLATILES** | | | | | | |
| DI-N-BUTYL PHTHALATE | | | | | | |
| BUTYL BENZYL PHTHALATE | | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | | | |
| DI-N-OCTYL PHTHALATE | | | | | | |
| **PESTICIDES/PCBS** | | | | | | |
| HEPTACHLOR EPOXIDE | | | | | | |
| 4,4'-DDE | 7.2 | 4.6 J | | 4.4 J | 4.2 J | |
| 4,4'-DDD | 4.3 J | | 5 J | 6.2 J | 4.7 J | 5.4 J |
| 4,4'-DDT | 18 | 13 J | 19 J | 30 J | 25 J | 49 J |
| ALPHA-CHLORDANE | | | | | | |
| GAMMA-CHLORDANE | | | | | | |
| AROCLOR-1260 | | | | | | |

mg/kg - microgram per kilogram
J - value is estimated

## TABLE 4 - 12
## OPERABLE UNIT NO. 1 - SITE 21
## TRANSFORMER STORAGE LOT 140
## SEDIMENT POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | 21-DD-SD11-06<br>UG/KG | 21-DD-SD13-06<br>UG/KG | 21-DD-SD13-612<br>UG/KG | 21-DD-SD15-06<br>UG/KG | 21-DD-SD15-612<br>UG/KG |
|---|---|---|---|---|---|
| **VOLATILES** | | | | | |
| METHYLENE CHLORIDE | | | | 2 J | 2 J |
| ACETONE | | 37 J | | | |
| **SEMIVOLATILES** | | | | | |
| DI-N-BUTYL PHTHALATE | | | | | |
| BUTYL BENZYL PHTHALATE | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | 96 J | | | |
| DI-N-OCTYL PHTHALATE | | | | | |
| **PESTICIDES/PCBS** | | | | | |
| HEPTACHLOR EPOXIDE | | | | | |
| 4,4'-DDE | | | | | |
| 4,4'-DDD | | 3.9 J | | | |
| 4,4'-DDT | 5.2 D | | | | |
| ALPHA-CHLORDANE | | | | | |
| GAMMA-CHLORDANE | | | | | |
| AROCLOR-1260 | | 59 J | 43 J | | |

mg/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 13
# OPERABLE UNIT NO. 1 - SITE 21
# TRANSFORMER STORAGE LOT 140
# SEDIMENT POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS

| SAMPLE NO. | 21-DD-SD05-06 | 21-DD-SD05-612 | 21-DD-SD09-06 | 21-DD-SD09-612 | 21-DD-SD12-06 | 21-DD-SD12-612 |
|---|---|---|---|---|---|---|
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 1960 | 3970 | 1380 | 2420 | 978 | 762 |
| ARSENIC | 0.48 B | 0.92 B | 0.67 B | 0.78 B | 1.2 J | 1.2 J |
| BARIUM | 7.7 B | 10.4 B | 5.5 B | 11.6 B | 8.7 B | 15.7 B |
| BERYLLIUM | | | | | 0.24 B | 0.25 B |
| CADMIUM | | 1.2 | 1.2 | | | |
| CALCIUM | 28200 J | 20600 J | 141000 | 33000 | 169000 | 138000 |
| CHROMIUM | 2.6 J | 5.1 J | 2.9 J | 5 J | 9.9 | 8.8 |
| COPPER | 3.9 B | 4.2 B | 30.6 | 48.1 | 4.6 B | 5.6 B |
| IRON | 1730 | 2830 | 1640 J | 1740 J | 2670 | 2090 |
| LEAD | 17.1 | 9 | 20 | 38.2 | 19.8 J | 24.5 J |
| MAGNESIUM | 499 B | 416 B | 1630 | 653 B | 2610 | 2030 |
| MANGANESE | 13.2 | 12 | 45.2 J | 34.5 J | 95.4 | 50 |
| NICKEL | | | | | 5.6 B | |
| POTASSIUM | 78.5 B | 117 B | 164 B | 151 B | 321 B | 214 B |
| SELENIUM | | | | | | 0.25 J |
| SODIUM | 107 B | 90.9 B | 346 J | 104 J | 234 B | 258 B |
| VANADIUM | 4.1 B | 6.7 B | 4.3 B | 5 B | 10.4 B | 7.8 B |
| ZINC | 17.3 | 16.6 | 12 | 21.4 | 13.8 | 14.5 |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), bur greater than Instrument Detection Limit (IDL)

# TABLE 4 - 13
# OPERABLE UNIT NO. 1 - SITE 21
# TRANSFORMER STORAGE LOT 140
# SEDIMENT POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS

| SAMPLE NO. | 21-DD-SD13-06 | 21-DD-SD13-612 | 21-DD-SD14-06 | 21-DD-SD14-612 | 21-DD-SD15-06 | 21-DD-SD15-612 |
|---|---|---|---|---|---|---|
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 1030 | 892 | 1040 | 1520 | 1540 J | 1340 J |
| ARSENIC | 0.64 J | | 2 B | 1.1 B | | |
| BARIUM | 13.6 B | 5.8 B | 5.1 B | 10.8 B | 8 B | 5.4 B |
| BERYLLIUM | | | 0.22 B | 0.24 B | | |
| CADMIUM | | | | 1.4 | | |
| CALCIUM | 67000 | 48700 | 171000 | 68300 | 23700 | 32700 |
| CHROMIUM | 11.4 | 4.4 | 10.9 | 4.1 | 3.6 J | |
| COPPER | 3.1 B | 2.4 B | 3.8 B | 5.1 B | 2.6 B | 3.4 B |
| IRON | 1510 | 1570 | 1840 | 2600 | 2650 J | 1640 J |
| LEAD | 7.5 J | 9.9 J | 4.5 J | 11.4 J | 11.8 J | 10.1 J |
| MAGNESIUM | 1090 B | 1010 B | 2800 | 1510 | 415 B | 501 B |
| MANGANESE | 50.5 | 34.5 | 117 | 66.7 | 17.8 | 19.6 |
| NICKEL | | | 4.5 B | | | |
| POTASSIUM | 178 B | 157 B | 305 B | 325 B | 91.7 B | 86.8 B |
| SELENIUM | | | | | | |
| SODIUM | 98.2 B | 104 B | 189 B | 168 B | 89.7 B | |
| VANADIUM | 6.9 B | 4.6 B | 11.6 | 7.2 B | 3.9 B | 4.1 B |
| ZINC | 9.3 | 8.5 | 10.9 | 20.2 | 7.2 | 16 |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), bur greater than Instrument Detection Limit (IDL)

# TABLE 4 - 14
## OPERABLE UNIT NO. 1 - SITE 24
## INDUSTRIAL FLY ASH DUMP
## SURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO. | 24-BDA-SB01-00 | 24-BDA-SB08-00 | 24-BDA-SB09-00 | 24-BDA-SB13-00 | 24-BM-SB02-00 | 24-BM-SB04-00 | 24-BM-SB05-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| **VOLATILES** | | | | | | | |
| ACETONE | 61 J | 67 J | 44 J | | 180 | | 28 J |
| STYRENE | | | | | | | |
| **SEMIVOLATILES** | | | | | | | |
| 2-METHYLNAPHTHALENE | | | | | | | |
| ACENAPHTHENE | | | 68 J | | | | |
| FLUORENE | | | 47 J | | | | |
| PHENANTHRENE | | | 380 | | | | |
| ANTHRACENE | | | 73 J | | | | |
| CARBAZOLE | | | 36 J | | | | |
| FLUORANTHENE | | | 520 J | 39 J | | | |
| PYRENE | | | 870 | | | | |
| BUTYL BENZYL PHTHALATE | 39 J | | | | | | |
| BENZO(A)ANTHRACENE | | | 330 J | | | | |
| CHRYSENE | | | 260 J | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | | | 36 J | |
| BENZO(B)FLUORANTHENE | | | 350 J | | | | |
| BENZO(K)FLUORANTHENE | | | 140 J | | | | |
| BENZO(A)PYRENE | | | 240 J | | | | |
| INDENO(1,2,3-CD)PYRENE | | | 240 J | | | | |
| BENZO(GHI)PERYLENE | | | 140 J | | | | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 14
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# SURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO.<br>DEPTH<br>UNITS | 24-BDA-SB01-00<br>0-6"<br>UG/KG | 24-BDA-SB08-00<br>0-6"<br>UG/KG | 24-BDA-SB09-00<br>0-6"<br>UG/KG | 24-BDA-SB13-00<br>0-6"<br>UG/KG | 24-BM-SB02-00<br>0-6"<br>UG/KG | 24-BM-SB04-00<br>0-6"<br>UG/KG | 24-BM-SB05-00<br>0-6"<br>UG/KG |
|---|---|---|---|---|---|---|---|
| **PESTICIDES/PCBS** | | | | | | | |
| HEPTACHLOR | | | | | | | |
| HEPTACHLOR EPOXIDE | | | | | | | |
| DIELDRIN | | | | | | | |
| 4,4'-DDE | | | 20 | | | 10 | |
| 4,4'-DDD | | 6.9 J | 32 | | | 110 | |
| 4,4'-DDT | | | 27 | | | 17 J | 5.2 |
| ALPHA-CHLORDANE | | | | | | 2.2 | |
| GAMMA-CHLORDANE | | | | | | | |
| AROCLOR-1254 | | | | | | | |
| AROCLOR-1260 | | | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 14
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# SURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO. | 24-BM-SB11-00 | 24-BM-SB14-00 | 24-SSA-SB01-00 | 24-SSA-SB02-00 | 24-SSA-SB03-00 | 24-SSA-SB04-00 | 24-SSA-SB05-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| **VOLATILES** | | | | | | | |
| ACETONE | | | | | | | |
| STYRENE | | 5 J | | | | | |
| **SEMIVOLATILES** | | | | | | | |
| 2-METHYLNAPHTHALENE | 110 J | | | | | | |
| ACENAPHTHENE | | | | | | | |
| FLUORENE | | | | | | | |
| PHENANTHRENE | | | | | | | |
| ANTHRACENE | | | | | | | |
| CARBAZOLE | | | | | | | |
| FLUORANTHENE | | 41 J | | | | | 74 J |
| PYRENE | | 57 J | | | | | 65 J |
| BUTYL BENZYL PHTHALATE | | | | | | | |
| BENZO(A)ANTHRACENE | | | | | | | |
| CHRYSENE | | | | | | | 63 J |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | | 60 J | | |
| BENZO(B)FLUORANTHENE | | | | | | | 91 J |
| BENZO(K)FLUORANTHENE | | | | | | | |
| BENZO(A)PYRENE | | | | | | | |
| INDENO(1,2,3-CD)PYRENE | | | | | | | |
| BENZO(GHI)PERYLENE | | | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 14
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# SURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO.<br>DEPTH<br>UNITS | 24-BM-SB11-00<br>0-6"<br>UG/KG | 24-BM-SB14-00<br>0-6"<br>UG/KG | 24-SSA-SB01-00<br>0-6"<br>UG/KG | 24-SSA-SB02-00<br>0-6"<br>UG/KG | 24-SSA-SB03-00<br>0-6"<br>UG/KG | 24-SSA-SB04-00<br>0-6"<br>UG/KG | 24-SSA-SB05-00<br>0-6"<br>UG/KG |
|---|---|---|---|---|---|---|---|
| <u>PESTICIDES/PCBS</u> | | | | | | | |
| HEPTACHLOR | 1.8 J | | | | | | |
| HEPTACHLOR EPOXIDE | 5 J | | | | | | |
| DIELDRIN | | | | 8.2 J | 11 J | 4.1 J | 13 J |
| 4,4'-DDE | 8.4 J | | 22 | 33 J | 350 | 21 J | 31 |
| 4,4'-DDD | | | 5.3 | 27 J | 130 | 4.9 J | 63 |
| 4,4'-DDT | | | 60 | 50 J | 91 | 16 J | 320 |
| ALPHA-CHLORDANE | 26 J | | 4.1 J | 20 J | 25 | 3.6 J | 4.3 |
| GAMMA-CHLORDANE | 20 J | | 2.5 | 24 J | 23 | 2.8 J | 2.4 |
| AROCLOR-1254 | 85 J | | | | | | |
| AROCLOR-1260 | 130 | | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 14
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# SURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO. | 24-SSA-SB06-00 | 24-SSA-SB08-00 | 24-SSA-SB09-00 | 24-SSA-SB10-00 |
|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG |
| <u>VOLATILES</u> | | | | |
| ACETONE | 14 J | | 32 J | 780 J |
| STYRENE | | | | |
| <u>SEMIVOLATILES</u> | | | | |
| 2-METHYLNAPHTHALENE | | | | |
| ACENAPHTHENE | | | | |
| FLUORENE | | | | |
| PHENANTHRENE | | | | |
| ANTHRACENE | | | | |
| CARBAZOLE | | | | |
| FLUORANTHENE | | | | |
| PYRENE | | | | |
| BUTYL BENZYL PHTHALATE | | | | |
| BENZO(A)ANTHRACENE | | | | |
| CHRYSENE | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | |
| BENZO(B)FLUORANTHENE | | | | |
| BENZO(K)FLUORANTHENE | | | | |
| BENZO(A)PYRENE | | | | |
| INDENO(1,2,3-CD)PYRENE | | | | |
| BENZO(GHI)PERYLENE | | | | |

ug/kg - microgram per kilogram
J - value is estimated

## TABLE 4 - 14
## OPERABLE UNIT NO. 1 - SITE 24
## INDUSTRIAL FLY ASH DUMP
## SURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO. | 24-SSA-SB06-00 | 24-SSA-SB08-00 | 24-SSA-SB09-00 | 24-SSA-SB10-00 |
|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG |
| **PESTICIDES/PCBS** | | | | |
| HEPTACHLOR | | | | |
| HEPTACHLOR EPOXIDE | | | | |
| DIELDRIN | | 5.3 J | | |
| 4,4'-DDE | | 33 J | | |
| 4,4'-DDD | | 32 J | | |
| 4,4'-DDT | 15 | 13 J | | |
| ALPHA-CHLORDANE | | 6.5 J | | |
| GAMMA-CHLORDANE | | 4.8 J | | |
| AROCLOR-1254 | | | | |
| AROCLOR-1260 | | | | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 15
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# SURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO. | 24-BDA-SB01-00 | 24-BDA-SB02-00 | 24-BDA-SB03-00 | 24-BDA-SB04-00 | 24-BDA-SB05-00 | 24-BDA-SB06-00 | 24-BDA-SB07-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 563 | 1320 | 2860 | 1450 | 5360 | 4340 | 3440 J |
| ANTIMONY | | | | | | | |
| ARSENIC | 0.75 J | 0.65 J | | | 0.77 B | 0.58 B | |
| BARIUM | 5.2 B | 5.9 B | 7.5 B | 4.4 B | 15.3 B | 10.8 B | 5.5 B |
| BERYLLIUM | 0.21 B | 0.21 B | 0.23 B | | | 0.22 B | |
| CADMIUM | | | | | | | |
| CALCIUM | 207000 J | 214000 J | 2840 | 361 B | 1200 J | 75300 J | 1040 B |
| CHROMIUM | 8.4 | 6.9 | 3.4 J | 4.6 J | 2.7 J | 8.6 J | 4.9 J |
| COBALT | | | | | | | |
| COPPER | 6.1 | 2.9 B | 2 J | 1.9 J | 2.7 B | 3.2 B | 1.5 B |
| IRON | 1840 | 2080 | 1130 | 702 | 1770 | 2500 | 1100 J |
| LEAD | 1.5 | 2.4 | 8.4 | 5.2 | 8 | 3.6 | 5.3 J |
| MAGNESIUM | 2960 | 3330 | 124 B | 77.5 B | 177 B | 1360 | 112 B |
| MANGANESE | 31.4 | 32.9 | 6.6 J | 3.8 J | 25.3 | 19.9 | 3 B |
| MERCURY | | | | | 0.15 | | |
| NICKEL | | | | | | | |
| POTASSIUM | 206 B | 258 B | 82.2 B | 66.3 B | 160 B | 242 B | 157 B |
| SELENIUM | | | | | | | |
| SILVER | | | | | | | |
| SODIUM | 363 J | 373 J | | | 45.3 B | 141 B | 22.2 B |
| THALLIUM | 0.23 J | | | 0.3 B | | 0.22 B | |
| VANADIUM | 8 B | 7.1 B | 4.3 B | 3.2 B | 9.6 B | 8.4 B | 7 B |
| ZINC | 9.6 | 7.3 | 5.2 J | 3.2 J | 5.5 | 7.3 | 4.5 |
| CYANIDE | | | | | | | |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

## TABLE 4 - 15
## OPERABLE UNIT NO. 1 - SITE 24
## INDUSTRIAL FLY ASH DUMP
## SURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## TAL METALS AND CYANIDE

| SAMPLE NO. | 24-BDA-SB08-00 | 24-BDA-SB09-00 | 24-BDA-SB10-00 | 24-BDA-SB11-00 | 24-BDA-SB12-00 | 24-BDA-SB13-00 | 24-BM-SB01-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 5170 J | 6630 | 2470 | 705 | 7090 J | 3210 | 1150 |
| ANTIMONY | | 2.4 J | | | | | 1.8 J |
| ARSENIC | 1.1 J | 1.5 B | 1.2 J | | 2.3 B | 0.61 B | 0.88 B |
| BARIUM | 7.9 B | 15.8 B | 6 B | 6.3 B | 38.2 B | 9 B | 45.2 |
| BERYLLIUM | | | | | | | 0.22 B |
| CADMIUM | | | 1.6 | | | | |
| CALCIUM | 485 B | 8770 | 526 B | 267 B | 3050 | 418 J | 238000 J |
| CHROMIUM | 5 J | 9.4 J | 6.2 J | 3.4 J | 9.3 J | | |
| COBALT | | | | | | | |
| COPPER | 1.4 B | 3.6 B | 1.8 J | 0.85 B | 5 B | 1.5 B | 5.2 B |
| IRON | 2620 J | 2760 | 2110 | 411 | 3260 J | 1060 | 2210 |
| LEAD | 9.7 J | 393 | 7.2 | 4.9 J | 24.4 J | 5.9 | 5.7 |
| MAGNESIUM | 121 B | 364 B | 91.2 B | 38.3 B | 285 B | 110 B | 785 B |
| MANGANESE | 7.4 | 12.8 J | 5.5 J | 15.6 J | 16.1 | 5.3 | 40.3 |
| MERCURY | 0.2 | | | | | | |
| NICKEL | | | | | | | |
| POTASSIUM | 163 B | 256 B | 222 B | 40.8 B | 325 B | 139 B | 158 B |
| SELENIUM | | 0.32 J | 0.32 J | | 0.35 B | | 0.26 J |
| SILVER | | | | | | | |
| SODIUM | 20.7 B | 69.6 B | 41.7 B | 34.9 B | 58.4 B | 44.6 B | 120 B |
| THALLIUM | | | | | | | |
| VANADIUM | 7.2 B | 12.6 | 8.9 B | 3 B | 17.8 | 6.6 B | 19.8 |
| ZINC | 4.1 B | 19.2 | 3.9 J | 3.4 B | 19.3 | 7.7 | 17.2 |
| CYANIDE | | | | | | | |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

## TABLE 4 - 15
## OPERABLE UNIT NO. 1 - SITE 24
## INDUSTRIAL FLY ASH DUMP
## SURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## TAL METALS AND CYANIDE

| SAMPLE NO. | 24-BM-SB02-00 | 24-BM-SB03-00 | 24-BM-SB04-00 | 24-BM-SB05-00 | 24-BM-SB06-00 | 24-BM-SB07-00 | 24-BM-SB08-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 88.2 | 10400 | 5410 | 3230 | 8580 | 7920 | 1990 |
| ANTIMONY | 2.6 J | 2.1 J | | | | | |
| ARSENIC | | 35.2 B | 1.1 B | 0.5 B | 21.8 J | 13.8 J | 1.2 B |
| BARIUM | 31.7 B | 230 | 24.5 B | 8.4 B | 142 J | 502 | 40.4 |
| BERYLLIUM | | 4 | | | 3.8 | 3.3 | 0.2 B |
| CADMIUM | | | | | | 1.9 | |
| CALCIUM | 356000 J | 3380 J | 44400 | 3520 | 4560 J | 3670 | 159000 |
| CHROMIUM | 2 | 23 | 7.6 J | | 8.6 J | 9.7 J | |
| COBALT | | 14.4 | | | 3.8 B | 10.5 B | 2.4 B |
| COPPER | 3.6 B | 39.7 | 3.4 B | 1.3 B | 26.5 | 50 J | 6.6 |
| IRON | 2430 | 7480 | 2860 J | 1390 | 6970 J | 13900 | 2550 |
| LEAD | 1.6 | 21 | 8.7 J | 6 J | 6 J | 7 | 5.9 J |
| MAGNESIUM | 722 B | 611 B | 608 B | 108 B | 596 B | 385 B | 498 B |
| MANGANESE | 78.9 | 37.4 | 15.8 J | 6.9 J | 37.1 J | 93.4 J | 41.2 J |
| MERCURY | | 0.45 | | | 0.49 | | |
| NICKEL | | 68.7 | | | 22.7 | 18.8 | 6 B |
| POTASSIUM | 24.8 B | 1880 | 212 B | 99.4 B | 1890 | 1360 B | 194 B |
| SELENIUM | | 18 J | 0.49 J | 0.35 J | 4.5 J | 3.6 J | 0.32 J |
| SILVER | | | | | | | |
| SODIUM | 120 B | 261 B | 98.8 B | 45 B | 186 B | 152 B | 106 B |
| THALLIUM | | 1.4 B | | | 1 B | 1 B | |
| VANADIUM | 2.8 B | 253 | 10.6 | 6.3 B | 141 | 123 | 24.8 |
| ZINC | 18 | 30.7 | 16.1 | 6.3 | 13.9 J | 12.4 J | 23.6 |
| CYANIDE | | 0.72 | | | 1.3 | 1.2 | |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

## TABLE 4 - 15
## OPERABLE UNIT NO. 1 - SITE 24
## INDUSTRIAL FLY ASH DUMP
## SURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## TAL METALS AND CYANIDE

| SAMPLE NO. | 24-BM-SB09-00 | 24-BM-SB10-00 | 24-BM-SB11-00 | 24-BM-SB12-00 | 24-BM-SB13-00 | 24-BM-SB14-00 | 24-BM-SB15-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 14400 | 1770 | 3650 | 1960 | 8330 | 856 | 18700 |
| ANTIMONY | | | | | | | |
| ARSENIC | 3.3 | 0.49 B | 10 J | 0.95 J | 1.6 B | | 1.7 B |
| BARIUM | 48.6 | 26.8 B | 111 J | 48.4 J | 37 B | 46.9 | 19.1 B |
| BERYLLIUM | 0.6 B | | 1.7 | 0.47 B | 0.24 B | | 0.23 B |
| CADMIUM | | | | | | | |
| CALCIUM | 1370 | 945 J | 196000 J | 1240 J | 254 B | 139 B | 73.2 B |
| CHROMIUM | 19.4 J | 2.9 | 8 J | | 10.5 J | | 21.6 J |
| COBALT | 2 B | | 5 B | | 2.2 B | | |
| COPPER | 8.2 | 2.7 B | 314 | 6.1 | 10.8 | 1.2 B | 2.8 B |
| IRON | 6450 | 945 | 7050 J | 1530 J | 3300 J | 492 J | 5210 J |
| LEAD | 24.8 J | 13.1 | 41.5 J | 14.9 J | 11 J | 5.7 J | 8.4 J |
| MAGNESIUM | 548 B | 110 B | 1350 | 204 B | 273 B | 44.2 B | 592 B |
| MANGANESE | 12.2 J | 23.1 | 79.9 J | 71.7 J | 6 J | 8.8 J | 8.5 J |
| MERCURY | | | 1.2 | | | | |
| NICKEL | 15.6 | | 80.8 | | | | |
| POTASSIUM | 717 B | 133 B | 753 B | 149 B | 262 B | 49.6 B | 417 B |
| SELENIUM | 0.58 J | 0.29 J | 3.5 J | 0.79 J | 0.72 J | 0.25 J | 0.48 J |
| SILVER | | | | | | | |
| SODIUM | 67 B | 58.2 B | 269 B | 53.6 B | 51.9 B | 39.6 B | 57.4 B |
| THALLIUM | | | 0.37 B | | | | |
| VANADIUM | 87.8 | 5.6 B | 634 | 9.5 B | 16 | 3.5 B | 24.6 |
| ZINC | 32.2 | 10.2 | 93.8 J | 80.1 J | 31.5 | 5 | 6.7 |
| CYANIDE | | | | | | | |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 15
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# SURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO. | 24-SSA-SB01-00 | 24-SSA-SB02-00 | 24-SSA-SB03-00 | 24-SSA-SB04-00 | 24-SSA-SB05-00 | 24-SSA-SB06-00 | 24-SSA-SB07-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 3090 | 3090 | 2200 | 1790 | 3720 | 3540 | 4320 |
| ANTIMONY | | | | | | | |
| ARSENIC | 0.66 B | 0.83 B | 0.65 J | 1.1 J | 1.4 B | 0.9 J | 0.81 B |
| BARIUM | 11.5 B | 10.2 B | 21.6 J | 13.8 B | 19.9 B | 15.8 B | 9 B |
| BERYLLIUM | 0.22 B | 0.24 B | 0.22 B | | 0.23 B | | |
| CADMIUM | | | | | | | |
| CALCIUM | 2020 J | 2540 J | 14400 J | 117000 J | 7620 J | | 1240 J |
| CHROMIUM | 5.3 | 4.3 | 4.6 J | 3.7 | 6.3 | 5.4 | 5.9 |
| COBALT | | | | | | | |
| COPPER | 8.6 | 3.5 B | 7.2 | 4.4 B | 5.2 B | 2.6 B | 1.1 B |
| IRON | 1490 | 1790 | 1290 J | 2000 | 2340 | 1540 | 1720 |
| LEAD | 45.7 | 27.7 J | 38.8 J | 33.6 J | 23.7 J | 11.5 J | 10.2 J |
| MAGNESIUM | 132 B | 114 B | 158 B | 453 B | 184 B | 191 B | 117 B |
| MANGANESE | 7.7 | 7.3 | 9.4 J | 22.6 | 13.1 | 13.7 | 5.1 |
| MERCURY | 0.58 | | 0.26 | | | | |
| NICKEL | | | | | | | |
| POTASSIUM | 77.8 B | 76.4 B | 64.3 B | 50.7 B | 107 B | 63.6 B | 78.2 B |
| SELENIUM | | | 0.41 J | | | | |
| SILVER | | | 1.3 B | | | | |
| SODIUM | 55.2 B | 61.7 B | 52.9 B | 82.1 B | 38.9 B | 57.5 B | 16.5 B |
| THALLIUM | | | | | | | |
| VANADIUM | 6 J | 4.7 J | 4.4 J | 4.2 J | 7.9 J | 9.2 B | 6.2 J |
| ZINC | 57.2 J | 16.5 J | 27 J | 16.7 J | | | 7.5 J |
| CYANIDE | | | | | | | |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 15
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# SURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO. | 24-SSA-SB08-00 | 24-SSA-SB09-00 | 24-SSA-SB10-00 |
|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" |
| UNITS | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 3440 | 596 | 1010 |
| ANTIMONY | | | |
| ARSENIC | 0.88 B | | 0.43 B |
| BARIUM | 14.7 B | 8.7 B | 4.9 B |
| BERYLLIUM | | | |
| CADMIUM | | | |
| CALCIUM | 11600 J | 589 J | 5210 J |
| CHROMIUM | 6.1 | | |
| COBALT | | | |
| COPPER | 4.5 B | 0.45 B | 1.3 B |
| IRON | 1910 | 249 | 555 |
| LEAD | 35.9 | 1.8 J | 6.7 J |
| MAGNESIUM | 259 B | 22.7 B | 98.3 B |
| MANGANESE | 13.1 | 26.7 | 4.7 |
| MERCURY | | | |
| NICKEL | | | |
| POTASSIUM | 93.1 B | | |
| SELENIUM | | | |
| SILVER | | | |
| SODIUM | 54.7 B | 21.6 B | 32.9 B |
| THALLIUM | | | |
| VANADIUM | 7 J | 1.3 J | 1.7 J |
| ZINC | 19.7 J | 2.4 J | 5.1 J |
| CYANIDE | | | |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 16
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO.<br>DEPTH<br>UNITS | 24-BDA-SB01-03<br>6-8'<br>UG/KG | 24-BDA-SB01-05<br>8-10'<br>UG/KG | 24-BDA-SB08-01A<br>0.5-2'<br>UG/KG | 24-BDA-SB09-01<br>2-4'<br>UG/KG | 24-BDA-SB11-02<br>4-6'<br>UG/KG | 24-BDA-SB13-01A<br>0.5-1.5'<br>UG/KG | 24-BM-SB02-04<br>8-10'<br>UG/KG |
|---|---|---|---|---|---|---|---|
| **VOLATILES** | | | | | | | |
| METHYLENE CHLORIDE | | | | | | | |
| ACETONE | | 60 J | 70 J | 140 J | 63 J | | |
| CARBON DISULFIDE | | | | | | | |
| 2-BUTANONE | | | | | | | |
| **SEMIVOLATILES** | | | | | | | |
| DI-N-BUTYL PHTHALATE | | | | | | | |
| FLUORANTHENE | | | | | | 45 J | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | 85 J | | | 170 J |
| **PESTICIDES/PCBS** | | | | | | | |
| 4,4'-DDD | | | | 8.2 J | | | |
| 4,4'-DDT | 43 J | 67 J | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

### TABLE 4 - 16
### OPERABLE UNIT NO. 1 - SITE 24
### INDUSTRIAL FLY ASH DUMP
### SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
### REMEDIAL INVESTIGATION CTO - 19177
### MCB CAMP LEJEUNE, NORTH CAROLINA
### ORGANIC CHEMICALS

| SAMPLE NO.<br>DEPTH<br>UNITS | 24-BM-SB05-04<br>8-10'<br>UG/KG | 24-BM-SB05-05<br>10-12'<br>UG/KG | 24-BM-SB10-02<br>4-6'<br>UG/KG | 24-BM-SB11-06<br>12-14'<br>UG/KG | 24-BM-SB14-04<br>8-10'<br>UG/KG | 24-BM-SB15-04<br>8-10'<br>UG/KG | 24-BM-SB15-06<br>12-14'<br>UG/KG |
|---|---|---|---|---|---|---|---|
| **VOLATILES** | | | | | | | |
| METHYLENE CHLORIDE | | | | 120 J | | | |
| ACETONE | 19 J | 78 J | | | | | 180 |
| CARBON DISULFIDE | | | | | 8 J | | |
| 2-BUTANONE | | | | | | | |
| **SEMIVOLATILES** | | | | | | | |
| DI-N-BUTYL PHTHALATE | | | | | | | |
| FLUORANTHENE | | | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | 1000 | 51 J | 170 J | | 44 J | 200 J | |
| **PESTICIDES/PCBS** | | | | | | | |
| 4,4'-DDD | | | | | | | |
| 4,4'-DDT | | | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

### TABLE 4 - 16
### OPERABLE UNIT NO. 1 - SITE 24
### INDUSTRIAL FLY ASH DUMP
### SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
### REMEDIAL INVESTIGATION CTO - 19177
### MCB CAMP LEJEUNE, NORTH CAROLINA
### ORGANIC CHEMICALS

| SAMPLE NO.<br>DEPTH<br>UNITS | 24-SSA-SB02-04<br>8-10'<br>UG/KG | 24-SSA-SB02-05<br>10-12'<br>UG/KG | 24-SSA-SB03-06<br>6-8'<br>UG/KG | 24-SSA-SB04-06<br>8-10'<br>UG/KG | 24-SSA-SB05-03<br>6-8'<br>UG/KG | 24-SSA-SB05-06<br>10-12'<br>UG/KG | 24-SSA-SB06-04<br>6-8'<br>UG/KG |
|---|---|---|---|---|---|---|---|
| **VOLATILES** | | | | | | | |
| METHYLENE CHLORIDE | | | | 33 B | | | |
| ACETONE | | | 51 J | 380 J | | 1800 J | |
| CARBON DISULFIDE | 5 J | | | 4 J | 6 J | | |
| 2-BUTANONE | | | | | | | 480 J |
| **SEMIVOLATILES** | | | | | | | |
| DI-N-BUTYL PHTHALATE | 74 J | | | | | | |
| FLUORANTHENE | | | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | | | | |
| **PESTICIDES/PCBS** | | | | | | | |
| 4,4'-DDD | | | | | 4.4 J | 6.4 J | 9.1 |
| 4,4'-DDT | | 4 J | | | 100 | 210 | 12 |

ug/kg - microgram per kilogram
J - value is estimated

## TABLE 4 - 16
## OPERABLE UNIT NO. 1 - SITE 24
## INDUSTRIAL FLY ASH DUMP
## SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO. | 24-SSA-SB06-06 | 24-SSA-SB07-04 | 24-SSA-SB09-03 | 24-SSA-SB09-04 | 24-SSA-SB10-03 | 24-GW07-04 | 24-GW08-06 |
|---|---|---|---|---|---|---|---|
| DEPTH | 12-14' | 8-10' | 6-8' | 8-10' | 6-8' | 10-12' | 12-14' |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| **VOLATILES** | | | | | | | |
| METHYLENE CHLORIDE | | | | | 120 J | | |
| ACETONE | | 120 J | 97 J | 130 J | | | 89 J |
| CARBON DISULFIDE | | | | | | | |
| 2-BUTANONE | | | | | | | |
| **SEMIVOLATILES** | | | | | | | |
| DI-N-BUTYL PHTHALATE | | | | | | | |
| FLUORANTHENE | | | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | | | | |
| **PESTICIDES/PCBS** | | | | | | | |
| 4,4'-DDD | 19 | | | | 7.1 | | |
| 4,4'-DDT | 220 | | | | 12 | 8.9 | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 16
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO. | 24-GW09-02 | 24-GW10-03 | 24-GW10-04 |
|---|---|---|---|
| DEPTH | 4-6' | 8-10' | 8-10' |
| UNITS | UG/KG | UG/KG | UG/KG |
| **VOLATILES** | | | |
| METHYLENE CHLORIDE | | | |
| ACETONE | | 12 J | |
| CARBON DISULFIDE | | | |
| 2-BUTANONE | | | |
| **SEMIVOLATILES** | | | |
| DI-N-BUTYL PHTHALATE | | | |
| FLUORANTHENE | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | 100 J |
| **PESTICIDES/PCBS** | | | |
| 4,4'-DDD | 11 | | |
| 4,4'-DDT | 29 | | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 17
## OPERABLE UNIT NO. 1 - SITE 24
## INDUSTRIAL FLY ASH DUMP
## SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## TAL METALS AND CYANIDE

| SAMPLE NO. | 24-BDA-SB01-03 | 24-BDA-SB01-05 | 24-BDA-SB02-04 | 24-BDA-SB03-03 | 24-BDA-SB04-03 | 24-BDA-SB05-01 |
|---|---|---|---|---|---|---|
| DEPTH | 6-8' | 8-12' | 8-10' | 6-8' | 6-8' | 2-4' |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 7000 | 4240 | 4370 | 964 | 2480 | 11300 |
| ARSENIC | 0.49 B | 0.47 B | 1.3 B | | | 1.4 B |
| BARIUM | 9.5 B | 6.4 B | 9.7 B | 3.1 B | 6.3 B | 17.8 B |
| BERYLLIUM | 0.22 B | 0.21 B | 0.23 B | | | 0.24 B |
| CALCIUM | 145 J | 80.6 J | 286 J | 125 J | 143 B | 89.8 J |
| CHROMIUM | 7.7 | 4.1 | 2.8 | | 4.2 J | 10.9 J |
| COBALT | | | | | | |
| COPPER | 1.1 B | 0.64 B | 1.1 B | 0.44 B | 1.3 J | 2.8 B |
| IRON | 1240 | 752 | 1190 | 411 | 556 | 3930 |
| LEAD | 4.3 | 4.1 | 3.3 | 1.5 | 1.9 | 6.4 |
| MAGNESIUM | 193 B | 134 B | 118 B | 29.8 J | 74.5 B | 277 B |
| MANGANESE | 3.8 | 3.4 | 13.6 | 2.4 B | 2.6 J | 5.2 |
| MERCURY | | | | | | |
| NICKEL | | | | | | |
| POTASSIUM | 250 B | 184 B | 178 B | 51.6 B | 112 B | 252 B |
| SELENIUM | 0.33 J | 0.45 J | | | | |
| SODIUM | 39.2 J | 43.1 J | 54.7 J | 48.4 J | | 50 B |
| THALLIUM | | | | | | |
| VANADIUM | 6.4 B | 3.4 B | 7.6 B | 2 B | 2.6 B | 18 |
| ZINC | 2.7 B | 1.7 B | 1.8 B | 1.3 B | 1.7 J | 4.5 B |
| CYANIDE | | | | | | |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 17
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO. | 24-BDA-SB06-01 | 24-BDA-SB07-01A | 24-BDA-SB08-01A | 24-BDA-SB09-01 | 24-BDA-SB10-01A | 24-BDA-SB11-02 |
|---|---|---|---|---|---|---|
| DEPTH | 2-4' | 0.5-2' | 0.5-2' | 2-4' | 0.5-2' | 4-6' |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 5570 | 4430 J | 2470 J | 6120 | 2830 | 5700 |
| ARSENIC | 0.52 B | 0.62 B | 1 B |  | 1.7 J | 0.59 B |
| BARIUM | 10.1 B | 6 B | 4.3 B | 13 B | 6.8 B | 8.6 B |
| BERYLLIUM |  |  |  | 0.2 B |  |  |
| CALCIUM | 3950 J | 1390 | 1410 | 556 B | 467 B | 93.7 B |
| CHROMIUM | 6.1 J | 4.6 J | 2.1 J | 9 J | 7.3 J | 7.9 J |
| COBALT |  |  |  |  |  | 2.6 B |
| COPPER | 1.4 B | 1.1 B | 0.85 B | 2 B | 2.1 J | 1.3 B |
| IRON | 2720 | 1290 J | 1110 J | 1730 | 2780 | 2200 |
| LEAD | 4.7 | 3.4 J | 4.3 J | 6.2 J | 7 | 4.3 J |
| MAGNESIUM | 196 B | 133 B | 83.6 B | 277 B | 105 B | 229 B |
| MANGANESE | 5 | 2.4 B | 2.6 B | 8.4 J | 4.5 J | 5 J |
| MERCURY |  |  |  |  |  |  |
| NICKEL |  |  |  |  |  |  |
| POTASSIUM | 163 B | 223 B | 124 B | 454 B | 273 B | 250 B |
| SELENIUM |  |  |  |  | 0.47 J |  |
| SODIUM | 57.9 B | 26.1 B | 16.6 B | 45.6 B | 81.3 B | 42.8 B |
| THALLIUM |  |  |  |  |  |  |
| VANADIUM | 9 B | 10 B | 4.9 B | 10 | 11.3 B | 8.6 B |
| ZINC | 4.3 B |  | 1.3 B | 7.8 | 8.7 J | 2.9 B |
| CYANIDE |  |  |  |  |  |  |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 17
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO. | 24-BDA-SB12-01A | 24-BDA-SB13-01A | 24-BM-SB01-04 | 24-BM-SB02-04 | 24-BM-SB03-04 | 24-BM-SB04-03 |
|---|---|---|---|---|---|---|
| DEPTH | 0.5-1' | 0.5-1.5' | 8-10' | 8-10' | 8-10' | 6-8' |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 2180 J | 4070 | 7780 | 5730 | 8410 | 5110 |
| ARSENIC | 1.2 B | 0.78 B | 1.6 B | | 0.66 B | 0.92 J |
| BARIUM | 12.1 B | 7.6 B | 9 B | 13.8 B | 9.4 B | 6.3 B |
| BERYLLIUM | | | | | | |
| CALCIUM | 1710 | 345 J | 106 J | 560 J | 170 J | 35.3 B |
| CHROMIUM | 4.1 J | 3.4 J | 8.4 | 10.6 | 10.5 | 6.7 J |
| COBALT | | | | | | |
| COPPER | 2.4 B | 1.1 B | 1.1 B | 0.92 B | 1.1 B | 0.89 B |
| IRON | 1640 J | 1170 | 1770 | 1620 | 1640 | 1060 J |
| LEAD | 14.9 J | 4.9 | 3.6 | 4.5 | 3.4 | 5.1 J |
| MAGNESIUM | 99.6 B | 102 B | 253 B | 272 B | 316 B | 190 B |
| MANGANESE | 8.2 | 3.2 B | 3.6 | 5.1 | 5.7 | 4 J |
| MERCURY | | | | | | |
| NICKEL | | | | | | |
| POTASSIUM | 100 B | 167 B | 339 B | 302 B | 503 B | 343 B |
| SELENIUM | 0.32 J | | | | 0.33 J | 0.25 J |
| SODIUM | 37.3 B | 50.5 B | 56.4 B | 39.1 B | 46.3 B | 48.3 B |
| THALLIUM | | | 0.23 B | | | |
| VANADIUM | 6.8 B | 6.9 B | 9.7 B | 9.2 B | 10.7 B | 7.8 B |
| ZINC | 15.3 | 4.4 B | 4.5 | 3.5 B | 4.1 B | 3.1 B |
| CYANIDE | | | | | | |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

TABLE 4 - 17
OPERABLE UNIT NO. 1 - SITE 24
INDUSTRIAL FLY ASH DUMP
SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
REMEDIAL INVESTIGATION CTO - 19177
MCB CAMP LEJEUNE, NORTH CAROLINA
TAL METALS AND CYANIDE

| SAMPLE NO. | 24-BM-SB05-04 | 24-BM-SB05-05 | 24-BM-SB06-04 | 24-BM-SB06-05 | 24-BM-SB07-04 | 24-BM-SB08-03 |
|---|---|---|---|---|---|---|
| DEPTH | 8-10' | 10-12' | 8-10' | 10-12' | 8-10' | 6-8' |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 3510 | 12400 | 16900 | 10800 | 11000 | 3190 |
| ARSENIC | 1.2 B | 1.4 B | 12.3 J | 15 J | 9.2 J | 5.2 |
| BARIUM | 9 B | 11.5 B | 628 J | 213 J | 467 | 126 |
| BERYLLIUM | | | 3.7 | 1.7 B | 3.8 | 1 |
| CALCIUM | 3840 | 76.2 B | 29600 J | 8300 J | 19000 | 62200 |
| CHROMIUM | | 13.4 J | 12.3 J | 8.9 J | 8.2 J | 5.2 J |
| COBALT | | 2.2 B | 13.8 B | 6.8 B | 11.5 B | 4.4 B |
| COPPER | 1.2 B | 1.9 B | 55 | 28.9 | 42.8 J | 12.4 |
| IRON | 1500 | 2340 | 13600 J | 4960 J | 10800 | 3590 |
| LEAD | 6.5 J | 4.5 J | 10.8 J | 19.3 J | 10.6 | 5.2 J |
| MAGNESIUM | 123 B | 425 B | 2950 | 730 B | 2360 B | 428 B |
| MANGANESE | 9.2 J | 7.4 J | 113 J | 24.2 J | 78.8 J | 22.8 J |
| MERCURY | | | | | 0.29 | |
| NICKEL | | | 19.3 | | 96.2 | 8.6 |
| POTASSIUM | 98.2 B | 677 B | 1030 B | 1710 B | 1110 B | 564 B |
| SELENIUM | | 0.31 J | 5.1 J | 3.7 J | 7.8 J | 0.94 J |
| SODIUM | 42.6 B | 87.9 B | 729 B | 665 B | 559 B | 119 B |
| THALLIUM | | | | 0.51 B | | |
| VANADIUM | 6.2 B | 16.7 | 116 | 28.5 | 594 | 78.6 |
| ZINC | 6.2 | 9.3 | 20.1 J | 12.7 J | 17.3 J | 8.2 |
| CYANIDE | | | | 1.7 | 1.5 | |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 17
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO. | 24-BM-SB09-01 | 24-BM-SB10-02 | 24-BM-SB11-06 | 24-BM-SB11-07 | 24-BM-SB12-03 | 24-BM-SB12-05 |
|---|---|---|---|---|---|---|
| DEPTH | 2-4' | 4-6' | 12-14' | 14-16' | 6-8' | 10-12' |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 8560 | 19800 | 7320 | 8100 | 6760 | 10800 |
| ARSENIC | 4.3 | 5.4 | 10.4 J | 4.4 J | 0.57 J | 6.7 J |
| BARIUM | 11.8 B | 27.4 B | 220 J | 12.5 J | 9.5 J | 12.8 J |
| BERYLLIUM | 0.2 B | 0.26 B | 2.4 | 0.24 B | 0.24 B | 0.24 B |
| CALCIUM | 741 B | 66.8 J | 10700 J | 421 J | | |
| CHROMIUM | 14.8 J | 32.8 | 13.2 J | 10.8 J | 5.9 J | 14.9 J |
| COBALT | | 3.1 B | 8.4 B | | | |
| COPPER | 2.6 B | 5.9 B | 38.3 | 2.4 B | 0.95 B | 2.6 B |
| IRON | 10100 | 17300 | 6660 J | 5110 J | 1490 J | 7270 J |
| LEAD | 7.1 J | 7.3 | 6.5 J | 5.6 J | 3.7 J | 5.6 J |
| MAGNESIUM | 508 B | 1000 B | 509 B | 273 B | 202 B | 416 B |
| MANGANESE | 8 J | 13.2 | 50.3 J | 4 J | 3.6 J | 5.4 J |
| MERCURY | | | 0.29 | | | |
| NICKEL | | | 8 B | | | |
| POTASSIUM | 629 B | 1200 B | 1240 B | 490 B | 256 B | 685 B |
| SELENIUM | 0.5 J | 0.65 J | 11.9 J | 0.66 J | | |
| SODIUM | 41 B | 84.1 B | 280 B | 50.9 B | 36 B | 66.9 B |
| THALLIUM | | | 0.56 B | | | |
| VANADIUM | 18.8 | 43.1 | 50.3 | 18.1 | 7.1 J | 24.3 |
| ZINC | 10 | 10.3 | 10.8 J | 3.1 J | 2.4 J | 4.7 J |
| CYANIDE | | | | | | |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 17
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO. | 24-BM-SB13-04 | 24-BM-SB14-04 | 24-BM-SB15-04 | 24-BM-SB15-06 | 24-SSA-SB01-03 | 24-SSA-SB01-05 |
|---|---|---|---|---|---|---|
| DEPTH | 2-4' | 8-10' | 8-10' | 12-14' | 6-8' | 10-12' |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 5840 | 8630 | 6720 | 12500 | 9040 | 8480 |
| ARSENIC | 0.61 B | 0.97 B | 1.1 B | 3.5 | 1.2 B | |
| BARIUM | 11 B | 12.9 B | 6.4 B | 13.3 B | 7.6 B | 7.8 B |
| BERYLLIUM | | | | 0.24 B | 0.23 B | |
| CALCIUM | 93.3 B | 98.3 B | 35.1 B | 20.9 B | 217 J | 83.5 J |
| CHROMIUM | 5.4 J | 11.3 J | 5.8 J | 15.4 J | 11.1 | 8.8 |
| COBALT | | 2.3 B | 1.8 B | 2.6 B | | |
| COPPER | 1.2 B | 1.4 B | 0.89 B | 2.4 B | 0.92 B | 1.2 B |
| IRON | 1510 J | 2140 J | 1340 J | 4800 J | 1610 | 935 |
| LEAD | 3.7 J | 3.6 J | 3.2 J | 6.1 J | 3.9 J | 5.9 J |
| MAGNESIUM | 191 B | 338 B | 179 B | 482 B | 149 B | 186 B |
| MANGANESE | 4.2 J | 5.3 J | 3.8 J | 9.3 J | 2.3 B | 3.4 B |
| MERCURY | | | | | | |
| NICKEL | | | | | | |
| POTASSIUM | 218 B | 427 B | 231 B | 744 B | 298 B | 347 B |
| SELENIUM | 0.33 J | 0.28 J | 0.4 J | 0.29 J | | |
| SODIUM | 49.7 B | 57.8 B | 40.6 B | 50.8 B | 39.2 B | 55 B |
| THALLIUM | | | | | | |
| VANADIUM | 7 B | 12.5 | 6.4 B | 20.2 | 11.5 | 8.5 B |
| ZINC | 7.2 | 9.9 | 3.6 B | 6.4 | 2.5 J | 2.2 J |
| CYANIDE | | | | | | |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

### TABLE 4 - 17
### OPERABLE UNIT NO. 1 - SITE 24
### INDUSTRIAL FLY ASH DUMP
### SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
### REMEDIAL INVESTIGATION CTO - 19177
### MCB CAMP LEJEUNE, NORTH CAROLINA
### TAL METALS AND CYANIDE

| SAMPLE NO. | 24-SSA-SB02-04 | 24-SSA-SB02-05 | 24-SSA-SB03-03 | 24-SSA-SB03-06 | 24-SSA-SB04-04 | 24-SSA-SB04-06 |
|---|---|---|---|---|---|---|
| DEPTH | 8-10' | 10-12' | 6-8' | 12-14' | 8-10' | 14-16' |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 6720 | 8290 | 7480 | 3590 | 7680 | 2430 |
| ARSENIC | | | 2.4 J | 0.71 J | | 0.46 B |
| BARIUM | 7.6 B | 8.7 B | 8 J | 4.5 J | 8.7 B | 3 B |
| BERYLLIUM | 0.23 B | 0.24 B | 0.23 B | 0.22 B | 0.22 B | |
| CALCIUM | 57.5 J | 63.9 J | 61.3 J | | 26.9 J | 151 J |
| CHROMIUM | 9 | 12.3 | 7.8 J | 2.2 J | 10.1 | 4.4 |
| COBALT | 2.1 B | | | | | |
| COPPER | 1.2 B | 1.7 B | 1.4 B | 1.1 B | 1.5 B | 0.46 B |
| IRON | 1210 | 1210 | 1650 J | 819 J | 1070 | 538 |
| LEAD | 3.3 J | 4.8 J | 4.5 J | 2.3 J | 4.5 J | 2.4 J |
| MAGNESIUM | 205 B | 230 B | 175 B | 118 B | 138 B | 69.1 B |
| MANGANESE | 3.2 B | 3.1 B | 2.5 J | 2 J | 2.6 B | 1.6 B |
| MERCURY | | | 0.13 | 0.11 | | |
| NICKEL | | | | | | |
| POTASSIUM | 327 B | 398 B | 237 B | 210 B | 269 B | 133 B |
| SELENIUM | | | | | | |
| SODIUM | 51.2 B | 52.3 B | 51.5 B | 42.3 B | 42.6 B | 34.4 B |
| THALLIUM | | | | | | |
| VANADIUM | 8.8 B | 9.9 B | 8.9 B | 5.3 J | 10.7 B | 3.9 J |
| ZINC | 3 J | 2.7 J | | | 2.8 J | 1.6 J |
| CYANIDE | | | | | | |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 17
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| | SAMPLE NO. | 24-SSA-SB05-03 | 24-SSA-SB05-06 | 24-SSA-SB06-04 | 24-SSA-SB06-06 | 24-SSA-SB07-04 | 24-SSA-SB08-03 |
|---|---|---|---|---|---|---|---|
| | DEPTH | 6-8' | 10-12' | 6-8' | 12-14' | 8-10' | 6-8' |
| | UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | | 9760 | 11400 | 12800 | 2630 | 6180 | 7110 |
| ARSENIC | | 2.3 | 0.54 B | | | | 0.56 B |
| BARIUM | | 10.2 B | 12.6 B | 14.2 B | 3.8 B | 6.8 B | 9.8 B |
| BERYLLIUM | | | 0.25 B | 0.24 B | | | |
| CALCIUM | | 58.6 J | 30.8 J | | | 34.8 J | 175 J |
| CHROMIUM | | 13.7 | 15.8 | 15.2 | 3.1 | 6.8 | 7.6 |
| COBALT | | | | | | | |
| COPPER | | 1.2 B | 1.7 B | 2 B | 0.47 B | 1.2 B | 1.5 B |
| IRON | | 2250 | 1600 | 2720 | 523 | 1210 | 1580 |
| LEAD | | 5.1 J | 6.2 J | 5.7 J | 3.1 J | 4 J | 4.3 J |
| MAGNESIUM | | 291 B | 315 B | 289 B | | 183 B | 172 B |
| MANGANESE | | 3.3 B | 3.7 | 4.4 | | 3.1 B | 2.4 B |
| MERCURY | | | | | | | |
| NICKEL | | | | | | | |
| POTASSIUM | | 385 B | 586 B | 521 B | 166 B | 353 B | 338 B |
| SELENIUM | | | | | | | |
| SODIUM | | 33.7 B | 37.7 B | 59.9 B | 54.6 B | 35.7 B | 19.8 B |
| THALLIUM | | | | | | | |
| VANADIUM | | 11.6 | 15.8 | 13 | 3.8 J | 9.2 B | 11.5 B |
| ZINC | | 2.6 J | 3.2 J | | | 2.2 J | 2.9 J |
| CYANIDE | | | | | | | |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 17
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO. | 24-SSA-SB09-03 | 24-SSA-SB09-04 | 24-SSA-SB10-03 | 24-GW07-04 | 24-GW07-05 | 24-GW08-05 |
|---|---|---|---|---|---|---|
| DEPTH | 6-8' | 8-10' | 6-8' | 8-10' | 10-12' | 10-12' |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 7820 | 4220 | 9530 | 5250 | 4260 | 4480 |
| ARSENIC | | | | | | |
| BARIUM | 8.7 B | 5.5 B | 10.5 B | 6.4 B | 4.9 B | 6.2 B |
| BERYLLIUM | 0.25 B | 0.24 B | 0.24 B | | | |
| CALCIUM | 43.4 J | 37.8 J | 79.5 J | | | |
| CHROMIUM | 10.2 | 6.5 | 15 | 5.5 | 5.4 | 7.1 |
| COBALT | | | | | | |
| COPPER | 1.5 B | 0.96 B | 1.7 B | 0.68 B | 0.45 B | 0.95 B |
| IRON | 2240 | 828 | 1750 | 1250 | 1220 | 956 |
| LEAD | 4.3 J | 5.1 J | 5 J | 3.2 J | 1.7 J | 2.5 J |
| MAGNESIUM | 169 B | 136 B | 252 B | 108 B | 115 B | 129 B |
| MANGANESE | 2.5 B | 2.6 B | 3.8 | | | |
| MERCURY | | | | | | |
| NICKEL | | | | | | |
| POTASSIUM | 372 B | 289 B | 486 B | 135 B | 190 B | 232 B |
| SELENIUM | | | | | | |
| SODIUM | 36 B | 26.2 B | 37 B | 32.8 B | 30.3 B | 32.7 B |
| THALLIUM | | | | | | |
| VANADIUM | 16.5 | 6.5 J | 14.6 | 7.1 J | 6.1 J | 8.8 B |
| ZINC | 3.2 J | 2.6 J | 3.1 J | | | |
| CYANIDE | | | | | | |

mg/kg - milligram per kilogram

J - value is estimated

B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

## TABLE 4 - 17
## OPERABLE UNIT NO. 1 - SITE 24
## INDUSTRIAL FLY ASH DUMP
## SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## TAL METALS AND CYANIDE

| SAMPLE NO. | 24-GW08-06 | 24-GW09-01 | 24-GW09-02 | 24-GW10-03 | 24-GW10-04 |
|---|---|---|---|---|---|
| DEPTH | 12-14' | 2-4' | 4-6' | 6-8' | 8-10' |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 2210 | 6950 | 2680 | 8220 | 10500 |
| ARSENIC |  | 0.97 B | 1.4 B |  |  |
| BARIUM | 3.4 B | 12 B | 5.2 B | 10.3 B | 14.4 B |
| BERYLLIUM |  |  | 0.24 B |  | 0.25 B |
| CALCIUM |  |  |  |  |  |
| CHROMIUM | 4.1 | 9.7 | 6.7 | 7.7 | 11.2 |
| COBALT |  |  |  |  |  |
| COPPER | 0.48 B | 0.71 B | 0.71 B | 1.7 B | 2.7 B |
| IRON | 690 | 2930 | 3120 | 1010 | 1820 |
| LEAD | 1.3 J | 2.9 J | 2.6 J | 5.1 J | 4.6 J |
| MAGNESIUM |  | 281 B | 115 B | 124 B | 268 B |
| MANGANESE |  | 5.2 |  |  | 4.7 |
| MERCURY |  |  |  |  |  |
| NICKEL |  |  |  |  |  |
| POTASSIUM | 157 B | 379 B | 202 B | 286 B | 601 B |
| SELENIUM |  |  |  |  |  |
| SODIUM | 37.2 B | 30.7 B | 43.9 B | 34.7 B | 47.9 B |
| THALLIUM |  |  |  |  |  |
| VANADIUM | 5.8 J | 11.1 B | 9 B | 14.9 | 18.4 |
| ZINC |  |  |  |  |  |
| CYANIDE |  |  |  |  |  |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 18
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# TEST PIT POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

VOLATILES

| SAMPLE NO.<br>UNITS | 24-TP-01<br>UG/KG | 24-TP-02<br>UG/KG | 24-TP-03<br>UG/KG | 24-TP-05<br>UG/KG |
|---|---|---|---|---|
| ACETONE | | 16 | | 13 |
| TRICHLOROETHENE | 7 J | | | 2 J |

PESTICIDES/PCBS

| | | | | |
|---|---|---|---|---|
| 4,4'-DDD | | | 12 | |
| 4,4'-DDT | | | | 8.4 |

mg/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 19
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# TEST PIT POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO. | 24-TP-01 | 24-TP-02 | 24-TP-03 | 24-TP-04 | 24-TP-05 | 24-TP-06 | 24-TP-07 |
|---|---|---|---|---|---|---|---|
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 8540 J | 6120 J | 6490 J | 438 J | 1920 J | 9130 J | 9940 J |
| ARSENIC | 0.76 B | 0.8 B | 1.1 B | 1.2 B | 3.1 | 22.5 | 0.76 B |
| BARIUM | 12.1 B | 14.1 B | 13.9 B | 53.3 | 79.5 | 446 | 17.6 B |
| BERYLLIUM | 0.25 B | | | 0.21 B | 0.76 B | 3.5 | 0.24 B |
| CALCIUM | 1360 | 772 B | 15100 | 359000 | 304000 | 6740 | 2270 |
| CHROMIUM | 8.4 J | 7.3 J | 8.4 J | | 3 J | 10.5 J | 13.7 J |
| COBALT | 2 B | | | | | 9.8 B | |
| COPPER | 1.7 B | 0.91 B | 2 B | 4.4 B | 12.4 | 35.9 | 2.2 B |
| IRON | 1380 J | 2280 J | 3130 J | 2800 | 2340 J | 6120 J | 1630 J |
| LEAD | 4.7 J | 3.5 J | 5.5 J | 0.77 J | 3 J | 9.3 J | 5.1 J |
| MAGNESIUM | 209 B | 221 B | 308 B | 1110 | 1250 B | 814 B | 259 B |
| MANGANESE | 4.7 | 0.91 B | 6.6 | 66.9 | 48.7 | 46.3 | 15.6 |
| MERCURY | | | | | | 0.2 | |
| NICKEL | | | | | 6.6 B | 19.5 | |
| POTASSIUM | 419 B | 222 B | 157 B | 96.7 B | 316 B | 1930 | 537 B |
| SELENIUM | | | | | | 6.2 | |
| SILVER | | | | | | | 0.73 B |
| SODIUM | 27.1 B | 22 B | 32.9 B | 119 B | 139 B | 290 B | 22 B |
| THALLIUM | | | | | | 0.49 J | |
| VANADIUM | 11.8 B | 10.7 B | 10.4 B | 10.2 B | 20.7 | 100 | 13.2 |
| ZINC | 4.4 B | 1.6 B | 4.4 | 50.4 | 8.6 | 14.3 | 3.7 B |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 20
# OPERABLE UNIT NO. 1 - SITE 24
# INDUSTRIAL FLY ASH DUMP
# SUMMARY OF TEST PIT WASTES
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TCLP RESULTS AND RCRA

| Sample No.<br>Parameter (Units) | 24-TPW-04 | 24-TPW-06 | 24-TPW-07 |
|---|---|---|---|
| VOLATILES (mg/L) | | | |
| 1,1-Dichloroethene | <0.05 | <0.05 | <0.05 |
| 1,2-Dichloroethane | <0.05 | <0.05 | <0.05 |
| 2-Butanone | <0.10 | <0.10 | <0.10 |
| Carbon Tetrachloride | <0.05 | <0.05 | <0.05 |
| Chlorobenzene | <0.05 | <0.05 | <0.05 |
| Tetrachloroethene | <0.05 | <0.05 | <0.05 |
| Trichloroethene | <0.05 | <0.05 | <0.05 |
| Vinyl Chloride | <0.10 | <0.10 | <0.10 |
| SEMIVOLATILES (mg/L) | | | |
| 1,4-Dichlorobenzene | <0.10 | <0.10 | <0.10 |
| 2,4,5-Trichlorophenol | <0.50 | <0.50 | <0.50 |
| 2,4,6-Trichlorophenol | <0.10 | <0.10 | <0.10 |
| 2,4-Dinitrotoluene | <0.10 | <0.10 | <0.10 |
| 2-Methylphenol | <0.10 | <0.10 | <0.10 |
| 3-Methylphenol | <0.10 | <0.10 | <0.10 |
| 4-Methylphenol | <0.10 | <0.10 | <0.10 |
| Hexachlorobenzene | <0.10 | <0.10 | <0.10 |
| Hexachlorobutadiene | <0.10 | <0.10 | <0.10 |
| Hexachloroethane | <0.10 | <0.10 | <0.10 |
| Nitrobenzene | <0.10 | <0.10 | <0.10 |
| Pentachlorophenol | <0.50 | <0.50 | <0.50 |
| Pyridine | <0.10 | <0.10 | <0.10 |
| ORGANOCHLORINE PESTICIDES (ug/L) | | | |
| Chlordane | <0.5 | <0.5 | <0.5 |
| Endrin | <0.1 | <0.1 | <0.1 |
| Gamma-BHC | <0.05 | <0.05 | <0.05 |
| Heptachlor | <0.05 | <0.05 | <0.05 |
| Methoxychlor | <0.5 | <0.5 | <0.5 |
| Toxaphene | <1 | <1 | <1 |
| CHLORINATED HERBICIDES (ug/L) | | | |
| 2,4,5-TP (*Silvex*) | <0.5 | <0.5 | <0.5 |
| 2,4-D | <0.5 | <0.5 | <0.5 |
| METALS (mg/L) | | | |
| Arsenic | 0.1 | 0.1 | 0.1 |
| Barium | 1.2 | 0.59 | 1.6 |
| Cadmium | <0.005 | <0.005 | <0.005 |
| Chromium | <0.01 | <0.01 | <0.01 |
| Lead | <0.05 | <0.05 | <0.05 |
| Mercury | <0.0002 | <0.002 | <0.002 |
| Selenium | <0.1 | <0.1 | <0.1 |
| Silver | <0.01 | <0.01 | <0.01 |
| RCRA | | | |
| Flash Point (F) | >200 | >200 | >200 |
| pH (S.U.) | 6.6 | 5.6 | 7.4 |
| Reactive Cyanide (mg/L) | <10 | <10 | <10 |
| Reactive Sulfide (mg/L) | <10 | <10 | <10 |

Notes: mg/L - milligram per liter
mg/L - milligram per liter

# TABLE 4-21

## SUMMARY OF GROUNDWATER FIELD PARAMETERS
## SITE 24
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Well No. | Depth of Well (ft.) (1) | Purge Volume (gals.) | Field Parameters | | | |
|---|---|---|---|---|---|---|
| Date of Measurement | | | Well Volume | Specific Conductance at 25 deg. C (micromhos/cm) | Temperature (deg. C) | pH (S.U.) |
| 24GW01<br>6-1-93 | 22.40 | 6.7 | 1 | 78 | 16.5 | 5.87 |
| | | | 2 | 72 | 16.5 | 5.84 |
| | | | 3 | 70 | 16.1 | 5.77 |
| 24GW02<br>6-1-93 | 20.56 | 8.1 | 1 | 87 | 18.0 | 5.77 |
| | | | 2 | 85 | 17.3 | 5.70 |
| | | | 3 | 83 | 17.1 | 5.66 |
| 24GW03<br>6-1-93 | 21.90 | 7.89 | 1 | 531 | 17.9 | 6.24 |
| | | | 2 | 866 | 17.8 | 6.22 |
| | | | 3 | 750 | 17.7 | 6.14 |
| 24GW04<br>6-1-93 | 24.32 | 7.5 | 1 | 356 | 16.9 | 7.81 |
| | | | 2 | 346 | 16.7 | 7.60 |
| | | | 3 | 356 | 16.8 | 7.59 |
| 24GW06<br>6-2-93 | 27.67 | 14.4 | 1 | 449 | 19.1 | 7.29 |
| | | | 2 | 450 | 18.4 | 6.94 |
| | | | 3 | 450 | 18.2 | 7.18 |
| | | | 4 | 456 | 18.2 | 7.17 |
| 24GW07<br>6-2-93 | 20.02 | 10.29 | 1 | 58 | 17.3 | 5.56 |
| | | | 2 | 58 | 17.2 | 5.57 |
| | | | 3 | 58 | 17.4 | 5.71 |
| 24GW08<br>6-2-93 | 21.4 | 16.0 | 1 | 154 | 19.6 | 5.88 |
| | | | 2 | 155 | 19.0 | 5.40 |
| | | | 3 | 156 | 18.2 | 6.04 |
| | | | 4 | 160 | 18.3 | 6.34 |
| | | | 5 | 161 | 17.5 | 6.08 |
| 24GW09<br>6-2-93 | 14.46 | 18.0 | 1 | 161 | 16.9 | 5.83 |
| | | | 2 | 167 | 16.3 | 5.66 |
| | | | 3 | 159 | 16.0 | 5.43 |
| | | | 4 | 159 | 15.9 | 5.34 |
| 24GW10<br>6-2-93 | 20.22 | 14.7 | 1 | 69 | 18.7 | 5.94 |
| | | | 2 | 61 | 17.6 | 5.80 |
| | | | 3 | 60 | 17.0 | 5.69 |

(1) Well depth taken from below ground surface (bgs)

## TABLE 4-22

## SUMMARY OF GROUNDWATER ENGINEERING PARAMETERS
## OPERABLE UNIT NO. 1
## REMEDIAL INVESTIGATION CTO 0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Engineering Parameter | Sample Identification | | | |
|---|---|---|---|---|
| | 24GW08 | 78GW34 | 78GW31-3 | 78GW04-1 |
| $BOD_5$ | <2 | 2 | <2 | 5 |
| TSS | 1,300 | 8,800 | 38 | 150 |
| TDS | 120 | 480 | 860 | 270 |
| TVS | 1,500 | 1,300 | 280 | 84 |
| COD | <10 | 17 | <10 | <10 |
| TOC | 1 | 1 | 2 | 1 |

Note: All result concentrations expressed in mg/l.

$BOD_5$ - 5-day Biological Oxygen Demand
TSS - Total Suspended Solids at 103 C.
TDS - Total Dissolved Solids at 180 C.
TVS - Total Volatile Solids at 550 C.
COD - Chemical Oxygen Demand
TOC - Nonpurgeable Organic Carbon.

## TABLE 4 - 23
## OPERABLE UNIT NO. 1 - SITE 78
## HADNOT POINT INDUSTRIAL AREA
## SURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO.<br>DEPTH<br>UNITS | 78-B1103-SB02-00<br>0-6"<br>UG/KG | 78-B1103-SB03-00<br>0-6"<br>UG/KG | 78-B1103-SB04-00<br>0-6"<br>UG/KG | 78-B1103-SB05-00<br>0-6"<br>UG/KG | 78-B1300-SB01-00<br>0-6"<br>UG/KG | 78-B1300-SB02-00<br>0-6"<br>UG/KG | 78-B1300-SB03-00<br>0-6"<br>UG/KG |
|---|---|---|---|---|---|---|---|
| **VOLATILES** | | | | | | | |
| CHLOROMETHANE | | | | | | | |
| BROMOMETHANE | | | | | | | |
| METHYLENE CHLORIDE | | | | | | | |
| ACETONE | | | | | | | |
| 1,1-DICHLOROETHENE | | | | | | | |
| TOLUENE | | | 9 J | | | | |
| XYLENES (total) | | | 10 J | | | | |
| **SEMIVOLATILES** | | | | | | | |
| NAPHTHALENE | | | | | | | |
| 2-METHYLNAPHTHALENE | | | | | | | |
| ACENAPHTHENE | | | | | | | |
| DIBENZOFURAN | | | | | | | |
| FLUORENE | | | | | | | |
| PHENANTHRENE | 46 J | 370 J | 220 J | 110 J | | | |
| ANTHRACENE | | 65 J | | | | | |
| CARBAZOLE | | 60 J | | | | | |
| DI-N-BUTYL PHTHALATE | | | 70 J | | | | |
| FLUORANTHENE | 120 J | 710 | 480 | 280 J | | | |
| PYRENE | 77 J | 470 | 430 | 190 J | | | |
| BUTYL BENZYL PHTHALATE | | | 91 J | 77 J | | | |
| BENZO(A)ANTHRACENE | 58 J | 350 J | 220 J | 100 J | | | |
| CHRYSENE | 53 J | 270 J | 260 J | 160 J | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | 1700 | | | | |
| BENZO(B)FLUORANTHENE | 77 J | 340 J | 280 J | 200 J | | | |
| BENZO(K)FLUORANTHENE | | 190 J | 160 J | 69 J | | | |
| BENZO(A)PYRENE | 56 J | 260 J | 220 J | 140 J | | | |
| INDENO(1,2,3-CD)PYRENE | | 100 J | 170 J | 78 J | | | |
| DIBENZ(A,H)ANTHRACENE | | | 52 J | | | | |
| BENZO(GHI)PERYLENE | | 95 J | 170 J | 86 J | | | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 23
## OPERABLE UNIT NO. 1 - SITE 78
## HADNOT POINT INDUSTRIAL AREA
## SURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO. | 78-B1103-SB02-00 | 78-B1103-SB03-00 | 78-B1103-SB04-00 | 78-B1103-SB05-00 | 78-B1300-SB01-00 | 78-B1300-SB02-00 | 78-B1300-SB03-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| <u>PESTICIDES/PCBS</u> | | | | | | | |
| HEPTACHLOR | | | 48 | | | | |
| DIELDRIN | | 390 | | | | | |
| 4,4'-DDE | 140 | 840 | 960 | 490 | 67 J | 29 J | |
| ENDRIN | | | | | | | |
| 4,4'-DDD | 18 J | 23 J | 330 J | 43 | | 3.7 J | |
| 4,4'-DDT | 70 | 230 | 580 | 180 | 35 J | 11 J | 3.8 |
| ENDRIN ALDEHYDE | | | | | 7.1 J | | |
| ALPHA-CHLORDANE | 12 J | | 1900 J | 30 J | | | |
| GAMMA-CHLORDANE | | | 1300 J | | | | |
| AROCLOR-1260 | | | | | 100 J | | |

ug/kg - microgram per kilogram
J - value is estimated

## TABLE 4 - 23
## OPERABLE UNIT NO. 1 - SITE 78
## HADNOT POINT INDUSTRIAL AREA
## SURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO. | 78-B1300-SB04-00 | 78-B1300-SB05-00 | 78-B1502-SB01-00 | 78-B1502-SB02-00 | 78-B1502-SB03-00 | 78-B1502-SB04-00 | 78-B1502-SB05-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| VOLATILES | | | | | | | |
| CHLOROMETHANE | | | | | | | 12 |
| BROMOMETHANE | | | | | | | 8 J |
| METHYLENE CHLORIDE | | | | 10 J | | | |
| ACETONE | | | | | | | |
| 1,1-DICHLOROETHENE | | | | 2 J | | | |
| TOLUENE | | | | | | | |
| XYLENES (total) | | | | | | | |
| SEMIVOLATILES | | | | | | | |
| NAPHTHALENE | | | | | | | |
| 2-METHYLNAPHTHALENE | | | | | | | |
| ACENAPHTHENE | | | | | | | |
| DIBENZOFURAN | | | | | | | |
| FLUORENE | | | | | | | |
| PHENANTHRENE | | | 96 J | 110 J | 65 J | 86 J | |
| ANTHRACENE | | | | | | | |
| CARBAZOLE | | | | | | | |
| DI-N-BUTYL PHTHALATE | | | | | | | |
| FLUORANTHENE | | | 240 J | 220 J | 120 J | 230 J | |
| PYRENE | | | 160 J | 150 J | 68 J | 140 J | |
| BUTYL BENZYL PHTHALATE | | | | | | | |
| BENZO(A)ANTHRACENE | | | 94 J | 75 J | | 77 J | |
| CHRYSENE | | | 110 J | 93 J | | 110 J | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | 99 J | 56 J | | 110 J | |
| BENZO(B)FLUORANTHENE | | | 100 J | 250 J | 140 J | 80 J | |
| BENZO(K)FLUORANTHENE | | | 76 J | | | 80 J | |
| BENZO(A)PYRENE | | | 65 J | 61 J | | 66 J | |
| INDENO(1,2,3-CD)PYRENE | | | | | | | |
| DIBENZ(A,H)ANTHRACENE | | | | | | | |
| BENZO(GHI)PERYLENE | | | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 23
# OPERABLE UNIT NO. 1 - SITE 78
# HADNOT POINT INDUSTRIAL AREA
# SURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO. | 78-B1300-SB04-00 | 78-B1300-SB05-00 | 78-B1502-SB01-00 | 78-B1502-SB02-00 | 78-B1502-SB03-00 | 78-B1502-SB04-00 | 78-B1502-SB05-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| **PESTICIDES/PCBS** | | | | | | | |
| HEPTACHLOR | | | | | | | |
| DIELDRIN | | | 14 | 1300 J | | 45 | 6.2 |
| 4,4'-DDE | 7.8 J | | 16 | | 59 | 160 | 130 |
| ENDRIN | | | | | | | |
| 4,4'-DDD | | | 7.3 | 2900 J | | 8.4 | 11 J |
| 4,4'-DDT | | 9.4 J | 33 J | 16000 J | 42 J | 100 J | 34 J |
| ENDRIN ALDEHYDE | | | | | | | |
| ALPHA-CHLORDANE | | | | | | | |
| GAMMA-CHLORDANE | | | | | | | |
| AROCLOR-1260 | | | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

## TABLE 4 - 23
## OPERABLE UNIT NO. 1 - SITE 78
## HADNOT POINT INDUSTRIAL AREA
## SURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO. | 78-B1502-SB06-00 | 78-B1502-SB07-00 | 78-B1502-SB09-00 | 78-B1601-SB01-00 | 78-B1601-SB02-00 | 78-B1601-SB03-00 | 78-B1608-SB01-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| <u>VOLATILES</u> | | | | | | | |
| CHLOROMETHANE | | | | | | | |
| BROMOMETHANE | | | | | | | |
| METHYLENE CHLORIDE | | | | | | | |
| ACETONE | | | | | 31 | | |
| 1,1-DICHLOROETHENE | | | | | | | |
| TOLUENE | | | | | | | |
| XYLENES (total) | | | | | | | |
| <u>SEMIVOLATILES</u> | | | | | | | |
| NAPHTHALENE | | | | | | | |
| 2-METHYLNAPHTHALENE | | | | | | | |
| ACENAPHTHENE | | | | | | | |
| DIBENZOFURAN | | | | | | | |
| FLUORENE | | | | | | | |
| PHENANTHRENE | 92 J | | | | | | |
| ANTHRACENE | | | | | | | |
| CARBAZOLE | | | | | | | |
| DI-N-BUTYL PHTHALATE | 83 J | | | | 300 J | | |
| FLUORANTHENE | 220 J | | 93 J | | | | 38 J |
| PYRENE | 150 J | | 65 J | | | | 39 J |
| BUTYL BENZYL PHTHALATE | | | | | | | 37 J |
| BENZO(A)ANTHRACENE | 74 J | | | | | | |
| CHRYSENE | 110 J | | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | 86 J | | 69 J | 35 J | | 120 J | |
| BENZO(B)FLUORANTHENE | 74 J | | 61 J | | | | |
| BENZO(K)FLUORANTHENE | 63 J | | | | | | |
| BENZO(A)PYRENE | 62 J | | | | | | |
| INDENO(1,2,3-CD)PYRENE | | | | | | | |
| DIBENZ(A,H)ANTHRACENE | | | | | | | |
| BENZO(GHI)PERYLENE | | | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 23
# OPERABLE UNIT NO. 1 - SITE 78
# HADNOT POINT INDUSTRIAL AREA
# SURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO. | 78-B1502-SB06-00 | 78-B1502-SB07-00 | 78-B1502-SB09-00 | 78-B1601-SB01-00 | 78-B1601-SB02-00 | 78-B1601-SB03-00 | 78-B1608-SB01-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| **PESTICIDES/PCBS** | | | | | | | |
| HEPTACHLOR | | | | | | | |
| DIELDRIN | 180 | | 730 | 8.5 | | 4.2 | 24 J |
| 4,4'-DDE | 620 | 9.7 | 1400 | 26 | 8.2 J | 23 | 160 J |
| ENDRIN | | | | | | | |
| 4,4'-DDD | 24 J | | | 10 | | | |
| 4,4'-DDT | 1800 | | 2900 J | 21 J | 5.6 J | 23 J | 210 |
| ENDRIN ALDEHYDE | | | | | | | |
| ALPHA-CHLORDANE | | | | | | | |
| GAMMA-CHLORDANE | | | | | | | |
| AROCLOR-1260 | | | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

## TABLE 4 - 23
## OPERABLE UNIT NO. 1 - SITE 78
## HADNOT POINT INDUSTRIAL AREA
## SURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO. | 78-B1608-SB02-00 | 78-B1608-SB03-00 | 78-B1608-SB04-00 | 78-B1608-SB05-00 | 78-B903-SB01-00 | 78-B903-SB02-00 | 78-B903-SB03-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| **VOLATILES** | | | | | | | |
| CHLOROMETHANE | | | | | | | |
| BROMOMETHANE | | | | | | | |
| METHYLENE CHLORIDE | | | | | | | |
| ACETONE | | | | | | | |
| 1,1-DICHLOROETHENE | | | | | | | |
| TOLUENE | | | | | | | |
| XYLENES (total) | | | | | | | |
| **SEMIVOLATILES** | | | | | | | |
| NAPHTHALENE | | | | | 1400 | | 81 J |
| 2-METHYLNAPHTHALENE | | | | | 440 | | |
| ACENAPHTHENE | | | | | 1300 | 110 J | 230 J |
| DIBENZOFURAN | | | | | 850 | | 98 J |
| FLUORENE | | | | | 1400 | | 180 J |
| PHENANTHRENE | 70 J | 49 J | 38 J | | 9000 | 770 | 1700 |
| ANTHRACENE | | | | | 2000 | 170 J | 380 J |
| CARBAZOLE | | | | | 1100 | 130 J | 230 J |
| DI-N-BUTYL PHTHALATE | | | 58 J | | | | |
| FLUORANTHENE | 230 J | 67 J | 110 J | 67 J | 8800 | 2100 | 2600 |
| PYRENE | 210 J | 66 J | 100 J | 43 J | 7600 | 1500 | 1900 |
| BUTYL BENZYL PHTHALATE | 73 J | 51 J | 42 J | | | | |
| BENZO(A)ANTHRACENE | 92 J | | 45 J | | 2900 | 740 | 1000 |
| CHRYSENE | 130 J | | 63 J | | 2300 | 900 | 1000 |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | | | | |
| BENZO(B)FLUORANTHENE | 210 J | 59 J | 92 J | 46 J | 2700 | 590 | 710 |
| BENZO(K)FLUORANTHENE | | | | | 1400 | 550 | 500 |
| BENZO(A)PYRENE | 130 J | | 63 J | | 2000 | 540 | 670 |
| INDENO(1,2,3-CD)PYRENE | 110 J | | 51 J | | 330 J | 210 J | 400 |
| DIBENZ(A,H)ANTHRACENE | 46 J | | | | | | 210 J |
| BENZO(GHI)PERYLENE | 160 J | | 65 J | | 300 J | 180 J | 330 J |

ug/kg - microgram per kilogram
J - value is estimated

### TABLE 4 - 23
### OPERABLE UNIT NO. 1 - SITE 78
### HADNOT POINT INDUSTRIAL AREA
### SURFACE SOIL POSITIVE DETECTION SUMMARY
### REMEDIAL INVESTIGATION CTO - 19177
### MCB CAMP LEJEUNE, NORTH CAROLINA
### ORGANIC CHEMICALS

| SAMPLE NO. | 78-B1608-SB02-00 | 78-B1608-SB03-00 | 78-B1608-SB04-00 | 78-B1608-SB05-00 | 78-B903-SB01-00 | 78-B903-SB02-00 | 78-B903-SB03-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| **PESTICIDES/PCBS** | | | | | | | |
| HEPTACHLOR | | | | | | | |
| DIELDRIN | | | | | | 37 | |
| 4,4'-DDE | 170 | | | | 37 J | 28 | 23 J |
| ENDRIN | | | | | 24 J | | |
| 4,4'-DDD | 23 J | | | | | 6.5 J | |
| 4,4'-DDT | 47 | | | | 10 J | 6 J | 5.4 J |
| ENDRIN ALDEHYDE | | | | | | | |
| ALPHA-CHLORDANE | | | | | | | |
| GAMMA-CHLORDANE | | | | | | | |
| AROCLOR-1260 | | | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 24
# OPERABLE UNIT NO. 1 - SITE 78
# HADNOT POINT INDUSTRIAL AREA
# SURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO. | 78-B1103-SB02-00 | 78-B1103-SB03-00 | 78-B1103-SB04-00 | 78-B1103-SB05-00 | 78-B1502-SB01-00 | 78-B1502-SB02-00 | 78-B1502-SB03-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 4880 | 4990 | 4560 | 2700 | 2910 | 3720 | 2990 |
| ANTIMONY | | | | | | | |
| ARSENIC | 1.6 B | 1 B | 1.6 B | 2.8 | 1.8 B | 1.2 B | 0.95 B |
| BARIUM | 152 | 425 | 140 | 237 | 109 | 40.8 B | 22.9 B |
| BERYLLIUM | | 0.23 B | 0.23 B | | 0.22 B | 0.21 B | 0.23 B |
| CADMIUM | 1.2 | | 2.8 | 3.5 | | 1.9 | |
| CALCIUM | 4550 | 14300 | 18800 | 65700 | 24700 | 10300 | 2140 |
| CHROMIUM | 14.6 | 8.8 | 20 | 18.7 | 14.5 | 23 | 9.3 |
| COBALT | 2.2 B | | | | 2.2 B | | |
| COPPER | 6.8 | 9.7 | 15.3 | 20.8 | 11.4 | 29.6 | 16.3 |
| IRON | 2010 | 2420 | 1700 | 2200 | 2330 | 7880 | 2020 |
| LEAD | 291 | 86.5 | 674 | 962 | 101 | 404 | 181 |
| MAGNESIUM | 208 B | 521 B | 511 B | 1260 | 664 B | 496 B | 185 B |
| MANGANESE | 15.5 | 31.3 | 16.7 | 23.2 | 24.4 | 45.1 | 23.6 |
| MERCURY | | | | | | | |
| NICKEL | | | | | | | |
| POTASSIUM | 118 B | 288 B | 150 B | 130 B | 211 B | 279 B | 90.4 B |
| SELENIUM | 0.24 B | 0.63 B | 0.58 B | 0.41 B | 0.28 B | 0.26 B | 0.27 B |
| SODIUM | 48.3 B | 65.4 B | 70.4 B | 158 B | 81.6 B | 62.1 B | 42.9 B |
| VANADIUM | 9 B | 8.8 B | 8.6 B | 7.8 B | 6.7 B | 9.5 B | 8.9 B |
| ZINC | 1280 J | 87.2 J | 2900 J | 4730 J | 74.3 J | 230 J | 126 J |

mg/kg - milligram per kiliogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

TABLE 4 - 24
OPERABLE UNIT NO. 1 - SITE 78
HADNOT POINT INDUSTRIAL AREA
SURFACE SOIL POSITIVE DETECTION SUMMARY
REMEDIAL INVESTIGATION CTO - 19177
MCB CAMP LEJEUNE, NORTH CAROLINA
TAL METALS AND CYANIDE

| SAMPLE NO. | 78-B1502-SB04-00 | 78-B1502-SB05-00 | 78-B1502-SB06-00 | 78-B1502-SB07-00 | 78-B1502-SB09-00 | 78-B1601-SB01-00 | 78-B1601-SB03-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 2300 | 3190 | 3800 | 2370 | 3390 | 3420 | 2820 |
| ANTIMONY | | | | | | | |
| ARSENIC | 0.91 B | 0.69 B | 0.85 B | 0.95 B | 0.96 B | 0.78 J | 0.82 J |
| BARIUM | 21 B | 8.2 B | 28.3 B | 16.1 B | 37.7 B | 10.7 B | 8.2 B |
| BERYLLIUM | 0.24 B | | | | 0.25 B | 0.22 B | |
| CADMIUM | | | | | 1.5 | | |
| CALCIUM | 2490 | 2540 | 2260 | 1000 B | 3010 | 772 B | 1030 B |
| CHROMIUM | 11.2 | 2.2 | 11.2 | 2.9 | 12.6 | 6 | 5.6 |
| COBALT | | | | | | | |
| COPPER | 17.4 | 5 B | 15.7 | 9.5 | 25.6 | 7.8 | 2.4 B |
| IRON | 1710 | 1760 | 1450 | 1050 | 2070 | 1740 | 1520 |
| LEAD | 188 | 33.8 | 152 | 74.9 | 196 | 77 | 15.5 |
| MAGNESIUM | 272 B | 162 B | 223 B | 107 B | 265 B | 136 B | 112 B |
| MANGANESE | 18.6 | 5.6 | 11.9 | 11 | 31.8 | 6 | 4.3 |
| MERCURY | | | | | 2.2 | | |
| NICKEL | | | | | 4.9 B | | |
| POTASSIUM | 161 B | 102 B | 139 B | 65.4 B | 303 B | 125 B | 100 B |
| SELENIUM | 0.24 B | | 0.4 B | 0.38 B | 0.47 B | 0.31 B | |
| SODIUM | 44.7 B | 32.9 B | 37.7 B | 37.3 B | 42.1 B | 49.7 B | 42.4 B |
| VANADIUM | 7.2 B | 5.8 B | 6.3 B | 3.1 B | 9.1 B | 6 B | 5.2 B |
| ZINC | 109 J | 13.1 J | 70.3 J | 40.7 J | 111 J | 45.9 J | 18.1 J |

mg/kg - milligram per kiliogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 24
# OPERABLE UNIT NO. 1 - SITE 78
# HADNOT POINT INDUSTRIAL AREA
# SURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO. | 78-B1608-SB01-00 | 78-B1608-SB02-00 | 78-B1608-SB03-00 | 78-B1608-SB04-00 | 78-B1608-SB05-00 | 78-B903-SB01-00 | 78-B903-SB03-00 |
|---|---|---|---|---|---|---|---|
| DEPTH | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" | 0-6" |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 3340 | 1720 | 2030 | 3100 | 1410 | 2640 J | 2500 J |
| ANTIMONY | | | 1.3 J | | | | |
| ARSENIC | 0.93 J | 1.4 J | 1.5 B | 0.99 B | 1.1 B | 0.8 B | 1.1 B |
| BARIUM | 10.8 B | 520 | 32.6 B | 19.5 B | 62 | 13.2 B | 10.7 B |
| BERYLLIUM | | 0.21 B | 0.22 B | | 0.21 B | | |
| CADMIUM | | 3.2 | 4.2 | | 2.8 | | |
| CALCIUM | 5340 | 30400 | 13900 | 3030 | 25600 | 2910 | 2980 |
| CHROMIUM | 7.6 | 12.6 | 74.6 | 12.3 | 20.7 | 4 J | 3.9 J |
| COBALT | | 2.1 B | | | | | |
| COPPER | 9.9 | 17.7 | 24.6 | 8 | 18.4 | 6.7 | 3.5 B |
| IRON | 1860 | 3220 | 4180 | 2280 | 4810 | 1360 J | 1220 J |
| LEAD | 43.8 | 165 | 749 | 107 | 230 | 54 | 12.8 J |
| MAGNESIUM | 223 B | 1180 | 1020 B | 324 B | 1550 | 170 B | 144 B |
| MANGANESE | 11 | 30.3 | 42.9 | 17.4 | 42.7 | 14.2 | 15.3 |
| MERCURY | | | | | | | |
| NICKEL | | | 6.8 B | | | | |
| POTASSIUM | 145 B | 131 B | 125 B | 109 B | 116 B | 87.9 B | 58.3 B |
| SELENIUM | | 0.26 B | 0.44 B | 0.23 B | 0.28 B | 0.25 B | 0.33 J |
| SODIUM | 48.1 B | 91.7 B | 70.2 B | 44.4 B | 138 B | 30.9 B | 32.8 B |
| VANADIUM | 5.6 B | 11.5 | 16.1 | 5.9 B | 10.5 B | 6 B | 4.4 B |
| ZINC | 35.8 J | 190 J | 211 J | 36.2 J | 165 J | 34.1 | 18.6 |

mg/kg - milligram per kiliogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 25
# OPERABLE UNIT NO. 1 - SITE 78
# HADNOT POINT INDUSTRIAL AREA
# SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO.<br>DEPTH<br>UNITS | 78-B1103-SB05-03<br>6-7'<br>UG/KG | 78-B1300-SB02-03<br>6-8'<br>UG/KG | 78-B1502-SB03-03<br>6-8'<br>UG/KG | 78-B1502-SB06-03<br>6-8'<br>UG/KG | 78-B1502-SB09-05<br>10-12'<br>UG/KG | 78-B1601-SB01-03<br>6-7'<br>UG/KG | 78-B1608-SB01-03<br>6-7'<br>UG/KG | 78-B1608-SB03-04<br>8-9'<br>UG/KG |
|---|---|---|---|---|---|---|---|---|
| **VOLATILES** | | | | | | | | |
| ACETONE | | | 210 | | 22 | 47 J | | |
| 1,2-DICHLOROETHENE (total) | | | | | | | | |
| TOLUENE | | | | | | | | |
| ETHYLBENZENE | | | | | | 55 J | | |
| XYLENES (total) | | | | | | 450 | | |
| **SEMIVOLATILES** | | | | | | | | |
| NAPHTHALENE | | | | | | 850 | | |
| 2-METHYLNAPHTHALENE | | | | | | 890 | | |
| ACENAPHTHENE | | | | | | | | |
| PHENANTHRENE | | | | | | 220 J | | |
| ANTHRACENE | | | | | | | | |
| CARBAZOLE | | | | | | | | |
| DI-N-BUTYLPHTHALATE | | | | | | | | |
| FLUORANTHENE | | | | | | 160 J | | |
| PYRENE | | | | | | 110 J | | |
| BENZO(A)ANTHRACENE | | | | | | | | |
| CHRYSENE | | | | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | | 120 J | 81 J | | |
| DI-N-OCTYL PHTHALATE | | | | | | | | |
| BENZO(B)FLUORANTHENE | | | | | | | | |
| BENZO(K)FLUORANTHENE | | | | | | | | |
| BENZO(A)PYRENE | | | | | | | | |
| INDENO(1,2,3-CD)PYRENE | | | | | | | | |
| BENZO(GHI)PERYLENE | | | | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

## TABLE 4 - 25
## OPERABLE UNIT NO. 1 - SITE 78
## HADNOT POINT INDUSTRIAL AREA
## SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO. | 78-B1103-SB05-03 | 78-B1300-SB02-03 | 78-B1502-SB03-03 | 78-B1502-SB06-03 | 78-B1502-SB09-05 | 78-B1601-SB01-03 | 78-B1608-SB01-03 | 78-B1608-SB03-04 |
|---|---|---|---|---|---|---|---|---|
| DEPTH | 6-7' | 6-8' | 6-8' | 6-8' | 10-12' | 6-7' | 6-7' | 8-9' |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| <u>PESTICIDES/PCBS</u> | | | | | | | | |
| DIELDRIN | | | | | | | 1.3 J | |
| 4,4'-DDE | 34 J | | | | | 4.0 J | 2.1 J | 4.4 |
| 4,4'-DDD | | 6.3 | | | | 4.0 J | | |
| 4,4'-DDT | 9.7 J | | | 7.5 | | | 3.1 J | 5.2 |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 25
# OPERABLE UNIT NO. 1 - SITE 78
# HADNOT POINT INDUSTRIAL AREA
# SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO. | 78-B903-SB01-02 | 78-B903-SB02-02 | 78-B903-SB03-02 | 78-GW33-02 | 78-GW34-02 | 78-GW35-05 | 78-GW35-06 |
|---|---|---|---|---|---|---|---|
| DEPTH | 4-5' | 5-6' | 4-5' | 2-4' | 4-6' | 10-12' | 12-14' |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| **VOLATILES** | | | | | | | |
| ACETONE | 26 | 110 | 40 | 59 | 21 | 30 | 30 |
| 1,2-DICHLOROETHENE (total) | | 6 J | 16 | | | | |
| TOLUENE | | | | | | | |
| ETHYLBENZENE | | | | | | | |
| XYLENES (total) | | | | | | | |
| **SEMIVOLATILES** | | | | | | | |
| NAPHTHALENE | | 74 J | | | | | |
| 2-METHYLNAPHTHALENE | | | | | | | |
| ACENAPHTHENE | | 97 J | | | | | |
| PHENANTHRENE | | 590 | | | | | |
| ANTHRACENE | | 150 J | | | | | |
| CARBAZOLE | | 89 J | | | | | |
| DI-N-BUTYLPHTHALATE | | | | | | | |
| FLUORANTHENE | | 700 | | | | | |
| PYRENE | | 480 | | | | | |
| BENZO(A)ANTHRACENE | | 320 J | | | | | |
| CHRYSENE | | 300 J | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | | | | |
| DI-N-OCTYL PHTHALATE | | | | | | | |
| BENZO(B)FLUORANTHENE | | 170 J | | | | | |
| BENZO(K)FLUORANTHENE | | 190 J | | | | | |
| BENZO(A)PYRENE | | 170 J | | | | | |
| INDENO(1,2,3-CD)PYRENE | | 100 J | | | | | |
| BENZO(GHI)PERYLENE | | 95 J | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

### TABLE 4 - 25
### OPERABLE UNIT NO. 1 - SITE 78
### HADNOT POINT INDUSTRIAL AREA
### SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
### REMEDIAL INVESTIGATION CTO - 19177
### MCB CAMP LEJEUNE, NORTH CAROLINA
### ORGANIC CHEMICALS

| SAMPLE NO. | 78-B903-SB01-02 | 78-B903-SB02-02 | 78-B903-SB03-02 | 78-GW33-02 | 78-GW34-02 | 78-GW35-05 | 78-GW35-06 |
|---|---|---|---|---|---|---|---|
| DEPTH | 4-5' | 5-6' | 4-5' | 2-4' | 4-6' | 10-12' | 12-14' |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| **PESTICIDES/PCBS** | | | | | | | |
| DIELDRIN | | | | | | | |
| 4,4'-DDE | | | | | | | |
| 4,4'-DDD | | | | | | | |
| 4,4'-DDT | | | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 25
# OPERABLE UNIT NO. 1 - SITE 78
# HADNOT POINT INDUSTRIAL AREA
# SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO. | 78-GW36-04 | 78-GW36-05 | 78-GW37-02 | 78-GW37-03 | 78-GW38-10 | 78-GW39-05 | 78-GW39-06 |
|---|---|---|---|---|---|---|---|
| DEPTH | 8-10' | 10-12' | 4-6' | 6-8' | 20-22' | 10-12' | 12-14' |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| **VOLATILES** | | | | | | | |
| ACETONE | 19 | 19 | | | 36 | 15 | 14 |
| 1,2-DICHLOROETHENE (total) | | | | | | | |
| TOLUENE | | | | | | | 3 J |
| ETHYLBENZENE | | | | | | | |
| XYLENES (total) | | | | | | | |
| **SEMIVOLATILES** | | | | | | | |
| NAPHTHALENE | | | | | | | |
| 2-METHYLNAPHTHALENE | | | | | | | |
| ACENAPHTHENE | | | | | | | |
| PHENANTHRENE | | | | | | | |
| ANTHRACENE | | | | | | | |
| CARBAZOLE | | | | | | | |
| DI-N-BUTYLPHTHALATE | | | 100 J | 83 J | | | |
| FLUORANTHENE | | | | | | | |
| PYRENE | | | | | | | |
| BENZO(A)ANTHRACENE | | | | | | | |
| CHRYSENE | | | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | | | | |
| DI-N-OCTYL PHTHALATE | | | | | | | |
| BENZO(B)FLUORANTHENE | | | | | | | |
| BENZO(K)FLUORANTHENE | | | | | | | |
| BENZO(A)PYRENE | | | | | | | |
| INDENO(1,2,3-CD)PYRENE | | | | | | | |
| BENZO(GHI)PERYLENE | | | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

### TABLE 4 - 25
### OPERABLE UNIT NO. 1 - SITE 78
### HADNOT POINT INDUSTRIAL AREA
### SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
### REMEDIAL INVESTIGATION CTO - 19177
### MCB CAMP LEJEUNE, NORTH CAROLINA
### ORGANIC CHEMICALS

| SAMPLE NO. | 78-GW36-04 | 78-GW36-05 | 78-GW37-02 | 78-GW37-03 | 78-GW38-10 | 78-GW39-05 | 78-GW39-06 |
|---|---|---|---|---|---|---|---|
| DEPTH | 8-10' | 10-12' | 4-6' | 6-8' | 20-22' | 10-12' | 12-14' |
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| <u>PESTICIDES/PCBS</u> | | | | | | | |
| DIELDRIN | | | | | | | |
| 4,4'-DDE | | | | | | | |
| 4,4'-DDD | | | 48 | 42 | | | |
| 4,4'-DDT | | | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4 - 26
# OPERABLE UNIT NO. 1 - SITE 78
# HADNOT POINT INDUSTRIAL AREA
# SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO. | 78-B903-SB01-02 | 78-B903-SB03-02 | 78-GW33-02 | 78-GW33-03 | 78-GW34-01 | 78-GW34-02 |
|---|---|---|---|---|---|---|
| DEPTH | 5-6' | 4-5' | 2-4' | 6-8' | 2-4' | 4-6' |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 6760 J | 8550 J | 6570 | 4280 | 2730 | 12600 |
| ARSENIC | 1.9 B | 0.74 B | 0.86 B | | 6.2 | |
| BARIUM | 10.6 B | 11.3 B | 4.4 B | 4.6 B | 2.8 B | 12.7 B |
| BERYLLIUM | | 0.26 B | | | | |
| CALCIUM | 73.5 B | 124 B | 293 B | 168 B | 297 B | 129 B |
| CHROMIUM | 7.2 J | 9 J | 7.1 | 4.3 | 4.7 | 18.5 |
| COPPER | 1.2 B | 0.51 B | 1.2 B | 0.72 B | 0.7 B | 3.4 B |
| IRON | 4010 J | 4690 J | 5890 | 1950 | 3940 | 2120 |
| LEAD | 6.5 J | 2.6 J | 2.9 J | 2.6 J | 2.1 J | 4.5 J |
| MAGNESIUM | 156 B | 157 B | 193 B | 220 B | 106 B | 458 B |
| MANGANESE | 1.9 B | 2 B | 4.2 | 4.1 | 1.6 B | 9.2 |
| POTASSIUM | 145 B | 125 B | 187 B | 222 B | 155 B | 780 B |
| SELENIUM | 0.29 J | 0.38 J | 0.34 J | | 0.26 J | 1.2 J |
| SODIUM | 93 B | 30.2 B | 42.3 B | 41 B | 31.9 B | 51.7 B |
| VANADIUM | 11.8 B | 19.2 | 8.8 B | 6 B | 8.4 B | 18.7 |
| ZINC | 1.7 B | 2 B | 2.9 B | 1.9 B | 1.6 B | 7.9 |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 26
# OPERABLE UNIT NO. 1 - SITE 78
# HADNOT POINT INDUSTRIAL AREA
# SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS AND CYANIDE

| SAMPLE NO.<br>DEPTH<br>UNITS | 78-GW35-05<br>10-12'<br>MG/KG | 78-GW35-06<br>12-14'<br>MG/KG | 78-GW36-04<br>8-10'<br>MG/KG | 78-GW36-05<br>10-12'<br>MG/KG | 78-GW37-02<br>4-6'<br>MG/KG | 78-GW37-03<br>6-8'<br>MG/KG |
|---|---|---|---|---|---|---|
| ALUMINUM | 4540 | 9100 | 5670 | 6650 | 14100 | 8080 |
| ARSENIC | | | 0.71 B | 0.49 B | 0.66 B | 0.5 B |
| BARIUM | 5 B | 8.2 B | 6.2 B | 7.5 B | 11.4 B | 7.3 B |
| BERYLLIUM | | | | | | |
| CALCIUM | 29.1 B | 66.5 B | 77 B | 231 B | 31.1 B | 34.5 B |
| CHROMIUM | 4.3 | 11.6 | 8.3 | 6.1 | 11.1 | 7 |
| COPPER | 0.95 B | 1.5 B | 1.2 B | 0.7 B | 2 B | 2 B |
| IRON | 556 | 1870 | 650 | 996 | 2200 | 1370 |
| LEAD | 3.6 J | 4.7 J | 3.5 J | 3.2 J | 5.2 J | 4.6 J |
| MAGNESIUM | 107 B | 248 B | 140 B | 182 B | 391 B | 240 B |
| MANGANESE | 2.1 B | 4.8 | 3.1 B | 3.1 B | 6.3 | 4 |
| POTASSIUM | 194 B | 378 B | 119 B | 240 B | 595 B | 438 B |
| SELENIUM | | | | | | |
| SODIUM | 34.5 B | 34.1 B | 38.5 B | 32.4 B | 50.5 B | 43.3 B |
| VANADIUM | 4 B | 9.9 B | 5 B | 4.9 B | 15.2 | 12 B |
| ZINC | 1.4 B | 3.1 B | 2.1 B | 2.6 B | 3.8 B | 3.3 B |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4 - 26
## OPERABLE UNIT NO. 1 - SITE 78
## HADNOT POINT INDUSTRIAL AREA
## SUBSURFACE SOIL POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## TAL METALS AND CYANIDE

| SAMPLE NO. | 78-GW38-09 | 78-GW38-10 | 78-GW39-05 | 78-GW39-06 |
|---|---|---|---|---|
| DEPTH | 18-20' | 20-22' | 10-12' | 12-14' |
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 4810 | 5020 | 3660 | 4670 |
| ARSENIC | 0.6 B | | 1 B | |
| BARIUM | 9.6 B | 13 B | 6.5 B | 9.7 B |
| BERYLLIUM | | | | |
| CALCIUM | 152 B | 86.1 B | 47.2 B | 42.6 B |
| CHROMIUM | 4.4 | | 4.5 | 4.2 |
| COPPER | 1.1 B | 1 B | 1.5 B | 0.75 B |
| IRON | 792 | 602 | 2070 | 462 |
| LEAD | 2.2 J | 1 J | 4.7 J | 3 J |
| MAGNESIUM | 131 B | 126 B | 119 B | 101 B |
| MANGANESE | 3.7 | 2.5 B | 2.7 B | 2.5 B |
| POTASSIUM | 123 B | 123 B | 138 B | 88 B |
| SELENIUM | | | | |
| SODIUM | 36.1 B | 36.2 B | 41.2 B | 48.4 B |
| VANADIUM | 4.6 B | 3.2 B | 6.5 B | 2.2 B |
| ZINC | 3.2 B | 2.7 B | 2.2 B | 2.2 B |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4-27

## SUMMARY OF ANALYTICAL RESULTS FROM THE MONITORING WELLS SAMPLED ON DECEMBER 9, 1993
## REMEDIAL INVESTIGATION CTO-177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| DETECTED COMPOUNDS | MONITORING WELLS | | | | | |
|---|---|---|---|---|---|---|
| | 78GW01 (Shallow) | 78GW09-1 (Shallow) | 78GW18 (Shallow) | 78GW26 (Shallow) | 78GW30-2 (Intermediate) | 78GW30-3 (Deep) |
| Benzene | ND | ND | ND | ND | 7 J | ND |
| Toluene | ND | ND | ND | ND | 3 J | ND |
| Xylene (Total) | ND | ND | ND | ND | 3 J | ND |
| Vinyl Chloride | ND | ND | ND | ND | 33 | ND |
| Chloroform | ND | 6 J | ND | ND | ND | ND |
| 1,2-DCE (Total) | 27 | 2400 D | ND | ND | 12 | ND |
| TCE | 62 | 2100 D | ND | ND | ND | ND |
| 1,1-DCE | ND | 280 D | ND | ND | ND | ND |
| 1,1-DCA | ND | 61 JD | ND | ND | ND | ND |
| 1,1,1-TCA | ND | 750 D | ND | ND | ND | ND |

Notes: All concentrations are in the units of (µg/l).

# TABLE 4-28

## SUMMARY OF GROUNDWATER FIELD PARAMETERS
## SITE 78
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Well No. | | | Field Parameters | | | |
|---|---|---|---|---|---|---|
| Date of Measurement | Depth of Well (ft.) (1) | Purge Volume (gals.) | Well Volume | Specific Conductance at 25 deg. C (micromhos/cm) | Temperature (deg. C) | pH (S.U.) |
| 78GW13(3)<br>5-21-93 | 27.66 | 7.5 | 1 | 165 | 17.1 | 5.13 |
| | | | 2 | 177 | 17.1 | 5.00 |
| | | | 3 | 189 | 17.1 | 4.94 |
| 78GW20(3)<br>5-21-93 | 27.24 | 10.5 | 1 | 330 | 15.8 | 5.37 |
| | | | 2 | 336 | 15.6 | 5.16 |
| | | | 3 | 332 | 16.0 | 5.09 |
| 78GW21(3)<br>5-21-93 | 27.84 | 13.5 | 1 | 339 | 19.1 | 5.74 |
| | | | 2 | 322 | 19.0 | 6.84 |
| | | | 3 | 299 | 19.1 | 6.64 |
| 78GW22-1(4)<br>5-21-93 | 23.18 | 7.5 | 1 | 584 | 17.6 | 6.23 |
| | | | 2 | 577 | 18.1 | 6.13 |
| | | | 3 | 577 | 18.0 | 6.04 |
| 78GW02(3)<br>5-22-93 | 22.15 | 6.0 | 1 | 235 | 19.7 | 6.51 |
| | | | 2 | 231 | 18.3 | 6.41 |
| | | | 3 | 208 | 18.2 | 6.57 |
| 78GW03(3)<br>5-22-93 | 27.34 | 9.0 | 1 | 210 | 17.7 | 5.87 |
| | | | 2 | 212 | 17.1 | 5.86 |
| | | | 3 | 218 | 17.0 | 5.95 |
| 78GW05(3)<br>5-22-93 | 27.68 | 9.0 | 1 | 11 | 18.8 | 5.77 |
| | | | 2 | 12 | 18.1 | 5.68 |
| | | | 3 | 11 | 18.5 | 5.79 |
| 78GW06(3)<br>5-22-93 | 25.90 | 6.0 | 1 | 106 | 17.3 | 4.64 |
| | | | 2 | 106 | 17.1 | 4.67 |
| | | | 3 | 106 | 17.2 | 4.61 |
| 78GW07(3)<br>5-22-93 | 19.74 | 3.0 | 1 | 205 | 20.3 | 5.30 |
| | | | 2 | 190 | 19.6 | 5.26 |
| | | | 3 | 190 | 19.8 | 5.25 |
| 78GW08(3)<br>5-22-93 | 27.66 | 7.5 | 1 | 137 | 18.9 | 5.24 |
| | | | 2 | 137 | 18.6 | 5.31 |
| | | | 3 | 143 | 18.9 | 5.31 |

(1) Well depth taken from below ground surface (bgs)
(2) Well bailed dry
(3) Shallow Well
(4) Intermediate Well
(5) Deep Well

## TABLE 4-28 (Continued)

## SUMMARY OF GROUNDWATER FIELD PARAMETERS
## SITE 78
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Well No. | Depth of Well (ft.) (1) | Purge Volume (gals.) | Field Parameters | | | |
|---|---|---|---|---|---|---|
| Date of Measurement | | | Well Volume | Specific Conductance at 25 deg. C (micromhos/cm) | Temperature (deg. C) | pH (S.U.) |
| 78GW10(3)<br>5-22-93 | 27.48 | 7.5 | 1 | 203 | 18.9 | 6.65 |
| | | | 2 | 200 | 18.9 | 6.56 |
| | | | 3 | 206 | 18.8 | 6.55 |
| 78GW9-3(5)<br>5-22-93 | 152.4 | 67.5 | 1 | 1144 | 23.0 | 11.87 |
| | | | 2 | 1029 | 22.7 | 11.86 |
| | | | 3 | 879 | 21.7 | 11.87 |
| 78GW11(3)<br>5-22-93 | 27.75 | 7.5 | 1 | 111 | 20.3 | 4.66 |
| | | | 2 | 103 | 18.9 | 4.70 |
| | | | 3 | 102 | 19.0 | 4.74 |
| 78GW22-1(3)<br>5-22-93 | 17.70 | 6.0 | 1 | 490 | 17.4 | 6.14 |
| | | | 2 | 442 | 16.7 | 6.52 |
| | | | 3 | 370 | 16.7 | 6.48 |
| | | | 4 | 378 | 17.0 | 6.55 |
| 78GW4-1(3)<br>5-23-93 | 26.85 | 5.0 | 1 | 200 | 22.6 | 6.39 |
| | | | 2 | 282 | 21.0 | 6.33 |
| | | | 3 | 329 | 22.3 | 6.62 |
| | | | 4 | 368 | 21.3 | 6.38 |
| | | | 5 | 350 | 22.3 | 6.76 |
| 78GW4-2(4)<br>5-23-93 | 80.5 | 160 | 1 | 525 | 22.8 | 11.34 |
| | | | 2 | 247 | 22.8 | 9.86 |
| | | | 3 | 238 | 23.1 | 9.29 |
| | | | 4 | 239 | 23.0 | 8.06 |
| 78GW9-2(4)<br>5-23-93 | 73.9 | 30 | 1 | 580 | 25.0 | 7.15 |
| | | | 2 | 580 | 25.0 | 7.13 |
| | | | 3 | 580 | 25.0 | 6.99 |
| 78GW12(3)<br>5-23-93 | 27.63 | 8.0 | 1 | 219 | 18.4 | 6.38 |
| | | | 2 | 211 | 18.5 | 6.34 |
| | | | 3 | 202 | 18.1 | 6.24 |
| 78GW14(3)<br>5-23-93 | 27.60 | 9.0 | 1 | 279 | 21.8 | 4.21 |
| | | | 2 | 246 | 20.7 | 4.15 |
| | | | 3 | 236 | 21.7 | 4.12 |
| 78GW16(3)<br>5-23-93 | 27.46 | 7.5 | 1 | 246 | 19.7 | 6.79 |
| | | | 2 | 237 | 19.2 | 6.55 |
| | | | 3 | 237 | 19.3 | 6.69 |

(1) Well depth taken from below ground surface (bgs)
(2) Well bailed dry
(3) Shallow Well
(4) Intermediate Well
(5) Deep Well

## TABLE 4-28 (Continued)

## SUMMARY OF GROUNDWATER FIELD PARAMETERS
## SITE 78
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Well No. | | | Field Parameters | | | |
|---|---|---|---|---|---|---|
| Date of Measurement | Depth of Well (ft.) (1) | Purge Volume (gals.) | Well Volume | Specific Conductance at 25 deg. C (micromhos/cm) | Temperature (deg. C) | pH (S.U.) |
| 78GW17-2(4)<br>5-23-93 | 49.74 | 18.0 | 1 | 450 | 21.6 | 9.61 |
| | | | 2 | 650 | 21.4 | 7.46 |
| | | | 3 | 656 | 20.7 | 7.43 |
| 78-GW22(3)<br>5-23-93 | 27.64 | 10.5 | 1 | 490 | 17.3 | 6.75 |
| | | | 2 | 485 | 18.2 | 6.72 |
| | | | 3 | 496 | 16.8 | 6.77 |
| 78-GW23(3)<br>5-23-93 | 27.24 | 9.0 | 1 | 248 | 19.0 | 4.52 |
| | | | 2 | 226 | 19.2 | 4.52 |
| | | | 3 | 209 | 19.4 | 4.69 |
| 78-GW25(3)<br>5-23-93 | 27.45 | 9.0 | 1 | 294 | 18.1 | 6.00 |
| | | | 2 | 295 | 17.4 | 5.70 |
| | | | 3 | 292 | 17.9 | 5.75 |
| 78-GW29(3)<br>5-23-93 | 27.58 | 3.3 | 1 | 478 | 17.6 | 5.37 |
| | | | 2 | 467 | 17.5 | 5.28 |
| | | | 3 | 455 | 17.6 | 5.36 |
| 78-GW32-2(4)<br>5-23-93 | 22.58 | 7.5 | 1 | 497 | 19.0 | 6.67 |
| | | | 2 | 445 | 18.4 | 6.26 |
| | | | 3 | 445 | 18.4 | 6.29 |
| 78GW32-3(5)<br>5-23-93 | 158 | 291 | 1 | 299 | 22.0 | 8.94 |
| | | | 2 | 184 | 21.6 | 7.90 |
| | | | 3 | 305 | 22.9 | 7.68 |
| 78-GW4-1D(3)<br>5-24-93 | 158.5 | 277.5 | 1 | 546 | 22.9 | 6.85 |
| | | | 2 | 525 | 22.7 | 6.65 |
| | | | 3 | 520 | 22.5 | 6.90 |
| 78GW15(3)<br>5-24-93 | 24.60 | 7.5 | 1 | 202 | 20.9 | 6.15 |
| | | | 2 | 219 | 20.8 | 6.15 |
| | | | 3 | 195 | 21.3 | 6.04 |
| 78GW17-1(3)<br>5-24-93 | 27.22 | 8.0 | 1 | 226 | 19.0 | 7.16 |
| | | | 2 | 368 | 21.3 | 7.05 |
| | | | 3 | 406 | 19.0 | 7.19 |
| 78GW24-1(4)<br>5-24-93 | 27.22 | 10.5 | 1 | 192 | 18.4 | 6.15 |
| | | | 2 | 185 | 18.2 | 6.06 |
| | | | 3 | 169 | 19.0 | 5.97 |

(1) Well depth taken from below ground surface (bgs)
(2) Well bailed dry
(3) Shallow Well
(4) Intermediate Well
(5) Deep Well

## TABLE 4-28 (Continued)

## SUMMARY OF GROUNDWATER FIELD PARAMETERS
## SITE 78
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Well No.<br>Date of Measurement | Depth of Well (ft.) (1) | Purge Volume (gals.) | Field Parameters | | | |
|---|---|---|---|---|---|---|
| | | | Well Volume | Specific Conductance at 25 deg. C (micromhos/cm) | Temperature (deg. C) | pH (S.U.) |
| 78GW24-2(4)<br>5-24-93 | 78.56 | 33.0 | 1 | 463 | 21.7 | 7.37 |
| | | | 2 | 470 | 20.9 | 7.49 |
| | | | 3 | 465 | 20.6 | 7.54 |
| 78GW24-3(5)<br>5-24-93 | 147.75 | 73.0 | 1 | 368 | 23.9 | 7.18 |
| | | | 2 | 289 | 22.6 | 7.48 |
| | | | 3 | 371 | 22.1 | 7.54 |
| | | | 4 | 350 | 22.2 | 7.50 |
| 78GW31-3(5)<br>5-24-93 | 144.0 | 360.0 | 1 | 955 | 22.4 | 12.15 |
| | | | 2 | 308 | 22.2 | 11.60 |
| | | | 3 | 193 | 23.3 | 10.85 |
| | | | 4 | 172 | 21.8 | 10.60 |
| 78GW33(3)<br>6-2-93 | 13.42 | 20.0 | 1 | 520 | 23.0 | 5.74 |
| | | | 2 | 406 | 23.0 | 6.03 |
| | | | 3 | 368 | 22.5 | 5.33 |
| | | | 4 | 368 | 22.5 | 5.24 |
| 78GW34(3)<br>6-3-93 | 15.35 | 12.0(2) | 1 | 131 | 20.5 | 5.21 |
| | | | 2 | 128 | 19.9 | 5.34 |
| 78GW35(3)<br>6-3-93 | 22.75 | 22.5 | 1 | 139 | 21.5 | 5.01 |
| | | | 2 | 142 | 20.8 | 4.97 |
| | | | 3 | 146 | 21.0 | 4.83 |
| 78GW36(3)<br>6-3-93 | 19.98 | 15.0 | 1 | 161 | 23.0 | 6.66 |
| | | | 2 | 179 | 22.0 | 6.68 |
| | | | 3 | 188 | 21.7 | 6.69 |
| 78GW37(3)<br>6-3-93 | 15.0 | 11.25 | 1 | 133 | 20.4 | 5.74 |
| | | | 2 | 121 | 19.6 | 5.47 |
| | | | 3 | 113 | 19.3 | 5.33 |
| 78GW38(3)<br>6-3-93 | 28.35 | 16.5 | 1 | 395 | 21.3 | 6.68 |
| | | | 2 | 391 | 21.1 | 6.79 |
| | | | 3 | 385 | 20.9 | 6.91 |
| 78GW39(3)<br>6-3-93 | 21.6 | 12.0 | 1 | 359 | 19.9 | 5.43 |
| | | | 2 | 325 | 19.5 | 5.44 |
| | | | 3 | 316 | 19.2 | 5.41 |

(1) Well depth taken from below ground surface (bgs)
(2) Well bailed dry
(3) Shallow Well
(4) Intermediate Well
(5) Deep Well

## TABLE 4-29

## COMPARISON OF GROUNDWATER DATA FROM SHALLOW WELLS - 1987, 1991, and 1993
## SITE 78
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Year/Parameter | Well Number | | | | | | | | | | | | | Federal MCLs(2) | NCWQS(3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 78GW01 | 78GW02 | 78GW03 | 78GW04-1 | 78GW05 | 78GW06 | 78GW07 | 78GW08 | 78GW09-1 | 78GW10 | 78GW11 | 78GW12 | 78GW13 | | |
| <u>1987</u> | | | | | | | | | | | | | | | |
| Trichloroethene | ND(1) | ND | ND | 3.4 | ND | ND | ND | ND | 6,100 | 8.6 | 49 | ND | ND | 5.0 | 2.8 |
| Trans-1,2-Dichloroethene | ND | ND | ND | 4.4 | ND | ND | ND | ND | 740 | ND | 13 | ND | ND | 100 | 70 |
| 1,2-Dichloroethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 5.0 | 0.38 |
| 1,1,1-Trichloroethane | ND | ND | 13 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 200 | 200 |
| Benzene | 43 | 12 | 1.4 | 25 | ND | ND | ND | ND | ND | ND | ND | ND | ND | 5.0 | 1.0 |
| Toluene | 100 | 38 | ND | 35 | ND | ND | ND | ND | ND | ND | ND | ND | ND | 1,000 | 1,000 |
| Ethylbenzene | 12 | ND | 9.0 | ND | ND | ND | ND | ND | 1,100 | ND | ND | ND | ND | 700 | 29 |
| Total Xylenes | 62 | 28 | ND | ND | ND | ND | ND | ND | 4,500 | ND | ND | ND | ND | 10,000 | 400 |
| Vinyl Chloride | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 2.0 | 0.015 |
| <u>1991</u> | | | | | | | | | | | | | | | |
| Tetrachloroethene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 5.0 | 0.7 |
| Trichloroethene | 91 | ND | ND | 0.9 | ND | ND | ND | ND | 14,000 | ND | ND | ND | ND | -- | -- |
| 1,2-Dichloroethane | 73 | ND | ND | ND | ND | ND | ND | ND | 1,200 | ND | ND | ND | ND | -- | -- |
| 1,1-Dichloroethene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 7.0 | 7.0 |
| 1,1,2-Dichloroethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 5.0 | NE(4) |
| Benzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| Toluene | ND | ND | ND | ND | ND | ND | ND | ND | 330 | ND | ND | ND | ND | -- | -- |
| Ethylbenzene | ND | ND | ND | ND | ND | ND | ND | ND | 700 | ND | ND | ND | ND | -- | -- |
| Total Xylenes | ND | ND | ND | ND | ND | ND | ND | ND | 3,300 | ND | ND | ND | ND | -- | -- |

Notes: (1) ND = Not Detected
(2) MCLs = Maximum Contaminant Levels
(3) NCWQS = North Carolina Water Quality Standards
(4) NE = Not Established
(5) This value represents a total-1,2-DCE concentration

Samples collected in 1987 and 1991 were not collected by Baker. Accordingly, the quality of the data is unknown (i.e., data level).
Samples collected from newly installed wells (78GW33 - 78GW39) are not shown.
All concentrations are shown in micrograms per liter (µg/l).

## TABLE 4-29 (Continued)

## COMPARISON OF GROUNDWATER DATA FROM SHALLOW WELLS - 1987, 1991, and 1993
## SITE 78
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Year/Parameter | Well Number | | | | | | | | | | | | Federal MCLs$^{(2)}$ | NCWQS$^{(3)}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 78GW14 | 78GW15 | 78GW16 | 78GW17-1 | 78GW19 | 78GW20 | 78GW21 | 78GW22-1 | 78GW23 | 78GW24-1 | 78GW25 | 78GW29 | | |
| <u>1987</u> | | | | | | | | | | | | | | |
| Trichloroethene | ND | 1.0 | ND | ND | 6.0 | ND | ND | ND | 13,000 | 57 | ND | ND | -- | -- |
| Trans-1,2-Dichloroethene | ND | ND | ND | ND | 2.5 | ND | ND | ND | 7,100 | 6,400 | ND | ND | -- | -- |
| 1,2-Dichloroethane | ND | 2.8 | ND | ND | ND | ND | ND | ND | ND | 12 | ND | ND | -- | -- |
| 1,1,1-Trichloroethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| Vinyl Chloride | ND | ND | ND | ND | ND | ND | ND | ND | ND | 250 | ND | ND | -- | -- |
| Benzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| Toluene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| Ethylbenzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| Total Xylenes | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| <u>1991</u> | | | | | | | | | | | | | | |
| Tetrachloroethene | ND | ND | ND | ND | 2.0 | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| Trichloroethene | ND | 4.0 | ND | 5.0 | 2.0 | ND | ND | 5.0 | 3,700 | 180 | ND | ND | -- | -- |
| 1,2-Dichloroethane | ND | 7.0 | ND | 5.0 | 0.8 | ND | ND | ND | 8,900 | 42,000 | ND | ND | -- | -- |
| 1,1-Dichloroethene | ND | ND | ND | ND | ND | ND | ND | ND | ND | 6.5 | ND | ND | -- | -- |
| 1,1,2-Dichloroethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | 3.0 | ND | ND | -- | -- |
| Benzene | ND | ND | ND | ND | ND | ND | ND | 7,900 | 24 | 3.0 | ND | ND | -- | -- |
| Toluene | ND | ND | ND | ND | ND | ND | ND | 16,000 | 13 | 13 | ND | ND | -- | -- |
| Ethylbenzene | ND | ND | ND | ND | ND | ND | 0.9 | 1,900 | 9.0 | 3.0 | ND | ND | -- | -- |
| Total Xylenes | ND | ND | ND | ND | ND | ND | 5.0 | 9,800 | 4.1 | 10 | ND | ND | -- | -- |

Notes: (1) ND = Not Detected
(2) MCLs = Maximum Contaminant Levels
(3) NCWQS = North Carolina Water Quality Standards
(4) NE = Not Established
(5) This value represents a total-1,2-DCE concentration

Samples collected in 1987 and 1991 were not collected by Baker. Accordingly, the quality of the data is unknown (i.e., data level).
Samples collected from newly installed wells (78GW33 - 78GW39) are not shown.
All concentrations are shown in micrograms per liter (µg/l).

## TABLE 4-29 (Continued)

## COMPARISON OF GROUNDWATER DATA FROM SHALLOW WELLS - 1987, 1991, and 1993
## SITE 78
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Year/Parameter | Well Number | | | | | | | | | | | | | Federal MCLs(2) | NCWQS(3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 78GW01 | 78GW02 | 78GW03 | 78GW04-1 | 78GW05 | 78GW06 | 78GW07 | 78GW08 | 78GW09-1 | 78GW10 | 78GW11 | 78GW12 | 78GW13 | | |
| 1993 | | | | | | | | | | | | | | | |
| Tetrachloroethene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| Dichloromethane | ND | 1.0 | ND | ND | 2.0 | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| Trichloroethene | 62 | ND | ND | 2.0J | ND | ND | ND | ND | 2100 D | ND | ND | ND | ND | -- | -- |
| 1,1-Dichloroethene | ND | ND | ND | ND | ND | ND | ND | ND | 280 D | ND | ND | ND | ND | -- | -- |
| 1,2-Dichloroethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| Vinyl Chloride | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| Cis-1,2-Dichloroethene | 27(5) | ND | ND | ND | ND | ND | ND | ND | 2400 D(5) | ND | ND | ND | ND | 70 | 70 |
| Trans-1,2-Dichloroethene | 27(5) | ND | ND | ND | ND | ND | ND | ND | 2400 D(5) | ND | ND | ND | ND | 100 | 70 |
| 1,1,2-Dichloroethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| 1,2-Dichloropropane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 1.0 | ND | 5.0 | 0.56 |
| Dichlorodifluoromethane | ND | ND | ND | ND | ND | ND | ND | 2.0 | ND | ND | ND | ND | ND | NE | 0.19 |
| Trichlorofluoromethane | ND | ND | ND | ND | ND | ND | ND | 1.0 | ND | ND | ND | ND | ND | NE | NE |
| 1,1-Dichlorethane | ND | ND | ND | ND | ND | ND | ND | ND | 61 JD | ND | ND | ND | ND | -- | -- |
| 1,1,1-Trichloroethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| Benzene | ND | ND | ND | ND | ND | ND | ND | ND | 750 D | ND | ND | ND | ND | -- | -- |
| Toluene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| Ethylbenzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| Total Xylenes | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |

Notes: (1) ND = Not Detected
(2) MCLs = Maximum Contaminant Levels
(3) NCWQS = North Carolina Water Quality Standards
(4) NE = Not Established
(5) This value represents a total-1,2-DCE concentration

Samples collected in 1987 and 1991 were not collected by Baker. Accordingly, the quality of the data is unknown (i.e., data level).
Samples collected from newly installed wells (78GW33 - 78GW39) are not shown.
All concentrations are shown in micrograms per liter (µg/l).

TABLE 4-29 (Continued)

## COMPARISON OF GROUNDWATER DATA FROM SHALLOW WELLS - 1987, 1991, and 1993
## SITE 78
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Year/Parameter | Well Number | | | | | | | | | | | | Federal MCLs(2) | NCWQS(3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 78GW14 | 78GW15 | 78GW16 | 78GW17-1 | 78GW19 | 78GW20 | 78GW21 | 78GW22-1 | 78GW23 | 78GW24-1 | 78GW25 | 78GW29 | | |
| 1993 | | | | | | | | | | | | | | |
| Tetrachloroethene | ND | 1.0 | ND | ND | 1.0 | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| Dichloromethane | 1.0 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| Trichloroethene | ND | 1.0 | ND | ND | 1.0 | ND | 2.0 | ND | 440J | ND | ND | ND | -- | -- |
| 1,1-Dichloroethene | ND | ND | ND | ND | ND | ND | ND | ND | ND | 7.0 | ND | ND | -- | -- |
| 1,2-Dichloroethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| Vinyl Chloride | ND | ND | ND | ND | ND | ND | ND | ND | ND | 97 | ND | ND | -- | -- |
| Cis-1,2-Dichloroethene | ND | ND | ND | ND | ND | ND | ND | ND | 14,000J | 3,400 | ND | ND | -- | -- |
| Trans-1,2-Dichloroethene | ND | ND | ND | ND | ND | ND | ND | ND | 190J | 140 | ND | ND | -- | -- |
| 1,1,2-Dichloroethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | 2.0 | ND | ND | -- | -- |
| 1,2-Dichloropropane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | -- | -- |
| Benzene | ND | ND | ND | ND | ND | ND | ND | 9,200J | ND | 51 | ND | ND | -- | -- |
| Toluene | ND | ND | ND | ND | ND | ND | ND | 18,000J | ND | 2.0 | ND | ND | -- | -- |
| Ethylbenzene | ND | ND | ND | ND | ND | ND | ND | 3,000J | 5.0J | ND | ND | ND | -- | -- |
| Total Xylenes | ND | ND | ND | ND | ND | ND | ND | 16,000J | 28J | 1.0 | ND | ND | -- | -- |

Notes: (1) ND = Not Detected
(2) MCLs = Maximum Contaminant Levels
(3) NCWQS = North Carolina Water Quality Standards
(4) NE = Not Established
(5) This value represents a total-1,2-DCE concentration

Samples collected in 1987 and 1991 were not collected by Baker. Accordingly, the quality of the data is unknown (i.e., data level).
Samples collected from newly installed wells (78GW33 - 78GW39) are not shown.
All concentrations are shown in micrograms per liter (µg/l).

## TABLE 4-30

## COMPARISON OF GROUNDWATER DATA FROM DEEP WELLS - 1991 and 1993
## SITE 78
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Year/Parameter | Well Number | | | | | | Federal MCLs(2) | NCWQS(3) |
|---|---|---|---|---|---|---|---|---|
| | 78GW04-3 | 78GW09-3 | 78GW24-3 | 78GW30-3 | 78GW31-3 | 78GW32-3 | | |
| 1991 | | | | | | | | |
| Toluene | ND(1) | ND | ND | ND | 34 | ND | 1,000 | 1,000 |
| Ethylbenzene | ND | ND | ND | ND | 12 | ND | 700 | 29 |
| Total Xylenes | ND | ND | ND | ND | 51 | ND | 10,000 | 400 |
| 1993 | | | | | | | | |
| Cis-1,2-Dichloroethene | 3.0 | ND | 3.0 | ND | 1.0J | ND | 100 | 70 |
| 1,2-Dichloroethane | ND | ND | ND | ND | ND | 1.0 | 5.0 | 0.38 |
| Trichloroethene | ND | ND | ND | ND | ND | 6.0 | 5.0 | 2.8 |
| Trans-1,2-Dichloroethene | ND | ND | 1.0 | ND | ND | ND | 100 | 70 |
| Benzene | 30 | ND | 35 | ND | 15J | ND | 5.0 | 1.0 |

Notes: (1) ND = Not Detected
(2) MCLs = Maximum Contaminant Levels
(3) NCWQS = North Carolina Water Quality Standards
-- Samples collected in 1991 were not collected by Baker. Accordingly, the quality of the data is unknown (i.e., data level).
-- All concentrations are shown in micrograms per liter (μg/l).

# TABLE 4-31
## OPERABLE UNIT NO. 1 - SITE 78
## COGDELS CREEK AND THE NEW RIVER
## SURFACE WATER POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | 78-CC-SW01<br>UG/L | 78-CC-SW02<br>UG/L | 78-CC-SW03<br>UG/L | 78-CC-SW04<br>UG/L | 78-CC-SW05<br>UG/L | 78-CC-SW06<br>UG/L | 78-CC-SW07<br>UG/L |
|---|---|---|---|---|---|---|---|
| <u>VOLATILES</u> | | | | | | | |
| METHYLENE CHLORIDE | | | | | | | 5 J |
| ACETONE | | | | 11 | 16 J | | |
| 1,2-DICHLOROETHENE (total) | | 6 J | | | | | |
| TRICHLOROETHENE | 5 J | 47 | 20 | | 3 J | | |
| TOLUENE | | | | | | | |
| <u>SEMIVOLATILES</u> | | | | | | | |
| DI-N-BUTYL PHTHALATE | | | | | 2 J | 2 J | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | | | 7 J | |
| <u>PESTICIDES/PCBS</u> | | | | | | | |
| 4,4'-DDD | | | 0.19 | | | | |
| 4,4'-DDT | | | 0.18 | | | | |

ug/L - microgram per liter
J - value is estimated

TABLE 4-31
OPERABLE UNIT NO. 1 - SITE 78
COGDELS CREEK AND THE NEW RIVER
SURFACE WATER POSITIVE DETECTION SUMMARY
REMEDIAL INVESTIGATION CTO - 19177
MCB CAMP LEJEUNE, NORTH CAROLINA
ORGANIC CHEMICALS

| SAMPLE NO. | 78-CC-SW14 | 78-CC-SW15 | 78-CC-SW19 | 78-CC-SW20 |
|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L |
| **VOLATILES** | | | | |
| METHYLENE CHLORIDE | | | | |
| ACETONE | | | | |
| 1,2-DICHLOROETHENE (total) | | | | |
| TRICHLOROETHENE | | | | |
| TOLUENE | 3 J | | | |
| **SEMIVOLATILES** | | | | |
| DI-N-BUTYL PHTHALATE | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | 2 J | 33 | 3 J |
| **PESTICIDES/PCBS** | | | | |
| 4,4'-DDD | | 0.13 | | |
| 4,4'-DDT | | | | |

ug/L - microgram per liter
J - value is estimated

# TABLE 4-32
# OPERABLE UNIT NO. 1 - SITE 78
# COGDELS CREEK AND THE NEW RIVER
# SURFACE WATER POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS

| SAMPLE NO. | 78-CC-SW01 | 78-CC-SW02 | 78-CC-SW03 | 78-CC-SW04 | 78-CC-SW05 | 78-CC-SW06 | 78-CC-SW07 |
|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| ALUMINUM | 109 J | 78 J | 258 J | 3130 J | 330 | 697 | 7110 |
| ARSENIC | | | | | | | 2.2 B |
| BARIUM | 46 J | 29 J | 29 J | 21 J | 21 B | 23 B | 43 B |
| BERYLLIUM | | 1 J | 1 J | | | | |
| CALCIUM | 31900 J | 40700 J | 40000 J | 53500 J | 57500 | 32900 | 34800 |
| CHROMIUM | | | | | | | 13 |
| COPPER | 4 J | 3 J | 5 J | 42 J | 10 B | 7 B | 14 B |
| IRON | 544 J | 415 J | 875 J | 2140 J | 779 | 1240 | 4260 |
| LEAD | | | | 29.8 J | | | 11.9 |
| MAGNESIUM | 2070 J | 2170 J | 2210 J | 1420 J | 3880 B | 1900 B | 2180 B |
| MANGANESE | 19 J | 15 J | 35 J | 41 J | 51 | 25 | 47 |
| NICKEL | | | | | | | |
| POTASSIUM | 1640 J | 1380 J | 1240 J | 1720 J | 1510 B | 1340 B | 1850 B |
| SELENIUM | | | | 2 J | | | |
| SILVER | | | | | | | |
| SODIUM | 9630 J | 7990 J | 7300 J | 2060 J | 5690 | 5290 | 5470 |
| THALLIUM | | | 1.1 J | | 1.1 B | | |
| VANADIUM | | | | 16 J | 5 B | | 11 B |
| ZINC | 23 J | 17 J | 21 J | 152 J | 18 B | 11 B | 48 |

ug/L - microgram per liter
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

## TABLE 4-32
## OPERABLE UNIT NO. 1 - SITE 78
## COGDELS CREEK AND THE NEW RIVER
## SURFACE WATER POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## TAL METALS

| SAMPLE NO. | 78-CC-SW08 | 78-CC-SW09 | 78-CC-SW10 | 78-CC-SW11 | 78-CC-SW12 | 78-CC-SW13 | 78-CC-SW14 |
|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| ALUMINUM | 200 J | 125 J | 233 J | 183 J | 188 J | 1190 J | 64 B |
| ARSENIC | | | | | | 2.3 J | |
| BARIUM | 22 J | 22 J | 48 J | 28 J | 28 J | 30 J | 15 B |
| BERYLLIUM | | | | | | | |
| CALCIUM | 42300 J | 42100 J | 54400 J | 50800 J | 54400 J | 39100 J | 69400 |
| CHROMIUM | | | | | | | 12 J |
| COPPER | 8 J | 12 J | 6 J | 2 J | 2 J | 8 J | 3 B |
| IRON | 1530 J | 2260 J | 460 J | 1240 J | 1160 J | 853 J | 1830 |
| LEAD | 2.3 J | 2.3 J | 2 J | | | 2.4 J | |
| MAGNESIUM | 1700 J | 1780 J | 3190 J | 2330 J | 2450 J | 4010 J | 2680 B |
| MANGANESE | 131 J | 93 J | 40 J | 63 J | 57 J | 19 J | 61 |
| NICKEL | | | | | | | |
| POTASSIUM | 1370 J | 1750 J | 2420 J | 506 J | 575 J | 3570 J | 1520 B |
| SELENIUM | | | | | | | |
| SILVER | | | | | | | |
| SODIUM | 3950 J | 4100 J | 15400 J | 7410 J | 7360 J | 4660 J | 7370 |
| THALLIUM | | | | | | | |
| VANADIUM | | | 4 J | | | 4 J | |
| ZINC | 17 J | 26 J | 25 J | | | 18 J | |

ug/L - microgram per liter
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

## TABLE 4-32
## OPERABLE UNIT NO. 1 - SITE 78
## COGDELS CREEK AND THE NEW RIVER
## SURFACE WATER POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## TAL METALS

| SAMPLE NO.<br>UNITS | 78-CC-SW15<br>UG/L | 78-CC-SW16<br>UG/L | 78-CC-SW17<br>UG/L | 78-CC-SW18<br>UG/L | 78-CC-SW19<br>UG/L | 78-CC-SW20<br>UG/L |
|---|---|---|---|---|---|---|
| ALUMINUM | 34 B | 200 | 1670 | 872 | 17900 | 1620 |
| ARSENIC | | | | | 4.9 B | |
| BARIUM | 19 B | 13 B | 18 B | 19 B | 68 B | 39 B |
| BERYLLIUM | | | | | 1 B | |
| CALCIUM | 83400 | 77200 | 105000 | 104000 | 64300 | 57000 |
| CHROMIUM | | | | | 30 J | |
| COPPER | 3 B | 5 B | 10 B | 24 B | 29 | 9 B |
| IRON | 1080 | 756 | 1150 | 1530 | 14200 | 1910 |
| LEAD | | | 2.5 J | 35.6 | 42 | 6.5 |
| MAGNESIUM | 3460 B | 88000 | 289000 | 260000 | 15700 | 29700 |
| MANGANESE | 44 | 31 | 20 | 37 | 162 | 65 |
| NICKEL | | | | | 29 B | |
| POTASSIUM | 1250 B | 30800 | 110000 | 97300 | 6010 | 10000 |
| SELENIUM | | | | | 1 J | |
| SILVER | | | | | | 3 B |
| SODIUM | 7360 | 749000 | 2400000 | 2240000 | 98800 | 221000 |
| THALLIUM | | | | | | |
| VANADIUM | | | 5 B | 6 B | 33 B | 5 B |
| ZINC | | | | 18 B | 125 | 19 B |

ug/L - microgram per liter
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

# TABLE 4-33
## OPERABLE UNIT NO. 1 - SITE 78
## COGDELS CREEK AND THE NEW RIVER
## SEDIMENT POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | 78-CC-SD01-06<br>UG/KG | 78-CC-SD02-06<br>UG/KG | 78-CC-SD02-612<br>UG/KG | 78-CC-SD03-06<br>UG/KG | 78-CC-SD03-612<br>UG/KG | 78-CC-SD04-06<br>UG/KG | 78-CC-SD04-612<br>UG/KG |
|---|---|---|---|---|---|---|---|
| **VOLATILES** | | | | | | | |
| METHYLENE CHLORIDE | | 14 J | 18 J | 56 | | | |
| ACETONE | | | | | | | |
| 2-BUTANONE | | | | | | 23 J | |
| ETHYLBENZENE | | | | | 16 J | | |
| **SEMIVOLATILES** | | | | | | | |
| 4-METHYLPHENOL | | | | | | | |
| NAPHTHALENE | | | | | | | |
| ACENAPHTHENE | | | | | 65 J | | |
| DIBENZOFURAN | | | | | | | |
| FLUORENE | | | | | 51 J | | |
| PHENANTHRENE | | 60 J | | 220 J | 430 | 130 J | 210 J |
| ANTHRACENE | | | | | 70 J | | |
| CARBAZOLE | | | | | 42 J | | |
| DI-N-BUTYL PHTHALATE | | | | | | | |
| FLUORANTHENE | | 160 J | 79 J | 360 J | 490 | 210 J | 540 |
| PYRENE | | 160 J | 75 J | 500 | 660 | 240 J | 530 |
| BUTYL BENZYL PHTHALATE | | | | | | | 45 J |
| BENZO(A)ANTHRACENE | | 100 J | | 150 J | 240 J | 70 J | 270 J |
| CHRYSENE | | 100 J | 51 J | 250 J | 280 J | 190 J | 420 J |
| BIS(2-ETHYLHEXYL)PHTHALATE | 75 J | 180 J | 110 J | 240 J | 100 J | | |
| BENZO(B)FLUORANTHENE | | 180 J | 59 J | 320 J | 390 J | 140 J | 370 J |
| BENZO(K)FLUORANTHENE | | | | 72 J | 86 J | 110 J | 200 J |
| BENZO(A)PYRENE | | 84 J | | 150 J | 200 J | 110 J | 240 J |
| INDENO(1,2,3-CD)PYRENE | | 66 J | | 170 J | 200 J | 97 J | 160 J |
| DIBENZ(A,H)ANTHRACENE | | | | | | | 65 J |
| BENZO(GHI)PERYLENE | | | | | 110 J | 110 J | 150 J |

ug/kg - microgram per kilogram
J - value is estimated

## TABLE 4-33
## OPERABLE UNIT NO. 1 - SITE 78
## COGDELS CREEK AND THE NEW RIVER
## SEDIMENT POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | 78-CC-SD01-06<br>UG/KG | 78-CC-SD02-06<br>UG/KG | 78-CC-SD02-612<br>UG/KG | 78-CC-SD03-06<br>UG/KG | 78-CC-SD03-612<br>UG/KG | 78-CC-SD04-06<br>UG/KG | 78-CC-SD04-612<br>UG/KG |
|---|---|---|---|---|---|---|---|
| <u>PESTICIDES/PCBS</u> | | | | | | | |
| 4,4'-DDE | | | | 5 | 11 | | |
| 4,4'-DDD | | 8.3 J | | 10 | 16 | 5 J | |
| 4,4'-DDT | | | | 6.3 J | 34 | | |
| ALPHA-CHLORDANE | | 3.7 J | | | 3 J | | 2.5 J |
| GAMMA-CHLORDANE | | 3.2 J | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

**TABLE 4-33**
**OPERABLE UNIT NO. 1 - SITE 78**
**COGDELS CREEK AND THE NEW RIVER**
**SEDIMENT POSITIVE DETECTION SUMMARY**
**REMEDIAL INVESTIGATION CTO - 19177**
**MCB CAMP LEJEUNE, NORTH CAROLINA**
**ORGANIC CHEMICALS**

| SAMPLE NO.<br>UNITS | 78-CC-SD05-06<br>UG/KG | 78-CC-SD05-612<br>UG/KG | 78-CC-SD06-06<br>UG/KG | 78-CC-SD06-612<br>UG/KG | 78-CC-SD07-06<br>UG/KG | 78-CC-SD08-06<br>UG/KG | 78-CC-SD08-612<br>UG/KG |
|---|---|---|---|---|---|---|---|
| **VOLATILES** | | | | | | | |
| METHYLENE CHLORIDE | | | | | | | |
| ACETONE | 110 J | | 50 J | | 160 J | 250 | |
| 2-BUTANONE | | | | | | | |
| ETHYLBENZENE | | | | | | | 60 J |
| **SEMIVOLATILES** | | | | | | | |
| 4-METHYLPHENOL | | | | | | | |
| NAPHTHALENE | | | | | | | |
| ACENAPHTHENE | | | | | | | |
| DIBENZOFURAN | | | | | | | |
| FLUORENE | | | | | | | |
| PHENANTHRENE | | | 230 J | 660 | | | |
| ANTHRACENE | | | | 100 J | | | |
| CARBAZOLE | | | | | | | |
| DI-N-BUTYL PHTHALATE | | | | | | | |
| FLUORANTHENE | | 87 J | 510 | 1500 | | 230 J | |
| PYRENE | | | 330 J | 930 | | 440 J | |
| BUTYL BENZYL PHTHALATE | | | | | | | |
| BENZO(A)ANTHRACENE | | | 220 J | 700 | | | |
| CHRYSENE | | | 270 J | 730 | | 230 JX | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | 410 J | 520 | | | |
| BENZO(B)FLUORANTHENE | | | 330 J | 820 | | 330 J | |
| BENZO(K)FLUORANTHENE | | | 220 J | 660 | | 210 J | |
| BENZO(A)PYRENE | | | 180 J | 520 | | 290 J | |
| INDENO(1,2,3-CD)PYRENE | | | 230 J | 540 | | 290 J | |
| DIBENZ(A,H)ANTHRACENE | | | | | | 160 J | |
| BENZO(GHI)PERYLENE | | | | 490 | | 270 J | |

ug/kg - microgram per kilogram
J - value is estimated

## TABLE 4-33
## OPERABLE UNIT NO. 1 - SITE 78
## COGDELS CREEK AND THE NEW RIVER
## SEDIMENT POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | 78-CC-SD05-06<br>UG/KG | 78-CC-SD05-612<br>UG/KG | 78-CC-SD06-06<br>UG/KG | 78-CC-SD06-612<br>UG/KG | 78-CC-SD07-06<br>UG/KG | 78-CC-SD08-06<br>UG/KG | 78-CC-SD08-612<br>UG/KG |
|---|---|---|---|---|---|---|---|
| PESTICIDES/PCBS | | | | | | | |
| 4,4'-DDE | | | 7.2 J | 11 J | | | |
| 4,4'-DDD | 15 J | 30 J | 23 J | 37 J | | | |
| 4,4'-DDT | | 9.4 | 9 J | 19 J | | | |
| ALPHA-CHLORDANE | | | | 4.7 J | | | |
| GAMMA-CHLORDANE | | | | | | | 6.3 |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4-33
# OPERABLE UNIT NO. 1 - SITE 78
# COGDELS CREEK AND THE NEW RIVER
# SEDIMENT POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | 78-CC-SD09-06<br>UG/KG | 78-CC-SD09-612<br>UG/KG | 78-CC-SD10-06<br>UG/KG | 78-CC-SD12-06<br>UG/KG | 78-CC-SD12-612<br>UG/KG | 78-CC-SD13-06<br>UG/KG | 78-CC-SD14-06<br>UG/KG |
|---|---|---|---|---|---|---|---|
| **VOLATILES** | | | | | | | |
| METHYLENE CHLORIDE | | | | | | | |
| ACETONE | 140 | 90 J | | 240 J | | | |
| 2-BUTANONE | | | | | 14 J | | |
| ETHYLBENZENE | | | | | | | |
| **SEMIVOLATILES** | | | | | | | |
| 4-METHYLPHENOL | | | | | | 1800 | |
| NAPHTHALENE | | | | | | | |
| ACENAPHTHENE | | | | | | | |
| DIBENZOFURAN | | | | | | | |
| FLUORENE | | | | | | | |
| PHENANTHRENE | 370 J | 140 J | | | | | |
| ANTHRACENE | | | | | | | |
| CARBAZOLE | 88 J | | | | | | |
| DI-N-BUTYL PHTHALATE | | | | | | | |
| FLUORANTHENE | 1100 | 240 J | | | | | |
| PYRENE | 1200 J | 300 J | 50 J | | | | |
| BUTYL BENZYL PHTHALATE | 100 J | | | | | 84 J | |
| BENZO(A)ANTHRACENE | 300 J | 76 J | | | | | |
| CHRYSENE | 740 | 140 J | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | | | | | | | 82 J |
| BENZO(B)FLUORANTHENE | 970 | 200 J | | | | | |
| BENZO(K)FLUORANTHENE | 450 J | 76 J | | | | | |
| BENZO(A)PYRENE | 640 | 120 J | | | | | |
| INDENO(1,2,3-CD)PYRENE | 630 | 94 J | | | | | |
| DIBENZ(A,H)ANTHRACENE | 140 J | | | | | | |
| BENZO(GHI)PERYLENE | 500 J | 88 J | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4-33
# OPERABLE UNIT NO. 1 - SITE 78
# COGDELS CREEK AND THE NEW RIVER
# SEDIMENT POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | 78-CC-SD14-612<br>UG/KG | 78-CC-SD15-06<br>UG/KG | 78-CC-SD15-612<br>UG/KG | 78-CC-SD16-06<br>UG/KG | 78-CC-SD16-612<br>UG/KG | 78-CC-SD18-06<br>UG/KG | 78-CC-SD18-612<br>UG/KG |
|---|---|---|---|---|---|---|---|
| VOLATILES | | | | | | | |
| METHYLENE CHLORIDE | | | | | | | |
| ACETONE | | | | | | | |
| 2-BUTANONE | | | | | | | |
| ETHYLBENZENE | | | | | | | |
| SEMIVOLATILES | | | | | | | |
| 4-METHYLPHENOL | | | | | | | |
| NAPHTHALENE | | | | | | | 240 J |
| ACENAPHTHENE | | | | | | | 550 J |
| DIBENZOFURAN | | | | | | | 380 J |
| FLUORENE | | | | | | | 600 J |
| PHENANTHRENE | | | | | | | 4500 |
| ANTHRACENE | | | | | | | 1000 |
| CARBAZOLE | | | | | | | 660 |
| DI-N-BUTYL PHTHALATE | 120 J | | | | | | |
| FLUORANTHENE | | | | | | 110 J | 6800 |
| PYRENE | | | | | | 77 J | 4500 |
| BUTYL BENZYL PHTHALATE | | | | | | | |
| BENZO(A)ANTHRACENE | | | | | | | 2500 |
| CHRYSENE | | | | | | 62 J | 2400 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 290 J | | | | | | |
| BENZO(B)FLUORANTHENE | | | | | | | 2800 |
| BENZO(K)FLUORANTHENE | | | | | | | 1800 |
| BENZO(A)PYRENE | | | | | | | 1700 |
| INDENO(1,2,3-CD)PYRENE | | | | | | | 370 J |
| DIBENZ(A,H)ANTHRACENE | | | | | | | |
| BENZO(GHI)PERYLENE | | | | | | | 370 J |

ug/kg - microgram per kilogram
J - value is estimated

## TABLE 4-33
## OPERABLE UNIT NO. 1 - SITE 78
## COGDELS CREEK AND THE NEW RIVER
## SEDIMENT POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | 78-CC-SD09-06<br>UG/KG | 78-CC-SD09-612<br>UG/KG | 78-CC-SD10-06<br>UG/KG | 78-CC-SD12-06<br>UG/KG | 78-CC-SD12-612<br>UG/KG | 78-CC-SD13-06<br>UG/KG | 78-CC-SD14-06<br>UG/KG |
|---|---|---|---|---|---|---|---|
| PESTICIDES/PCBS | | | | | | | |
| 4,4'-DDE | | | | | | | |
| 4,4'-DDD | | | | 4.4 J | 4.5 J | | |
| 4,4'-DDT | | | | | | | |
| ALPHA-CHLORDANE | | | | | | | |
| GAMMA-CHLORDANE | | | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

### TABLE 4-33
### OPERABLE UNIT NO. 1 - SITE 78
### COGDELS CREEK AND THE NEW RIVER
### SEDIMENT POSITIVE DETECTION SUMMARY
### REMEDIAL INVESTIGATION CTO - 19177
### MCB CAMP LEJEUNE, NORTH CAROLINA
### ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | 78-CC-SD19-06<br>UG/KG | 78-CC-SD19-612<br>UG/KG | 78-CC-SD20-06<br>UG/KG |
|---|---|---|---|
| VOLATILES | | | |
| METHYLENE CHLORIDE | | | |
| ACETONE | 99 J | 150 J | 240 J |
| 2-BUTANONE | | | |
| ETHYLBENZENE | | | |
| SEMIVOLATILES | | | |
| 4-METHYLPHENOL | | | |
| NAPHTHALENE | | | |
| ACENAPHTHENE | | | |
| DIBENZOFURAN | | | |
| FLUORENE | | | |
| PHENANTHRENE | | | |
| ANTHRACENE | | | |
| CARBAZOLE | | | |
| DI-N-BUTYL PHTHALATE | | | |
| FLUORANTHENE | | | |
| PYRENE | | | |
| BUTYL BENZYL PHTHALATE | | | |
| BENZO(A)ANTHRACENE | | | |
| CHRYSENE | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | 620 J | | |
| BENZO(B)FLUORANTHENE | | | |
| BENZO(K)FLUORANTHENE | | | |
| BENZO(A)PYRENE | | | |
| INDENO(1,2,3-CD)PYRENE | | | |
| DIBENZ(A,H)ANTHRACENE | | | |
| BENZO(GHI)PERYLENE | | | |

ug/kg - microgram per kilogram
J - value is estimated

## TABLE 4-33
## OPERABLE UNIT NO. 1 - SITE 78
## COGDELS CREEK AND THE NEW RIVER
## SEDIMENT POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | 78-CC-SD19-06<br>UG/KG | 78-CC-SD19-612<br>UG/KG | 78-CC-SD20-06<br>UG/KG |
|---|---|---|---|
| <u>PESTICIDES/PCBS</u> | | | |
| 4,4'-DDE | 33 | 28 | |
| 4,4'-DDD | 110 J | 70 | 23 J |
| 4,4'-DDT | 17 | | |
| ALPHA-CHLORDANE | | | |
| GAMMA-CHLORDANE | | | |

ug/kg - microgram per kilogram
J - value is estimated

## TABLE 4-34
## OPERABLE UNIT NO. 1 - SITE 78
## COGDELS CREEK AND THE NEW RIVER
## SEDIMENT POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## TAL METALS

| SAMPLE NO. | 78-CC-SD01-06 | 78-CC-SD01-612 | 78-CC-SD02-06 | 78-CC-SD02-612 | 78-CC-SD03-06 | 78-CC-SD03-612 |
|---|---|---|---|---|---|---|
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 3960 | 7600 | 3430 | 2720 | 3550 | 2600 |
| ANTIMONY | | | | | | |
| ARSENIC | 3.1 J | 0.72 J | | | 0.57 J | 0.61 J |
| BARIUM | 6.1 B | 8.6 B | 11 B | 7.4 B | 11.4 B | 12.8 B |
| BERYLLIUM | | | | | | |
| CADMIUM | | | 1.5 | | | 1.5 |
| CALCIUM | 256 B | 120 B | 11400 | 12400 | 4730 | 666 B |
| CHROMIUM | | 7 J | | | 2.9 J | 7 J |
| COBALT | | | | | | |
| COPPER | 0.77 J | 1.3 J | 3.3 J | 1.5 J | 6.5 J | 4.7 J |
| IRON | 1520 | 1610 | 1040 | 829 | 1380 | 1170 |
| LEAD | 5.4 | 5.2 | 5.3 | 6.2 | 18.8 | 48.3 J |
| MAGNESIUM | 78.1 B | 212 B | 219 B | 266 B | 226 B | 138 B |
| MANGANESE | 2 J | 3.7 J | 9.5 J | 6.9 J | 10.1 J | 4.4 J |
| MERCURY | | | | | | |
| POTASSIUM | 111 B | 376 B | 91.3 B | 104 B | 140 B | 90.8 B |
| SELENIUM | 0.71 J | | | | 0.31 J | |
| SILVER | | | | | | |
| SODIUM | 49.7 B | 58.9 B | 73.8 B | | | |
| THALLIUM | | | | | | |
| VANADIUM | 4.8 B | 10.4 B | 3.3 B | 3.6 B | 6 B | 7.9 B |
| ZINC | 4.3 J | 2.9 J | 16.3 J | 15.4 J | 42.9 J | 35.8 J |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

### TABLE 4-34
### OPERABLE UNIT NO. 1 - SITE 78
### COGDELS CREEK AND THE NEW RIVER
### SEDIMENT POSITIVE DETECTION SUMMARY
### REMEDIAL INVESTIGATION CTO - 19177
### MCB CAMP LEJEUNE, NORTH CAROLINA
### TAL METALS

| SAMPLE NO.<br>UNITS | 78-CC-SD04-06<br>MG/KG | 78-CC-SD04-612<br>MG/KG | 78-CC-SD05-06<br>MG/KG | 78-CC-SD05-612<br>MG/KG | 78-CC-SD06-06<br>MG/KG | 78-CC-SD06-612<br>MG/KG |
|---|---|---|---|---|---|---|
| ALUMINUM | 749 | 737 | 420 | 238 | 2580 | 4010 |
| ANTIMONY | | | | | | |
| ARSENIC | | | | | | 1.3 B |
| BARIUM | 6.6 B | 9.5 B | 3.4 J | 1 J | 12.5 B | 16.5 B |
| BERYLLIUM | | | | | | 0.28 B |
| CADMIUM | | | | | | |
| CALCIUM | 12800 J | 6650 J | 2640 | 2750 | 3860 | 6060 |
| CHROMIUM | | | 3.1 | 3.1 | 5.7 | 6.7 |
| COBALT | | | | | | |
| COPPER | 3.7 B | 3.2 B | 2.1 B | 2 B | 6.5 B | 11.5 |
| IRON | 772 | 782 | 450 | 154 | 1550 | 2310 |
| LEAD | 40.5 | 16.5 | 3.3 J | 3.2 J | 17.3 J | 45.7 J |
| MAGNESIUM | 233 B | 174 B | 33.9 B | 23 B | 192 B | 315 B |
| MANGANESE | 9.5 | 7.8 | 2.1 B | 1.8 B | 16.1 | 14 |
| MERCURY | | | | | | |
| POTASSIUM | 56.1 B | 52.7 B | 26.6 B | | 111 B | 151 B |
| SELENIUM | | | | | | |
| SILVER | | | | | | |
| SODIUM | 72 J | 73.8 J | | | | |
| THALLIUM | | | | | | |
| VANADIUM | 2.1 B | 3 B | | | 4.8 B | 10.4 B |
| ZINC | 30.2 | 30 | 10.1 | 7.2 | 40.2 | 85.3 |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

### TABLE 4-34
### OPERABLE UNIT NO. 1 - SITE 78
### COGDELS CREEK AND THE NEW RIVER
### SEDIMENT POSITIVE DETECTION SUMMARY
### REMEDIAL INVESTIGATION CTO - 19177
### MCB CAMP LEJEUNE, NORTH CAROLINA
### TAL METALS

| SAMPLE NO. | 78-CC-SD07-06 | 78-CC-SD07-612 | 78-CC-SD08-06 | 78-CC-SD08-612 | 78-CC-SD09-06 | 78-CC-SD09-612 |
|---|---|---|---|---|---|---|
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 291 | 317 | 22600 | 18100 | 6580 | 1220 |
| ANTIMONY | | | 5.5 J | | 4.8 J | |
| ARSENIC | | | 6 B | 4.6 B | 2.6 B | 0.59 B |
| BARIUM | 1.6 B | 1.4 B | 89.5 B | 76 B | 39.2 B | 5.9 B |
| BERYLLIUM | | | 0.7 B | 0.52 B | 0.36 B | |
| CADMIUM | | | 11.9 | 10.9 | 9.6 | 1.9 |
| CALCIUM | 217 J | 191 J | 6190 J | 5840 J | 26500 J | 1980 J |
| CHROMIUM | | | 42 | 31 | 17.5 J | |
| COBALT | | | | | 3.2 B | |
| COPPER | 0.8 B | 1.1 B | 78.3 | 50.6 | 48.8 | 6.2 B |
| IRON | 283 | 249 | 11400 | 14000 | 5950 | 1010 |
| LEAD | 2 | 3.1 | 178 | 296 | 92.3 | 12.7 |
| MAGNESIUM | 12 J | 9.5 J | 1020 B | 790 B | 844 B | 97.6 B |
| MANGANESE | 2.1 B | 2.4 B | 22.4 | 19.6 | 63.1 | 4.6 |
| MERCURY | | | | | | |
| POTASSIUM | | | 883 B | 639 B | 253 B | 82.6 B |
| SELENIUM | | | 1 J | 0.52 J | | |
| SILVER | | | | | | |
| SODIUM | 35 B | 29.1 B | 223 B | 159 B | 94.1 B | 48.3 B |
| THALLIUM | | | 0.84 B | | | |
| VANADIUM | | 1.4 B | 52.4 | 59.4 | 19.3 | 4.6 B |
| ZINC | 5.6 | 5.7 | 301 | 363 | 254 | 26.8 |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

## TABLE 4-34
## OPERABLE UNIT NO. 1 - SITE 78
## COGDELS CREEK AND THE NEW RIVER
## SEDIMENT POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## TAL METALS

| SAMPLE NO. | 78-CC-SD10-06 | 78-CC-SD10-612 | 78-CC-SD11-06 | 78-CC-SD11-612 | 78-CC-SD12-06 | 78-CC-SD12-612 |
|---|---|---|---|---|---|---|
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 1010 | 1360 | 526 | 581 | 912 | 956 |
| ANTIMONY | | | | | | |
| ARSENIC | 0.65 J | | | | | |
| BARIUM | 6 B | 12.8 B | 2.6 J | 2.3 J | 2.9 B | 3.4 B |
| BERYLLIUM | | | | | | |
| CADMIUM | | 1.5 | | | 1.3 | |
| CALCIUM | 76000 J | 36400 J | 1980 | 2290 | 1850 J | 2070 J |
| CHROMIUM | 3.1 J | 3.9 J | 4.9 J | 2.6 J | | 3.4 |
| COBALT | | | | | | |
| COPPER | 3.3 B | 4.1 B | 1.8 J | 1.5 J | 1.8 B | 6.3 B |
| IRON | 1380 | 1590 | 738 | 580 | 681 | 705 |
| LEAD | 7.4 | 9.6 | 3.9 | 2.8 | 5.7 | 6.6 |
| MAGNESIUM | 1110 B | 582 B | 51.3 B | 55.1 B | 64.7 B | 63.9 B |
| MANGANESE | 18.2 | 18.9 | 3.1 J | 3.1 J | 2.9 B | 3.4 B |
| MERCURY | | | | | | |
| POTASSIUM | 100 B | 71 B | 29 B | 28.9 B | 37.7 B | 39.1 B |
| SELENIUM | 0.33 J | | | | | |
| SILVER | | | | | | |
| SODIUM | 258 B | 122 B | | | 47.9 J | 48.8 J |
| THALLIUM | | | | | | |
| VANADIUM | 4.5 B | 5.3 B | | 1 B | 1.6 B | 2.1 B |
| ZINC | 21.1 | 20.6 | 8.3 J | 7.4 J | 13.9 | 14.3 |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

## TABLE 4-34
## OPERABLE UNIT NO. 1 - SITE 78
## COGDELS CREEK AND THE NEW RIVER
## SEDIMENT POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## TAL METALS

| SAMPLE NO. | 78-CC-SD13-06 | 78-CC-SD13-612 | 78-CC-SD14-06 | 78-CC-SD14-612 | 78-CC-SD15-06 | 78-CC-SD15-612 |
|---|---|---|---|---|---|---|
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 3360 | 4390 | 500 | 588 | 421 | 414 |
| ANTIMONY | | | | | | |
| ARSENIC | 0.86 B | 0.72 B | | | | |
| BARIUM | 11.4 B | 12.6 B | 109 | 3 B | 2.1 B | 1.2 B |
| BERYLLIUM | | | | | | |
| CADMIUM | | 1.6 | | | | |
| CALCIUM | 1150 J | 1100 J | 11900 J | 9190 J | 3710 J | 2180 J |
| CHROMIUM | 6 | 4.8 | 3.1 | 2.5 | 3.2 | 3 |
| COBALT | | | | | | |
| COPPER | 2.3 B | 1.6 B | 4.2 B | 5.7 B | 4.2 B | 4 B |
| IRON | 1880 | 1820 | 336 J | 457 J | 234 J | 226 J |
| LEAD | 9.1 | 8 | 4.5 | 9.3 | 4.5 | 4.1 |
| MAGNESIUM | 119 B | 129 B | 187 B | 190 B | 85.5 B | 60.9 B |
| MANGANESE | 6.6 | 5.6 | 5 | 4.2 | 3.2 B | 2.5 B |
| MERCURY | | | | | | |
| POTASSIUM | 105 B | 112 B | 36.1 B | 43.4 B | 30.3 B | 23.9 B |
| SELENIUM | 0.46 J | | | | | |
| SILVER | | | | 0.75 B | | 1 B |
| SODIUM | 60 J | 56.6 J | 54.4 J | 51.4 J | 36.4 J | 26.1 J |
| THALLIUM | | | | | | |
| VANADIUM | 6.9 B | 7.8 B | 1.8 B | 2 B | 1.6 B | 1.2 B |
| ZINC | 10.6 | 8.3 | 10.7 | 12.7 | 7.4 | 7.2 |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

### TABLE 4-34
### OPERABLE UNIT NO. 1 - SITE 78
### COGDELS CREEK AND THE NEW RIVER
### SEDIMENT POSITIVE DETECTION SUMMARY
### REMEDIAL INVESTIGATION CTO - 19177
### MCB CAMP LEJEUNE, NORTH CAROLINA
### TAL METALS

| SAMPLE NO. | 78-CC-SD16-06 | 78-CC-SD16-612 | 78-CC-SD17-06 | 78-CC-SD17-612 | 78-CC-SD18-06 | 78-CC-SD18-612 |
|---|---|---|---|---|---|---|
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 2010 | 2830 | 429 | 1530 | 375 | 1440 |
| ANTIMONY | | | | | 3.4 J | 7.6 J |
| ARSENIC | 1.5 B | 1.4 B | | 3.3 | 1.5 B | 4.6 |
| BARIUM | 4.7 B | 4.4 B | 1.4 B | 3.8 B | 12.8 B | 53.9 B |
| BERYLLIUM | | | | | | |
| CADMIUM | | | | | | |
| CALCIUM | 5910 J | 68400 J | 504 J | 73.7 J | 124000 J | 32900 J |
| CHROMIUM | 9.2 | 5.9 | 3.6 | 4 | | 5.8 |
| COBALT | | | 2.1 B | | | |
| COPPER | 3.7 B | 4.2 B | 0.95 B | 0.95 B | 13.6 | 116 |
| IRON | 2890 J | 1910 J | 547 J | 963 J | 8140 J | 8690 J |
| LEAD | 9.1 | 8.4 | 3.4 | 17.2 | 83.6 | 359 |
| MAGNESIUM | 268 B | 1310 | 95 B | 112 B | 546 B | 1160 B |
| MANGANESE | 3 B | 72.3 | 2.6 B | 3.1 B | 47 | 52.7 |
| MERCURY | | | | | | |
| POTASSIUM | 145 B | 265 B | 39 B | 66.6 B | 52.8 B | 140 B |
| SELENIUM | | | | | | |
| SILVER | 0.99 B | 0.74 B | | | | |
| SODIUM | 393 J | 453 J | 502 J | 291 J | 84.1 J | 146 J |
| THALLIUM | | | | | | |
| VANADIUM | 8.9 B | 7.4 B | 1.9 B | 3.3 B | 2.9 B | 12.4 B |
| ZINC | 13.6 | 8.1 | 2.4 B | 2.4 B | 38.1 | 322 |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

### TABLE 4-34
### OPERABLE UNIT NO. 1 - SITE 78
### COGDELS CREEK AND THE NEW RIVER
### SEDIMENT POSITIVE DETECTION SUMMARY
### REMEDIAL INVESTIGATION CTO - 19177
### MCB CAMP LEJEUNE, NORTH CAROLINA
### TAL METALS

| SAMPLE NO. | 78-CC-SD19-06 | 78-CC-SD19-612 | 78-CC-SD20-06 | 78-CC-SD20-612 |
|---|---|---|---|---|
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 18100 | 7890 | 11100 | 10100 |
| ANTIMONY | | | | |
| ARSENIC | 6.2 B | 6.5 J | 4.8 B | 3 B |
| BARIUM | 36.2 B | 31.6 B | 94.8 B | 35.8 B |
| BERYLLIUM | 0.77 B | | | 1.5 B |
| CADMIUM | | | | |
| CALCIUM | 8700 J | 10400 J | 15500 J | 24200 J |
| CHROMIUM | 36.9 | 19.9 | 24.7 | |
| COBALT | | | | |
| COPPER | 35.4 | 19.9 B | 46.8 | 44.8 |
| IRON | 16300 J | 9950 J | 11600 J | 9180 J |
| LEAD | 93.1 | 58.5 | 103 | 71.6 |
| MAGNESIUM | 3160 B | 2890 B | 3240 B | 3890 B |
| MANGANESE | 69.2 | 33.9 | 63.6 | 56.7 |
| MERCURY | | | 0.73 | |
| POTASSIUM | 877 B | 408 B | 574 B | 531 B |
| SELENIUM | 0.77 B | | | |
| SILVER | 2.3 B | | 3.9 B | |
| SODIUM | 1970 J | 2680 J | 2680 J | 2490 J |
| THALLIUM | | | | |
| VANADIUM | 35.4 B | 18.7 B | 24.7 B | 22.4 B |
| ZINC | 162 | 78.4 | 140 | 113 |

mg/kg - milligram per kilogram
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but greater than Instrument Detection Limit (IDL)

### TABLE 4 - 35
### OPERABLE UNIT NO. 1 - SITE 78
### BEAVER DAM CREEK
### SURFACE WATER POSITIVE DETECTION SUMMARY
### REMEDIAL INVESTIGATION CTO - 19177
### MCB CAMP LEJEUNE, NORTH CAROLINA
### TAL METALS

| SAMPLE NO. | 78-BD-SW01 | 78-BD-SW02 | 78-BD-SW03 | 78-BD-SW04 | 78-BD-SW05 | 78-BD-SW06 | 78-BD-SW07 |
|---|---|---|---|---|---|---|---|
| UNITS | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| ALUMINUM | 216 J | 637 J | 199 J | 103 J | 655 | 448 | 5610 |
| ARSENIC |  | 11.8 J |  |  |  |  | 4.3 B |
| BARIUM | 34 J | 58 J | 42 J | 42 J | 60 B | 70 B | 75 B |
| BERYLLIUM |  |  |  |  | 1 B |  |  |
| CALCIUM | 99700 J | 64600 J | 66600 J | 68900 J | 45500 | 132000 | 141000 |
| CHROMIUM |  |  |  |  |  |  | 18 J |
| COPPER | 10 J | 17 J | 7 J | 3 J | 6 B | 6 B | 12 B |
| IRON | 1220 J | 11800 J | 2220 J | 624 J | 800 | 500 | 5200 |
| LEAD |  | 7.4 J |  |  |  |  | 22.2 |
| MAGNESIUM | 6840 J | 4880 J | 4650 J | 2960 J | 4250 B | 9800 | 6210 |
| MANGANESE | 150 J | 262 J | 85 J | 40 J | 24 | 35 | 259 |
| POTASSIUM | 1780 J | 1840 J | 1440 J | 1270 J | 1210 B | 2130 B | 4380 B |
| SODIUM | 10400 J | 7840 J | 12300 J | 15600 J | 8090 | 6960 | 13400 |
| VANADIUM |  | 13 J |  |  | 4 B |  | 17 B |
| ZINC | 34 J | 83 J | 26 J | 25 J | 33 | 96 | 64 |

ug/L - microgram per liter
J - value is estimated
B - reported value is less than Contract Required Detection Limit (CRDL), but grater than Instrument Detection Limit (IDL)

## TABLE 4-36
## OPERABLE UNIT NO. 1 - SITE 78
## BEAVER DAM CREEK
## SEDIMENT POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | 78-BD-SD01-06<br>UG/KG | 78-BD-SD01-612<br>UG/KG | 78-BD-SD02-06<br>UG/KG | 78-BD-SD02-612<br>UG/KG | 78-BD-SD03-06<br>UG/KG | 78-BD-SD03-612<br>UG/KG | 78-BD-SD04-06<br>UG/KG |
|---|---|---|---|---|---|---|---|
| **VOLATILES** | | | | | | | |
| METHYLENE CHLORIDE | | | 140 | | | | |
| ACETONE | 86 J | | 260 | 240 | 140 | | |
| CARBON DISULFIDE | | | | | | | |
| **SEMIVOLATILES** | | | | | | | |
| NAPHTHALENE | | | 280 J | | | | |
| ACENAPHTHENE | | | 340 J | | | | |
| DIBENZOFURAN | | | 200 J | | | | |
| FLUORENE | | | 270 J | | | | |
| PHENANTHRENE | | | 1900 | | 380 J | | |
| ANTHRACENE | | | 410 J | | | | |
| CARBAZOLE | | | 340 J | | | | |
| FLUORANTHENE | | 79 J | 2100 | 92 J | 440 | 74 J | |
| PYRENE | | | 1500 | 86 J | 360 J | 70 J | |
| BENZO(A)ANTHRACENE | | | 950 | | 170 J | | |
| CHRYSENE | | | 920 | 74 J | 210 J | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | 71 J | 220 J | 110 J | 82 J | 66 J | 110 J | 110 |
| BENZO(B)FLUORANTHENE | | | 600 | | 120 J | | |
| BENZO(K)FLUORANTHENE | | | 390 J | | 94 J | | |
| BENZO(A)PYRENE | | | 510 | | 100 J | | |
| INDENO(1,2,3-CD)PYRENE | | | 520 | | 86 J | | |
| BENZO(GHI)PERYLENE | | | 540 J | | 85 J | | |

ug/kg - microgram per kilogram
J - value is estimated

## TABLE 4-36
## OPERABLE UNIT NO. 1 - SITE 78
## BEAVER DAM CREEK
## SEDIMENT POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO. | 78-BD-SD01-06 | 78-BD-SD01-612 | 78-BD-SD02-06 | 78-BD-SD02-612 | 78-BD-SD03-06 | 78-BD-SD03-612 | 78-BD-SD04-06 |
|---|---|---|---|---|---|---|---|
| UNITS | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG | UG/KG |
| **PESTICIDES/PCBS** | | | | | | | |
| 4,4'-DDE | | 5.7 J | | 24 J | 8.2 | | |
| 4,4'-DDD | | | | | | | |
| 4,4'-DDT | | | | 8 J | | | |
| ALPHA-CHLORDANE | | | | 4.3 J | 2.5 | | |
| GAMMA-CHLORDANE | | | 2.4 | 4.3 J | 2.8 | 2.9 | |
| AROCLOR-1260 | | | | 70 | | | |

ug/kg - microgram per kilogram
J - value is estimated

## TABLE 4-36
## OPERABLE UNIT NO. 1 - SITE 78
## BEAVER DAM CREEK
## SEDIMENT POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | | 78-BD-SD04-612 | 78-BD-SD05-06<br>UG/KG | 78-BD-SD05-612<br>UG/KG | 78-BD-SD07-06<br>UG/KG | 78-BD-SD07-612<br>UG/KG |
|---|---|---|---|---|---|---|
| **VOLATILES** | | | | | | |
| METHYLENE CHLORIDE | | | | | | |
| ACETONE | | | 33 | 150 J | | |
| CARBON DISULFIDE | | | | 68 | | |
| **SEMIVOLATILES** | | | | | | |
| NAPHTHALENE | | | | | | |
| ACENAPHTHENE | | | | | | |
| DIBENZOFURAN | | | | | | |
| FLUORENE | | | | | | |
| PHENANTHRENE | | 160 J | | | | |
| ANTHRACENE | | | | | | |
| CARBAZOLE | | | | | | |
| FLUORANTHENE | | 180 J | | | | |
| PYRENE | | | | | | |
| BENZO(A)ANTHRACENE | | | | | | |
| CHRYSENE | | | | | | |
| BIS(2-ETHYLHEXYL)PHTHALATE | J | 160 J | 60 J | | | |
| BENZO(B)FLUORANTHENE | | | | | | |
| BENZO(K)FLUORANTHENE | | | | | | |
| BENZO(A)PYRENE | | | | | | |
| INDENO(1,2,3-CD)PYRENE | | | | | | |
| BENZO(GHI)PERYLENE | | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4-36
# OPERABLE UNIT NO. 1 - SITE 78
# BEAVER DAM CREEK
# SEDIMENT POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# ORGANIC CHEMICALS

| SAMPLE NO.<br>UNITS | 78-BD-SD04-612<br>UG/KG | 78-BD-SD05-06<br>UG/KG | 78-BD-SD05-612<br>UG/KG | 78-BD-SD07-06<br>UG/KG | 78-BD-SD07-612<br>UG/KG |
|---|---|---|---|---|---|
| **PESTICIDES/PCBS** | | | | | |
| 4,4'-DDE | 4.8 J | | | 93 J | 44 J |
| 4,4'-DDD | | | | 33 J | 39 J |
| 4,4'-DDT | | | | 47 J | 23 J |
| ALPHA-CHLORDANE | | | | 7.3 J | 3.6 J |
| GAMMA-CHLORDANE | | | | 5.6 J | 2.8 J |
| AROCLOR-1260 | | | | | |

ug/kg - microgram per kilogram
J - value is estimated

# TABLE 4-37
# OPERABLE UNIT NO. 1 - SITE 78
# BEAVER DAM CREEK
# SEDIMENT POSITIVE DETECTION SUMMARY
# REMEDIAL INVESTIGATION CTO - 19177
# MCB CAMP LEJEUNE, NORTH CAROLINA
# TAL METALS

| SAMPLE NO. | 78-BD-SD01-06 | 78-BD-SD01-612 | 78-BD-SD02-06 | 78-BD-SD02-612 | 78-BD-SD03-06 | 78-BD-SD03-612 | 78-BD-SD04-06 |
|---|---|---|---|---|---|---|---|
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 1670 J | 9760 J | 2350 J | 1260 J | 742 J | 1060 J | 909 J |
| ARSENIC | 0.53 J | 2.6 J | 1 J | 0.98 J |  | 0.74 J | 0.95 J |
| BARIUM | 6.8 J | 21.3 J | 7.4 J | 4.4 J | 3.9 J | 5.2 J | 9.8 J |
| BERYLLIUM | 0.24 J | 0.28 J | 0.27 J | 0.27 J | 0.26 J | 0.27 J | 0.26 J |
| CALCIUM | 20700 J | 5820 J | 11300 J | 6610 J | 2500 J | 2160 J | 1730 J |
| CHROMIUM | 3.4 J | 10.4 J | 4 J | 4.1 J |  |  | 4 J |
| COBALT |  |  |  |  |  |  |  |
| COPPER | 1.7 J | 9.2 J | 4.8 J | 4.4 J | 2.3 J | 3.8 J | 6.9 J |
| IRON | 1660 J | 7040 J | 2530 J | 1330 J | 871 J | 933 J | 1260 J |
| LEAD | 4.4 J | 50.7 J | 49.9 J | 32.2 J | 11.9 J | 10.2 J | 5.8 J |
| MAGNESIUM | 337 J | 543 J | 289 J | 189 J | 69.5 J | 120 J | 81.3 J |
| MANGANESE | 4.1 J | 12 J | 4.8 J | 3.8 J | 2.8 J | 2.2 J | 4.8 J |
| NICKEL |  |  |  |  |  |  |  |
| POTASSIUM | 113 J | 453 J | 133 J | 73.4 J | 42.5 J | 55.5 J | 66.2 J |
| SELENIUM |  | 0.39 J |  |  |  | 0.33 J |  |
| SODIUM | 71.5 J | 90.5 J | 76.1 J | 63.8 J | 61.5 J | 70.2 J | 62 J |
| THALLIUM |  |  |  |  |  |  |  |
| VANADIUM | 4.1 J | 19.3 J | 6.4 J | 3.3 J | 2.1 J | 2.7 J | 7.7 J |
| ZINC | 9.7 J | 25.5 J | 19.4 J | 19.9 J | 9.3 J | 15.6 J | 37.4 J |

mg/kg - milligram per kilogram
J - value is estimated

## TABLE 4-37

## OPERABLE UNIT NO. 1 - SITE 78
## BEAVER DAM CREEK
## SEDIMENT POSITIVE DETECTION SUMMARY
## REMEDIAL INVESTIGATION CTO - 19177
## MCB CAMP LEJEUNE, NORTH CAROLINA
## TAL METALS

| SAMPLE NO. | 78-BD-SD04-612 | 78-BD-SD05-06 | 78-BD-SD05-612 | 78-BD-SD06-06 | 78-BD-SD06-612 | 78-BD-SD07-06 | 78-BD-SD07-612 |
|---|---|---|---|---|---|---|---|
| UNITS | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG | MG/KG |
| ALUMINUM | 2820 J | 32300 | 37100 | 7360 | 9840 | 7860 | 2610 |
| ARSENIC | 12.1 J | 8.9 B | 5.6 | | 0.53 B | 1.5 B | 1 B |
| BARIUM | 37 J | 44.7 B | 49.1 B | 13.9 B | 16.8 B | 17.2 B | 6.9 B |
| BERYLLIUM | 1.1 J | 0.57 B | 0.56 B | | | | |
| CALCIUM | 5620 J | 1840 J | 1540 J | 1680 J | 211 J | 10300 J | 4680 J |
| CHROMIUM | 9.5 J | 33.4 | 41.2 | 9.6 | 10.7 | 14 | 4.7 |
| COBALT | | 7.6 B | 5 B | | 3 B | 3.3 B | |
| COPPER | 24.7 J | 5.1 B | 7.6 | 1.8 B | 1.3 B | 4.5 B | 1.9 B |
| IRON | 2620 J | 10600 | 10100 | 1570 | 1690 | 4240 | 1880 |
| LEAD | 43.8 J | 11 | 12.8 | 8.5 | 6.2 | 45.2 J | 9.2 |
| MAGNESIUM | 317 J | 1240 B | 1400 B | 321 B | 371 B | 530 B | 192 B |
| MANGANESE | 9 J | 26 | 30.9 | 11.9 | 6.9 | 26.7 | 15.5 |
| NICKEL | 10.1 J | 7.1 B | 6.2 B | | | | |
| POTASSIUM | 429 J | 1470 | 1550 | 295 B | 336 B | 414 B | 140 B |
| SELENIUM | 2.6 J | 0.74 J | 0.62 J | 0.3 J | | 0.51 J | 0.33 J |
| SODIUM | 129 J | 122 B | 146 B | 61.3 B | 64.5 B | 107 B | 63.3 B |
| THALLIUM | 0.53 J | | 0.31 B | | | | |
| VANADIUM | 21.9 J | 45.5 | 50.5 | 10.1 B | 12.2 B | 16.9 | 14.7 |
| ZINC | 36.2 J | 18.7 | 19.4 | 14.7 | 7.9 | 32.1 | 12.4 |

mg/kg - milligram per kilogram
J - value is estimated

# 5.0 CONTAMINANT FATE AND TRANSPORT

The potential for a contaminant to migrate and persist in an environmental medium is critical when evaluating the potential for a chemical to elicit an adverse human health or ecological effect. The environmental mobility of a chemical is influenced by its physical and chemical properties, the physical characteristics of the site, and the site chemistry. This section presents a discussion of the various physical and chemical properties of contaminants detected at OU No. 1 that impact the fate and transport of the contaminants in the environment. The basis for this discussion of contaminant fate and transport is discussed in Section 4.0, Nature and Extent of Contamination.

## 5.1 Chemical and Physical Properties Impacting Fate and Transport

Table 5-1 presents the physical and chemical properties associated with the organic contaminants detected at the site which determine inherent environmental mobility and fate. These properties include:

- Vapor pressure
- Water solubility
- Octanol/water partition coefficient
- Organic carbon adsorption coefficient (sediment partition)
- Specific gravity
- Henry's Law constant
- Mobility index

A discussion of the environmental significance of each of these properties follows.

Vapor pressure provides an indication of the rate at which a chemical may volatilize. It is of primary significance at environmental interfaces such as surface soil/air and surface water/air. Volatilization is not as important when evaluating groundwater and subsurface soils. Vapor pressure for monocyclic aromatics are generally higher than vapor pressures for PAHs. Contaminants with higher vapor pressures will enter the atmosphere at a quicker rate than the contaminants with low vapor pressures.

The rate at which a contaminant is leached from soil by infiltrating precipitation is proportional to its water solubility. More soluble contaminants are usually more readily

## TABLE 5-1

## ORGANIC PHYSICAL AND CHEMICAL PROPERTIES
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Chemical | Vapor Pressure (mm Hg) | Water Solubility (mg/l) | Octanol/Water Coefficient (log $K_{ow}$) | Sediment Partition (log $K_{oc}$) | Specific Gravity (g/cm$^3$) | Henry's Law Constant (atm-m$^3$/mole) | Mobility Index | Comments |
|---|---|---|---|---|---|---|---|---|
| ***Volatiles:*** | | | | | | | | |
| Benzene | 76 | 1780 | 2.13 | 1.92 | 0.879 | 5.55E-03 | 3.2 | Very mobile |
| Bromodichloromethane | 50 | 4500 | 2.10 | 1.79 | -- | 2.41E-03 | 3.6 | Very mobile |
| Chlorobenzene | 8.8 | 500 | 2.84 | 2.64 | 1.1066 | 3.58E-03 | 1 | Very mobile |
| 1,1-Dichloroethene | 500 | 400 | 1.48 | 2.26 | 1.218 | 1.90E-01 | 3.0 | Very mobile |
| 1,2-Dichloroethane | 61 | 8700 | 1.48 | 1.52 | 1.25 | 8.14E-04 | 4.2 | Very mobile |
| 1,2-Dichloroethene | 200 | 600 | 1.48 | 2.17 | 1.26 | 5.32E-03 | 2.9 | Very mobile |
| Ethylbenzene | 7 | 152 | 3.15 | 2.93 | 0.867 | 6.44E-03 | 0.1 | Very mobile |
| Tetrachloroethene | 14 | 150 | 2.6 | 2.6 | 1.626 | 2.87E-03 | 0.75 | Very mobile |
| Toluene | 22 | 515 | 2.69 | 2.54 | 0.867 | 5.90E-03 | 1.5 | Very mobile |
| 1,1,2-Trichloroethane | 19 | 4500 | 2.17 | 1.75 | 1.44 | 7.42E-04 | 3.2 | Very mobile |
| 1,1,2,2-Trichloroethane | 5 | 2900 | 2.56 | 1.92 | 1.60 | 3.83E-04 | 2.2 | Very mobile |
| Trichloroethene | 60 | 1100 | 2.29 | 2.09 | 1.46 | 1.17E-03 | 2.7 | Very mobile |
| Vinyl chloride | 2660 | 1100 | 0.6 | 1.91 | 0.9121 | 8.14E-02 | 4.6 | Very mobile |
| Xylenes (total) | 6 | 180 | 3.02 | 2.84 | 0.87 | 4.64E-03 | 0.19 | Very mobile |

Sources:
1. Verscheuren, K. 1983. Handbook of Environmental Data on Organic Chemicals. Van Nostrand Reinhold Co., New York.
2. Lyman, et al. 1982. Handbook of Chemical Property Estimation Methods. Environmental Behavior of Organic Compounds.
3. USEPA. 1982. Aquatic Fate Process Data for Organic Priority Pollutants. Final Report.

## TABLE 5-1 (Continued)

## ORGANIC PHYSICAL AND CHEMICAL PROPERTIES
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Chemical | Vapor Pressure (mm Hg) | Water Solubility (mg/l) | Octanol/Water Coefficient (log $K_{ow}$) | Sediment Partition (log $K_{oc}$) | Specific Gravity ($g/cm^3$) | Henry's Law Constant ($atm\text{-}m^3/mole$) | Mobility Index | Comments |
|---|---|---|---|---|---|---|---|---|
| ***Semivolatiles:*** | | | | | | | | |
| Benzo(a)anthracene | 5.0E-09 | 0.014 | 5.61 | 5.34 | NA | 1.0E-06 | -15.5 | Very Immobile |
| Benzo(b)fluoranthene | 10E-06 to 10E-07 | 0.009 | 6.57 | 6.26 | NA | 1.22E-05 | -14 | Very Immobile |
| Benzo(k)fluoranthene | 9.6E-11 | 0.0016 | 6.84 | 6.22 | NA | 3.87E-05 | -19 | Very Immobile |
| Benzo(a)pyrene | 5.0E-09 | 0.0038 | 6.04 | 5.72 | NA | 4.9E-07 | -16.4 | Very Immobile |
| Chrysene | 10E-06 to 10E-11 | 0.006 | 5.61 | 5.44 | 1.274 | 1.1E-06 | -13.7 | Very Immobile |
| 1,4-Dichlorobenzene | 6.0E-01 | 49 | 3.39 | 3.22 | 1.458 | 3.1E-03 | -1.8 | Slightly mobile |
| Fluoranthene | 10E-06 to 10E-04 | 0.265 | 5.33 | 4.84 | NA | 6.5E-06 | -9.4 | Immobile |
| Ideno(1,2,3-cd)pyrene | 1E-10 | 5.3E-04 | 6.51 | 6.20 | 1.070 | 6.95E-08 | -19.5 | Very Immobile |
| Pyrene | 6.85 | 0.14 | 5.32 | 4.91 | NA | 5.1E-06 | -11.9 | Very Immobile |
| ***Pesticides/PCBs:*** | | | | | | | | |
| Dieldren | 1.87E-04 | 0.1 | 5.6 | 4.31 | 1.75 | 4.57E-10 | -12 | Very Immobile |
| 4,4'-DDT | 1.9E-07 | 0.0034 | 6.19 | 4.89 | *NA | 1.58E-05 | -14 | Very immobile |
| 4,4'-DDD | 10.2E-07 | 0.09 | 5.99 | 4.47 | *NA | 2.2E-08 | -12 | Very immobile |
| 4,4'-DDE | 6.5E-06 | 0.04 | 4.28 | 3.66 | *NA | 6.8E-05 | -10 | Immobile |
| Endrin | 2.0E10-07 | 0.26 | 5.6 | 4.06 | NA | 4.0E-07 | -11 | Very Immobile |
| PCB-1254 | 7.7E-05 | 0.03 | 6.03 | 4.59 | 1.50 | 2.80E-03 | -10 | Immobile |

Sources:
1. Verscheuren, K. 1983. Handbook of Environmental Data on Organic Chemicals. Van Nostrand Reinhold Co., New York.
2. Lyman, et al. 1982. Handbook of Chemical Property Estimation Methods. Environmental Behavior of Organic Compounds.
3. USEPA. 1982. Aquatic Fate Process Data for Organic Priority Pollutants. Final Report.

leached than less soluble contaminants. The water solubilities indicate that the volatile organic contaminants including monocyclic aromatics are usually several orders-of-magnitude more soluble than PAHs.

The octanol/water partition coefficient ($K_{ow}$) is a measure of the equilibrium partitioning of contaminants between octanol and water. A linear relationship between octanol/water partition coefficient and the uptake of chemicals by fatty tissues of animal and human receptors (the bioconcentration factor - BCF) has been established (Lyman et al., 1982). The coefficient is also useful in characterizing the sorption of compounds by organic soils where experimental values are not available.

The organic carbon adsorption coefficient ($K_{oc}$) indicates the tendency of a chemical to adhere to soil particles organic carbon. Contaminants with high soil/sediment adsorption coefficients generally have low water solubilities and vice versa. For example, contaminants such as PAHs are relatively immobile in the environment and are preferentially bound to the soil. The compounds are not subject to aqueous transport to the extent of compounds with higher water solubilities. Erosional properties of surface soils may, however, enhance the mobility of these bound soils contaminants.

Specific gravity is the ratio of a given volume of pure chemical at a specified temperature to the weight of the same volume of water at a given temperature. Its primary use is to determine whether a contaminant will have a tendency to float or sink (as an immiscible liquid) in water if it exceeds its corresponding water solubility.

Vapor pressure and water solubility are of use in determining volatilization rates from surface water bodies and from groundwater. These two parameters can be used to estimate an equilibrium concentration of a contaminant in the water phase and in the air directly above the water. This can be expressed as Henry's Law Constant.

A quantitative assessment of mobility has been developed that uses water solubility (S), vapor pressure (VP), and organic carbon partition coefficient ($K_{oc}$) (Laskowski, 1983). This value is referred to as the Mobility Index (MI). It is defined as:

$$MI = \log((S*VP)/K_{oc})$$

A scale to evaluate MI is presented by Ford and Gurba (1894):

| Relative MI | Mobility Description |
|---|---|
| > 5 | extremely mobile |
| 0 to 5 | very mobile |
| -5 to 0 | slightly mobile |
| -10 to -5 | immobile |
| < -10 | very immobile |

## 5.2 Contaminant Transport Pathways

Based on the evaluation of existing conditions at Sites 21, 24, and 78, the following potential contaminant transport pathways have been identified.

- On-site atmospheric deposition of windblown dust.
- Leaching of sediment contaminants to surface water.
- Migration of contaminants in surface water.
- Leaching of soil contaminants to groundwater.
- Migration of groundwater contaminants off site.
- Groundwater infiltration from the shallow aquifer to the deep aquifer.

Contaminants released to the environment could also undergo the following during transportation:

- Physical transformations: volatilization, precipitation
- Chemical transformations: photolysis, hydrolysis, oxidation, reduction
- Biological transformation: biodegradation
- Accumulation in one or more media

The following paragraphs describe the potential transport pathways listed above.

### 5.2.1 On-Site Deposition of Windblown Dust

Wind can act as a contaminant transport pathway agent by eroding exposed soil and exposed sediment and blowing it off site. This is influenced by: wind velocity, the grain size/density of the soil/sediment particles and the amount of vegetative cover over the soil or sediment.

The majority of OU No. 1 is vegetated (i.e., grass, trees) or is covered by permanent structures and paved roads/walkways/parking lots. This would serve to retard airborne migration of site contaminants.

### 5.2.2 Leaching of Sediment Contaminants to Surface Water

When in contact with surface water, contaminants attached to sediment particles can disassociate from the sediment particle into surface water. This is primarily influenced by the physical and chemical properties of the contaminant, (i.e., water solubility, $K_{oc}$) and the physical and chemical properties of the sediment particle (i.e., grain size, $f_{oc}$).

Surface water sample analytical results indicate that there has not been significant leaching of sediment contaminants into surface water (Section 4.0), based on the infrequent occurrence and level of contamination.

### 5.2.3 Leaching of Soil Contaminants to Groundwater

Contaminants that adhere to soil particles or have accumulated in soil pore spaces can leach and migrate vertically to the groundwater. This is influenced by the depth to the water table, precipitation, infiltration, physical and chemical properties of the soil, and physical and chemical properties of the contaminant.

Groundwater samples were collected from shallow, intermediate, and deep monitoring wells at OU No. 1. The groundwater analytical results can be compared to soil sample analytical results to determine if contaminants detected in soil have migrated or may migrate in the future, to underlying groundwater.

### 5.2.4 Migration of Groundwater Contaminants

Contaminants leaching from soils to underlying groundwater can migrate as dissolved constituents in groundwater in the direction of groundwater flow. Three general processes govern the migration of dissolved contaminants caused by the flow of water: (1) advection, movement caused by flow of groundwater; (2) dispersion, movement caused by irregular mixing of waters during advection; and (3) retardation, principally chemical mechanisms which occur during advection. Subsurface transport of the immiscible contaminants is governed by a set of factors different from those of dissolved contaminants. The potential movement of immiscible organic liquids (non-aqueous phase liquids) will not be discussed in this section.

Advection is the process which most strongly influences the migration of dissolved organic solutes. Groundwater, under water table aquifer conditions (i.e., unconfined aquifer), generally flows from regions of the subsurface where the water table is under a higher head to regions (i.e., recharge areas) of where the water table is under a lower head (i.e., discharge areas). Hydraulic gradient is the term used to describe the magnitude of this force (i.e., the slope of the water table). In general, the gradient usually follows the topography for shallow, uniform sandy aquifers which are commonly found in coastal regions. In general, groundwater flow velocities, in sandy aquifers, under natural gradient conditions are probably between 10 meters/year to 100 meters/year (Lyman, et al., 1982).

The average seepage velocity of groundwater flow at OU No. 1 for both the shallow and deep water-bearing zones can be estimated using a variation of Darcy's Equation:

$$V_x = \frac{K\,i}{N_e} \qquad \text{(Fetter, 1988)}$$

Where: $V_x$ = average seepage velocity
$K$ = hydraulic conductivity (cm/sec)
$i$ = hydraulic gradient
$N_e$ = effective porosity

For the shallow lithology at OU No. 1, hydraulic conductivity (K) and effective porosity ($N_e$) can be estimated at 8.0 x $10^{-4}$ cm/sec (Baker, 1993a) and 0.28, respectively (Fetter, 1988). Hydraulic gradient for the shallow water-bearing zone at OU No. 1 has been calculated at 0.003 (Section 3.6.2). Average seepage velocity for the shallow water-bearing zone can thus be estimated as follows:

$$V_x = \frac{\left(8 \times 10^{-4}\,\frac{\text{cm}}{\text{sec}}\right)(0.003)}{0.28}$$

$$= 8.6 \times 10^{-6}\,\frac{\text{cm}}{\text{sec}} = 2.7\,\frac{\text{m}}{\text{yr}}$$

For the deeper lithology, (i.e., Castle Hayne), K and Ne can be estimated at 1.7 x $10^{-2}$ cm/sec (Harned, et al. 1989) and 0.33, respectively (Fetter, 1988).

The average seepage velocity for the deep water-bearing zone can also be estimated as follows:

$$V_x = \frac{\left(1.7 \times 10^{-2}\ \text{cm/sec}\right)\left(0.003\right)}{0.33}$$

$$= 1.5 \times 10^{-4}\ \frac{\text{cm}}{\text{sec}} = 47\,\frac{\text{m}}{\text{yr}}$$

Thus, when monitoring wells or potable supply wells in sand aquifers are located hundreds of meters downgradient of a contaminant source, the average travel time for the groundwater to flow from the source to the well point is typically on the order of years. In the zone of influence created by a high capacity production well or well field, however, the artificially increased gradient could substantially increase the local velocity, and the average travel times for groundwater flow are increased.

Dispersion results from two basic processes, molecular diffusion and mechanical mixing. The kinetic activity of dissolved solutes result in diffusion of solutes from a zone of high concentration to a lower concentration. Dispersion and spreading during transport result in the dilution of contaminants (maximum concentration of contaminant decreases with distance from the plume). For simple hydrogeological systems, the spreading is reported to be proportional to the flow rate. Furthermore, dispersion in the direction of flow is often observed to be markedly greater than dispersion in the directions transverse (perpendicular) to the flow. In the absence of detailed studies to determine dispersive characteristics at OU No. 1, longitudinal and transverse dispersivities are estimated based on similar hydrogeological systems (Mackay, et al., 1985).

Some dissolved contaminants may interact with the aquifer solids encountered along the flow path through adsorption, partitioning, ion exchange, and other processes. The interactions result in the contaminant distribution between aqueous phase and aquifer solids, diminution of concentrations in the aqueous phase, and retardation of the movement of the contaminant relative to groundwater flow. The higher the fraction of the contaminant sorbed, the more retarded its transport. Certain halogenated organic solvents sorption is affected by hydrophobility (antipathy for dissolving in water) and the fraction of solid organic matter in the aquifer solids (organic carbon content). If the aquifer below OU No. 1 is homogeneous, sorption of hydrophobic organic solute should be constant in space and time. If the sorptive interaction is at equilibrium and completely reversible, the solute should move at a constant average velocity equal to the groundwaters average velocity divided by the retardation factor.

Organic contaminants can be transformed into other organic compounds by a complex set of chemical and biological mechanisms. The principal classes of chemical reactions that can affect organic contaminants in water are hydrolysis and oxidation. However, it is believed that most chemical reactions occurring in the groundwater zone are likely to be slow compared with transformations mediated by microorganisms. Certain organic groundwater contaminants can be biologically transformed by microorganisms attached to solid surfaces within the aquifer. Factors which affect the rates of biotransformation of organic compounds include: water temperature and pH, the number of species of microorganisms present, the concentration of substrate, and presence of microbial toxicants and nutrients, and the availability of electron acceptors. Transformation of a toxic organic solute is no assurance that it has been converted to harmless or even less harmless hazardous products. Biotransformation of common groundwater contaminants, such as TCE, TCA, and PCE, can result in the formation of such intermediates as vinyl chloride (Mackay, et al., 1985).

The interaction of non-ionic organic compounds with solid phases can also be used to predict the fate of the highly nonpolar organic contaminants (i.e., 4,4'-DDT, PCBs). Sorptive binding is proportional to the organic content of the sorbent. Sorption of non-ionic organic pesticides can be attributed to an active fraction of the soil organic matter (Lyman et al., 1982). The uptake of neutral organics by soils results from their partitioning to the solutes aqueous solubility and to its liquid-liquid (e.g., octanol-water) partition coefficient (Chiou, 1979). Currently, literature information is available on the interrelation of soil organic properties to the binding of pesticides, herbicides, and high molecular weight pollutants such as PCBs. However, data is lacking for the non-ionic components of solvents and fuels, which may potentially be responsible for groundwater contamination at OU No. 1. Organic matrices in natural systems that have varying origins, degrees of humification, and degrees of association with inorganic matrices exhibit dissimilarities in their ability to sorb non-ionic organic contaminants.

The soils and sediments formed or deposited on the land surface can act as a reservoir for inorganic contaminants. Soils contain surface-active mineral and humic constituents involved in reactions that affect metal retention. The surfaces of fine-grained soil particles are very active chemically; surface sites are negatively or positively charged or they are electronically neutral. Oppositely charged metallic counterions from solutions in soils (i.e., groundwater) are attracted to these charged surfaces. The relative proportions of ions attracted to these various sites depends on the degree of acidity or alkalinity of the soil, on its mineralogical composition, and on its content of organic matter. The extent of adsorption depends on either the respective charges on the adsorbing surface and the metallic cation. In addition to these adsorption reactions, precipitation of new mineral phases also may occur if the chemical composition of the soil solution becomes supersaturated with respect to the insoluble precipitates. Of the probable precipitates, the most important of these phases are hydroxides, carbonates, and sulfides. The precipitation of hydroxide minerals is important for metals such as iron and aluminum, the precipitation of carbonate minerals is significant for calcium and barium, and the precipitation of sulfide minerals dominates the soil chemistry of zinc, cadmium, and mercury. A number of precipitates may form if metals are added to soils, the concentration of metal in solution, will be controlled, at equilibrium, by the solid phase that results in the lowest value of the activity of the metallic ion in solution (Evans, 1989).

Table 5-2 presents the general processes which influence the aquatic fate of contaminants at OU No. 1.

The following paragraphs summarize the site-specific fate and transport data for some potential contaminants of concern at OU No. 1.

## 5.3 Fate and Transport Summary

The following paragraphs summarize the contaminant group fate and transport data for contaminants detected in media collected at OU No. 1.

### 5.3.1 Volatile Organic Compounds

VOCs (i.e., vinyl chloride, TCE, and PCA) tend to be mobile in environmental media as indicated by their presence in groundwater and their corresponding MI values. Their environmental mobility is a function of high water solubilities, high vapor pressures, low $K_{ow}$ and $K_{oc}$ values, and high mobility indices.

Without a continuing source, VOCs do not generally tend to persist in environmental media because photolysis, oxidation, and biodegradation figure significantly in their removal.

## TABLE 5-2

## PROCESSES INFLUENCING FATE OF ORGANIC POLLUTANTS
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Processes | | | | | |
|---|---|---|---|---|---|---|
| | Sorption | Volatilization | Biodegradation | Photolysis-Direct | Hydrolysis | Bioaccumulation |
| *Pesticides* | | | | | | |
| Chlordane | + | + | ? | - | - | + |
| DDD | + | + | - | - | - | + |
| DDE | + | + | - | + | - | + |
| DDT | + | + | - | - | + | + |
| Dieldrin | + | + | - | + | - | + |
| Heptachlor | + | + | - | ? | ++ | + |
| Heptachlor Epoxide | + | - | ? | ? | - | + |
| *PCBs* | + | + | +(1) | ? | - | + |
| *Halogenated Aliphatic Hydrocarbons* | | | | | | |
| Chloromethane (methyl chloride) | - | + | - | - | - | - |
| Dichloromethane (methylene chloride) | - | + | ? | - | - | - |
| 1,1-Dichloroethane (ethylidene chloride) | - | + | ? | - | - | - |
| 1,2-Dichloroethane (ethylene dichloride) | - | + | ? | - | - | - |
| 1,1,2-Trichloroethane | ? | + | - | - | - | ? |
| Chloroethene (vinyl chloride) | + | - | - | - | - | - |
| 1,1,-Dichloroethene (vinylidene chloride) | ? | + | ? | - | - | ? |
| Trichloroethene | - | + | ? | - | - | - |
| Tetrachloroethene (perchloroethylene) | - | + | + | - | - | - |
| Bromodichloromethane | ? | ? | ? | ? | - | + |
| Dichlorodifluoromethane | ? | + | - | ? | - | ? |

## TABLE 5-2 (Continued)

## PROCESSES INFLUENCING FATE OF ORGANIC POLLUTANTS
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Processes | | | | | |
|---|---|---|---|---|---|---|
| | Sorption | Volatilization | Biodegradation | Photolysis-Direct | Hydrolysis | Bioaccumulation |
| *Monocyclic Aromatics* | | | | | | |
| Benzene | + | + | - | - | - | - |
| Ethylbenzene | ? | + | ? | - | - | - |
| Toluene | + | + | ? | - | - | - |
| Phenol | - | + | + | - | - | - |
| 2,4-Dimethyl phenol (2,4-xylenol) | - | - | ? | + | - | - |
| *Phthalate Esters* | | | | | | |
| Dimethyl phthalate | + | - | + | - | - | + |
| Diethyl phthalate | + | - | + | - | - | + |
| Di-n-butyl phthalate | + | - | + | - | - | + |
| Di-n-octyl phthalate | + | - | + | - | - | + |
| Bis (2-ethylhexyl) phthalate | + | - | + | - | - | + |
| Butyl benzyl phthalate | + | - | + | - | - | + |
| *Polycyclic Aromatic Hydrocarbons* | | | | | | |
| Acenaphthene(3) | + | - | + | + | - | - |
| Acenaphthylene(3) | + | - | + | + | - | - |
| Fluorene(3) | + | - | + | + | - | - |
| Naphthalene | + | - | + | + | - | - |
| Anthracene | + | + | + | + | - | - |
| Fluoranthene(3) | + | + | + | + | - | - |
| Phenanthrene(3) | + | + | + | + | - | - |
| Benzo(a)anthracene | + | + | + | + | - | - |

## TABLE 5-2 (Continued)

## PROCESSES INFLUENCING FATE OF ORGANIC POLLUTANTS
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Processes | | | | | |
|---|---|---|---|---|---|---|
| | Sorption | Volatilization | Biodegradation | Photolysis-Direct | Hydrolysis | Bioaccumulation |
| Benzo(b)fluoranthene(3) | + | - | + | + | - | - |
| Benzo(k)fluoranthene(3) | + | - | + | + | - | - |
| Chrysene(3) | + | - | + | + | - | - |
| Pyrene(3) | + | - | + | + | - | - |
| Benzo(g,h,i)perylene(3) | + | - | + | + | - | - |
| Benzo(a)pyrene | + | + | + | + | - | - |
| Dibenzo(a,h)anthracene(3) | + | - | + | + | - | - |
| Ideno(1,2,3-cd)pyrene(3) | + | - | + | + | - | - |

| | |
|---|---|
| ++ | Predominate fate determining process |
| + | Could be an important fate process |
| - | Not Likely to be an important process |
| ? | Importance of process uncertain or not known |

Notes: (1) Biodegradation is the only process known to transform polychlorinated biphenyls under environmental conditions, and only the lighter compounds are measurably biodegraded. There is experimental evidence that the heavier polychlorinated biphenyls (five chlorine atoms or more per molecule) can be photolyzed by ultraviolet light, but there are no data to indicate that this process is operative in the environment.

(2) Based on information for 4-nitrophenol.

(3) Based on information for PAHs as a group. Little or no information for these compounds exists.

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Source: USEPA. 1985. Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Groundwater - Part I.

### 5.3.2 Polycyclic Aromatic Hydrocarbons

Low water solubilities, high $K_{ow}$ and $K_{oc}$ indicate a strong tendency for PAHs to adsorp to soils. Of the PAHs, fluoranthene, is probably the best marker compound, since it is consistently the most abundant of the PAHs measured and provides the strongest correlation with total PAH values. Benzo(g, h, i) perylene is usually the most abundant compound in soils with low PAH values but becomes less important with increasing total PAH values. Other PAH are benzo(a)anthracene, chrysene, pyrene, benzo(g,h,i) perylene, benzo(b)fluoranthene and phenanthrene. Their mobility indices indicate that they are relatively immobile from a physical-chemical standpoint. An exception is naphthalene, which is considered only slightly immobile because of somewhat higher water solubility (Jones, et al., 1989).

PAHs generally lack adequate vapor pressures to be transmitted via vaporization and subsequent airborne transport. However, surface and shallow surface soil particles containing PAHs could potentially be subject to airborne transport and subsequent deposition, especially during mechanical disturbances such as vehicle traffic or digging (Jones, et al., 1989).

PAHs are somewhat persistent in the environment. In general their persistence increases with increasing ring numbers. Photolysis and oxidation may be important removal mechanisms in surface waters and surficial soils, while biodegradation could be an important fate process in groundwater, surface soils or deeper soils. PAHs are ubiquitous in nature. The presence of PAHs in the soil may be the result of aerially deposited material, and the chemical and biological conditions in the soil which result in selective microbial degradation/breakdown.

### 5.3.3 Pesticides/Polychlorinated Biphenyls

Pesticides/PCBs are persistent and immobile contaminants in environmental media. Pesticides travel at varying rates through soil, mainly due to their affinity for soil surfaces. The soil sorption coefficient ($K_d$) is the distribution of a pesticide between soil and water. In general, the $K_d$ values are higher for high organic carbon soil than for low organic carbon soils. Therefore, soils with high $K_d$ values will retain pesticides (i.e., 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD). As evidenced by the ubiquitous nature of 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD, volatilization is an important transport process from soils and waters.

PCBs have low vapor pressures, low water solubilities, and high $K_{oc}$ and $K_{ow}$ values. Adsorption of these contaminants to soil and sediment is the major fate of these contaminants in the environment.

### 5.3.4 Inorganics

Inorganics can be found as solid complexes at ambient temperature and pressure in soils at the site. Inorganic ions exist in pure solutions as hydrated ions. Groundwater, as opposed to a pure solution, is a highly complex chemical system which is heavily influenced by the mineralogy of the substrate. Factors affecting the transport of inorganics in saturated soils are interactive and far more complex and numerous than those affecting the transport of organic contaminants.

The most complicated pathway for inorganic contaminants is migration in subsurface soils and groundwaters, where oxidation reduction potential (Eh) and pH play critical roles. Table 5-3 presents and assessment of relative inorganic environmental mobilities as a function of Eh and pH. Soils at MCB Camp Lejeune are relatively neutral, therefore, inorganics in the subsurface soil should be relatively immobile.

Transport of inorganic species in groundwater is mainly a function of the inorganic's solubility in solution under the chemical conditions of the soil-solution matrix. The inorganic must be dissolved (i.e. in solution) for leaching and transport by advection with the groundwater to occur. Generally, dynamic and reversible processes control solubility and transport of the dissolved metal ions. Such process include precipitation/dissolution, adsorption/desorption, and ion exchange.

Inorganics could be sorbed onto colloidal materials, theoretically increasing their inherent mobility in saturated porous media. It is important to note, however, that colloids themselves are not mobile in most soil/water systems.

Inorganics such as arsenic and chromium depend upon speciation to influence their mobility. Speciation varies with the chemistry of the environmental medium and temporal factors. These variables make the site-specific mobility of an inorganic constituent difficult to assess.

# TABLE 5-3

# RELATIVE MOBILITIES OF INORGANICS AS A FUNCTION OF ENVIRONMENTAL CONDITIONS (Eh, pH)
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Relative Mobility | Environmental Conditions | | | |
|---|---|---|---|---|
| | Oxidizing | Acidic | Neutral/ Alkaline | Reducing |
| Very high | | | Se | |
| High | Se, Zn | Se, Zn, Cu, Ni, Hg, Ag | | |
| Medium | Cu, Ni, Hg, Ag, As, Cd | As, Cd | As, Cd | |
| Low | Pb, Ba, Se | Pb, Ba, Be | Pb, Ba, Be | |
| Very Low | Fe, Cr | Cr | Cr, Zn, Cu, Ni, Hg, Ag | Cr, Se, Zn, Cu, Ni, Hg, Pb, Ba, Be, Ag |

Notes:

Se = Selenium
Zn = Zinc
Cu = Copper
Ni = Nickel
Hg = Mercury
Ag = Silver
As = Arsenic

Cd = Cadmium
Ba = Barium
Pb = Lead
Fe = Iron
Cr = Chromium
Be = Beryllium
Zn = Zinc

Source: Swartzbaugh, et al. "Remediating Sites Contaminated with Heavy Metals." Hazardous Materials Control, November/December 1992.

# 6.0 BASELINE RISK ASSESSMENT

## 6.1 Introduction

In order to estimate potential human health effects associated with contaminants identified at OU No. 1, the study area has been divided into three areas of concern: Site 21 (Transformer Storage Lot 140); Site 24 (Industrial Fly Ash Dump); and Site 78 (Hadnot Point Industrial Area). The OU was divided into these areas based upon their current accessibility and usage. Following is a description of these areas of concern:

- Site 21 has a history of pesticide usage and transformer oil disposal. The approximately 7-acre area was used as a pesticide mixing area and as a cleaning area for pesticide application. It is currently used by the Base as a storage area for IDW wastes. A fence restricts trespassers.

- Site 24 was used for disposal of fly ash, cinders, solvents, used paint stripping compounds, sewage sludge, and water treatment spiractor sludge. The 100-acre area is no longer used for disposal. Currently, the heavily wooded area is used for military training exercises (i.e., tanks). Access is unrestricted.

- Site 78 is comprised of maintenance facilities, warehouses, painting shops, printing shops, auto body shops, and other similar facilities. Much of the 590 acre area is paved (i.e., roadways, parking lots, loading docks, and storage lots); however, there are small lawn areas associated with individual buildings at the HPIA and along stretches of roadways. Military personnel and civilians utilize the area for various activities.

The Baseline Risk Assessment (BRA) investigates the potential for contaminants of potential concern to affect human health and/or the environment, both now and in the future, under a "no further remedial action scenario." The BRA process evaluates the data generated during the sampling and analytical phase of the RI, identifying areas of interest and contaminants of concern with respect to geographical, demographic, and physical and biological characteristics of the study area. These, combined with the current understanding of physical and chemical properties of the site-associated constituents (with respect to environmental fate and transport processes), are then used to estimate the concentrations of contaminants at the end points of logical exposure pathways. Finally, contaminant intakes by hypothetical receptors are determined and combined with the toxicological properties of the contaminants to estimate (inferentially) the potential public health impacts posed by constituents detected at the sites.

The BRA for OU No. 1 has been conducted in accordance with current USEPA's Risk Assessment Guidance (USEPA, 1989b and USEPA, 1991a), and USEPA Region IV Supplemental Risk Guidance (USEPA, 1992g).

The components of the BRA include:

- identification of potential contaminants of concern;
- the exposure assessment;
- the toxicity assessment;
- risk characterization;
- uncertainty analysis; and
- conclusions of the BRA and potential site risk.

This BRA is divided into seven sections, including the introduction. Section 6.2 establishes the criteria for the selection of contaminants of potential concern (COPCs). The COPCs are chosen, for each media at each site, from an overall list of contaminants detected at the site. Section 6.3 discusses the site characteristics, identifies potential human exposure pathways, and describes potential current and future exposure scenarios. Section 6.4 presents the estimation of potential exposure, discussing the estimation of daily intakes, incremental cancer risks and hazard indices. In addition, advisory criteria for the evaluation of human health is discussed. Section 6.5 discusses the risk characterization. Section 6.6 discusses the sources of uncertainty in the BRA. Section 6.7 provides a summary of the potential human health impacts in the form of total site risks.

## 6.2 Contaminants of Potential Concern

COPCs are site-related contaminants used to quantitatively estimate human exposures and associated potential health effects. Five environmental media were investigated during this RI: surface soils, subsurface soils, groundwater, surface water, and sediments. This section presents the selection of COPCs for these media. The discussion of findings presented in Section 4.0, Nature and Extent of Contamination, was used as the basis for this section.

### 6.2.1 Criteria for Selecting Contaminants of Potential Concern

The criteria used in selecting the COPCs from the constituents detected during the field sampling and analytical phase of the investigation were:

- Historical information
- Prevalence
- Mobility
- Persistence
- Toxicity
- Examination of Applicable or Relevant and Appropriate Requirements (ARARs)
- Comparison to investigation associated field and laboratory blank data
- Comparison to background or naturally occurring levels
- Comparison to anthropogenic levels

The criteria chosen to establish the COPCs are based on the guidance in the USEPA's Risk Assessment Guidance for Superfund (USEPA, 1989b). A comparison to contaminant-specific criteria was also considered in the selection of COPCs. A brief description of the selection criteria used in choosing final COPCs is presented below. A contaminant did not need to fit into all of these categories in order to be retained as a COPC.

#### 6.2.1.1 Historical Information

The association of contaminants with site activities based on historical information was used along with the following procedures to determine retention or elimination of contaminants.

#### 6.2.1.2 Prevalence

The frequency of positive detections in sample sets and the level at which a contaminant is detected in a given medium are factors that determine a chemical's prevalence. The judicious use of data is used in setting limits on the inclusion of infrequently detected contaminants. The occurrence of a chemical must be evaluated with respect to the number of samples taken to determine the frequency criterion which warrants the inclusion of a chemical as a COPC. Contaminants that are infrequently detected, (i.e., less than 5 percent, when at least 20 samples of a medium are available) may be artifacts in the data due to sampling or analytical practices. A contaminant may not be retained for quantitative evaluation in the BRA if: (1) it is detected infrequently in an environmental medium, (2) it is absent or detected at low concentrations in other media, or (3) site history does not provide evidence the contaminant to be present.

### 6.2.1.3 Mobility

The physical and chemical properties of a contaminant are responsible for its transport in the environment. These properties, in conjunction with site conditions, determine whether a contaminant will tend to volatilize into the air from surface soils or surface waters, or be transported via advection or diffusion through soils, groundwaters, and surface waters. Physical and chemical properties also describe a contaminant's tendency to adsorb onto soil/sediment particles. Environmental mobility can correspond to either an increased or decreased potential to affect human health and/or the environment.

### 6.2.1.4 Persistence

The persistence of a contaminant in the environment depends on factors such as the microbial content of soil and water, organic carbon content, the concentration of the contaminant, climate, and the ability of the microbes to degrade the contaminant under site conditions. In addition, chemical degradation (i.e., hydrolysis), photochemical degradation and certain fate processes such as sorption may contribute to the elimination or retention of a particular compound in a given medium.

### 6.2.1.5 Toxicity

The potential toxicity of a contaminant is an important consideration when selecting COPCs for further evaluation in the human health assessment. For example the weight-of-evidence (WOE) classification should be considered in conjunction with concentrations detected at the site. Some effects considered in the selection of COPCs include carcinogenicity, mutagenicity, teratogenicity, systemic effects, and reproductive toxicity. Bioaccumulation and bioconcentration properties may affect the severity of the toxic response in an organism and/or subsequent receptors and are evaluated if relevant data exist.

Despite their inherent toxicity, certain inorganic contaminants are essential nutrients. Essential nutrients need not be considered for further consideration in the quantitative risk assessment if they are present in relatively low concentration (i,e., below 2 times the average base-specific background levels or slightly elevated above naturally occurring levels), or if the contaminant is toxic at doses much higher than those which could be assimilated through exposures at the site.

#### 6.2.1.6 Applicable or Relevant and Appropriate Requirements (ARARs)

In addition to these criteria, contaminant concentrations can be compared to contaminant-specific established State and Federal ARARs such as Federal MCLs or Ambient Water Quality Criteria (AWQC).

The only enforceable Federal regulatory standards for water are the Federal MCLs. In addition to the Federal standards, the State of North Carolina has developed the NCWQS for groundwater and surface water. Regulatory guidelines were used for comparative purposes to infer the potential health risks and environmental impacts when necessary. Relevant regulatory guidelines include AWQC and Health Advisories.

In general, chemical-specific ARARs are not available for soil. Therefore, base-specific background concentrations were compiled to evaluate background levels of organic and inorganic constituents in the surface and subsurface soil. Organic contaminants were not detected in the base-specific background samples. Therefore, it is likely that all organic contaminants detected in the surface and subsurface soil, within OU No. 1, are attributable to the practices which have or are currently taking place within the areas of concern. Additionally, in order to evaluate soil concentrations, the risk-based concentrations (RBCs) for residential soil ingestion developed by USEPA (Region III) were used as guidance criteria to evaluate soil concentrations. The RBCs were used as a benchmark for evaluating site investigation data and to assist in predicting single-contaminant health risks. These values were used in conjunction with other criteria in the selection of COPCs.

A brief explanation of the ARARs used for the evaluation of COPCs is presented below.

**Maximum Contaminant Levels** - MCLs are enforceable standards for public water supplies promulgated under the Safe Drinking Water Act and are designed for the protection of human health. MCLs are based on laboratory or epidemiological studies and apply to drinking water supplies consumed by a minimum of 25 persons. They are designed for prevention of human health effects associated with a lifetime exposure (70-year lifetime) of an average adult (70 kg) consuming 2 liters of water per day. MCLs also consider the technical feasibility of removing the contaminant from the public water supply.

**North Carolina Water Quality Standards (Groundwater)** - NCWQSs are the maximum allowable concentrations resulting from any discharge of contaminants to the land or waters of the state, which may be tolerated without creating a threat to human health or which otherwise render the groundwater unsuitable for its intended purpose.

**Health Advisories (HAs)** - HAs are guidelines developed by the USEPA Office of Drinking Water for nonregulated constituents in drinking water. These guidelines are designed to consider both acute and chronic toxic effects in children (assumed body weight 10 kg) who consume 1 liter of water per day or in adults (assumed body weight 70 kg) who consume 2 liters of water per day. HAs are generally available for acute (1 day), and subchronic (10 days), and chronic (longer-term) exposure scenarios. These guidelines are designed to consider only threshold effects and, as such, are not used to set acceptable levels of potential human carcinogens.

**Ambient Water Quality Criteria** - AWQC are non-enforceable regulatory guidelines and are of primary utility in assessing acute and chronic toxic effects in aquatic systems. They may also be used for identifying the potential for human health risks. AWQCs consider acute and chronic effects in both freshwater and saltwater aquatic life, and potential carcinogenic and noncarcinogenic health effects in humans from ingestion of both water (2 liters/day) and aquatic organisms (6.5 grams/day), or from ingestion of water alone (2 liters/day). The AWQCs for the protection of human health for potential carcinogenic substances are based on the USEPA's specified incremental cancer risk range of one additional case of cancer in an exposed population of 10,000,000 to 100,000 (i.e. the 10E-7 to 10E-5 range).

**North Carolina Water Quality Standards (Surface Water)** - The NCWQSs for surface water are the standard concentrations, that either alone or in combination with other wastes, in surface waters that will not render waters injurious to aquatic life or wildlife, recreational activities, public health, or impair the waters for any designated use.

### 6.2.1.7 Contaminant Concentrations in Blanks

The association with contaminants detected in field related blanks (i.e., trip blanks, equipment rinsates and/or field blanks) or laboratory method blanks with the same contaminants detected in analytical samples may eliminate non-site-related contaminants from the list of COPCs. Maximum contaminant concentrations reported in the blanks will be compared to the entire sample set to evaluate COPCs. In accordance with the National Functional Guidelines for Organics common lab contaminants (i.e., acetone, 2-butanone, methylene chloride, toluene, and phthalate esters) should be considered attributable to site activities only if the concentrations in the sample exceed ten times the maximum amount detected in any blank. If a contaminant is not a common lab contaminant, then concentrations that are less than 5 times the concentration found in any blank are believed to be non-site-related.

The maximum concentrations of detected common laboratory contaminants in blanks were as follows:

| | |
|---|---|
| ● Acetone | 23 µg/l |
| ● Methylene Chloride | 4.0 µg/l |
| ● Di-n-butylphthalate | 2.0 µg/l |
| ● bis(2-ethylhexyl)phthalate | 93 µg/l |

Blanks containing organic constituents that were not considered common laboratory contaminants (i.e., all other TCL compounds) were considered as positive results only when observed concentrations exceeded five times the maximum concentration detected in any blank (USEPA, 1989b). All TCL compounds at less than five times the maximum level of contamination noted in any blank were considered to be not detected in that sample. The maximum concentrations of all other detected blank contaminants were as follows:

| | |
|---|---|
| ● Chloroform | 6.0 µg/l |
| ● Bromodichloromethane | 3.0 µg/l |
| ● Bromomethane | 2.0 µg/l |
| ● Dichloromethane | 8.0 µg/l |

When assessing soil concentrations, the method detection limit and percent moisture were taken into account in order to correlate aqueous and solid detection limits.

#### 6.2.1.8 Background Naturally Occurring Levels

Naturally occurring levels of chemicals are present under ambient conditions. In general, comparison with naturally occurring levels is applicable only to inorganic analytes, because a majority of organic contaminants are not naturally occurring. An inorganic concentration was considered site-related only if it exceeded two times the average concentration determined for the site-specific background samples.

#### 6.2.1.9 Anthropogenic Levels

Ubiquitous anthropogenic background concentrations result from non-site related sources such as combustion of fossil fuels (i.e., automobiles), plant synthesis, natural fires and factories. A good example of ubiquitous, anthropogenic chemicals in environmental are the PAHs. In general, anthropogenic chemicals were not eliminated as COPCs without considering other selection criteria. It is difficult to determine that such chemicals are present at the site due to operations not related to the site or the surrounding area. Omitting anthropogenic background chemicals from the risk assessment could result in the loss of important information for those potentially exposed.

The remaining sections apply the aforementioned selection criteria beginning with the prevalence of detected analytical results in each medium of interest to establish a preliminary list of COPC for OU No. 1 (Sites 21, 24 and 78). Once this task has been completed, a final list of media-specific COPCs will be selected based on the remaining criteria (persistence, mobility, toxicity, and ARARs).

### 6.2.2 Selection of Contaminants of Potential Concern

The following sections present an overview of the analytical data obtained for each medium and site during the RI and the subsequent retention or elimination of COPCs using the aforementioned criteria for selection of COPCs.

#### 6.2.2.1 Surface Soil COPC Selection

*Site 21*

The VOCs, acetone and total xylenes, were detected in 1 of 9 samples. These were the only VOCs detected in the surface soil. The retention of these contaminants as COPCs was not warranted due to their infrequent detection. In addition, the level of acetone (300 µg/l) was attributed to levels detected in the investigation associated QA/QC blanks.

In the surface soil, the PAHs phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and benzo(g,h,i)perylene were retained as COPCs due to their prevalence and toxicity. SVOCs which were not retained as COPCs (naphthalene, 2-methlynaphthalene, fluorene, phenanthrene, anthracene, 3,3'-dichlorobenzidine, dibenz(a,h)anthracene, and benzo(g,h,i)perylene) were infrequently detected (i.e., 1 of 9 samples), or exhibit low toxic potential. Additionally, the concentration of bis(2-ethylhexyl)phthalate (maximum concentration of 650 µg/kg) was attributable to sampling or laboratory induced contamination.

Pesticide and PCB contaminants 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, alpha chlordane, gamma-chlordane, and PCB-1260 were prevalent in the soil. Due to their prevalence and toxic potential, these contaminants were retained as COPCs.

Inorganic constituents arsenic, chromium, copper, lead, manganese, vanadium, and zinc were present at levels in the soil at concentrations which exceeded two times the average site-specific background. In addition, these constituents were prevalent in the environment (detected in 9 of 9 samples), and toxicological indices are available for most of these chemicals. Therefore, these constituents were retained as COPCs. Copper and lead were retained as COPCs due to their prevalence (detected in 9 of 9 samples); however, they were not evaluated in the BRA due to inadequate toxicity data.

Table 6-1 presents the frequency and concentration range of surface soil organics. Table 6-2 presents the surface soil inorganic frequency, concentration range, and a comparison to base-specific background levels. Note that based on the number of tables included in this section, they are all presented at the end of this section.

*Site 24*

Twenty-five surface soil samples (0 to 6 inches) were analyzed for VOCs. Only acetone and styrene were detected in the surface soil. Acetone (8 of 25 samples) was present at concentrations less than associated blanks, or infrequently greater than the blank concentration (1 of 25 samples). Styrene was detected at a frequency of 1 of 25 samples. Consequently, these contaminants do no warrant retention as COPCs.

In the surface soil, the PAHs fluoranthene, pyrene, chrysene, and benzo(b)fluoranthene were retained as COPCs based on their prevalence (at least 2 detections), and their potential toxicity. Other SVOCs were infrequently detected (1 of 25 samples) and therefore were not retained as COPCs.

Pesticide and PCB contaminants (4,4'-DDE, 4,4'-DDD, 4,4'-DDT, alpha chlordane, gamma chlordane, PCB-1254 and PCB-1260) exceeded the frequency criterion. Therefore, these organics were also retained as COPCs.

Inorganic constituents arsenic, barium, beryllium, chromium, copper, lead, nickel, manganese, mercury, vanadium and zinc exceeded the five percent frequency criterion, were detected at concentrations greater than two times the average site-specific background, and for the exception of copper and lead have established toxicity values. Therefore, these inorganics were retained as COPCs.

Table 6-3 presents the organic surface soil concentration ranges and frequency. Table 6-4 presents the surface soil inorganic ranges and frequency along with base-specific background concentrations.

*Site 78*

The surface soil samples at Site 78 were collected from selected building areas. Because of the size of this industrial complex, this selective sampling program would bias analytical findings and not be truly indicative of overall site conditions and exposure potential. Therefore, after discussions with Mr. Kevin Koporec, USEPA Region IV, Waste Management Division, it was determined that contaminant levels in the surface soils from this area would not be used to assess human health risks. Consequently, COPCs were not selected for this area.

#### 6.2.2.2 Subsurface Soil COPC Selection

*Site 21*

The infrequent detection of methylene chloride, acetone, toluene, ethylbenzene, and total xylenes (1 of 15 samples) did not meet the five percent criteria for retention of a contaminant as a COPC. In addition, the presence of methylene chloride, acetone, and toluene was attributed to investigation related blanks. Therefore, these contaminants were not retained as COPCs.

Naphthalene and 2-methylnaphthalene were not retained as COPCs since the compounds were infrequently detected (1 of 15 samples), and the toxicity potential for these chemicals has not been published.

Pesticide contaminants 4,4'-DDD, 4,4'-DDT were detected at a frequency which exceeded the five percent criteria for retention as COPCs. In addition, the toxicity potential of these chemicals warrants their retention as COPCs. Alpha chlordane and gamma chlordane (1 of 33 samples) were not considered to be prevalent in the soil. Therefore, these contaminants were not retained as COPCs.

Inorganic constituents arsenic and manganese were the only inorganics which were prevalent at concentrations greater than two times the average site-specific background concentrations. Other inorganics were not prevalent at concentrations greater than two times the average base-specific concentration.

The subsurface soil organic findings are presented in Table 6-5. The subsurface soil inorganic findings and base-specific background concentrations are presented in Table 6-6.

*Site 24*

Forty-four subsurface soil locations (below 6 inches) were sampled from the four areas of concern within Site 24. VOCs methylene chloride (3 of 44 samples) and acetone (15 of 44 samples) were not retained as COPCs. These contaminants did not warrant retention as COPCs due to their presence in investigation associated QA/QC blanks. VOCs carbon disulfide (4 of 44 samples) and 2-butanone (1 of 44 samples) were not retained as COPCs due to their infrequent occurrence, low concentration, and low toxic potential.

SVOCs were relatively absent in these soils. Infrequent detections of di-n-butyl phthalate and fluoranthene (1 of 44 samples) did not warrant their retention as COPCs. Additionally, the presence of bis(2-ethylhexyl)phthalate (maximum concentration of 1,000 µg/kg) was attributable to sampling or laboratory induced contamination, apparent in associated QA/QC blanks.

The pesticides 4,4'-DDD and 4,4'-DDT were the only pesticide/PCB contaminants detected in the forty-four soil samples collected from the four areas of concern. These pesticides were detected at a frequency which exceeds the criteria. Therefore, these contaminants were retained as COPCs.

The inorganic constituents arsenic, barium, beryllium, chromium, manganese, vanadium, and zinc were retained as COPCs due to prevalence in excess of five percent of the samples, detected at concentrations greater than two times the average site-specific background levels, or potential toxicity. Inorganics constituents copper, lead, nickel, and selenium were not prevalent at concentrations less than two times site-specific background and consequently were not retained as COPCs.

Table 6-7 presents the range and frequency for the organics detected in the subsurface soil from Site 24. Table 6-8 presents a comparison of inorganic subsurface soil findings along with base-specific inorganic levels

*Site 78*

Subsurface soil samples were collected from building areas in and around Site 78. The subsurface soil sampling strategy, used in assessing levels of contamination, was not indicative of overall site conditions. However, contaminants detected in the subsurface soil were evaluated to see if they should be retained as COPCs in order to determine potential exposure to subsurface soil during potential excavation around sampled building areas.

Twenty-nine subsurface soil samples were collected for volatile analysis. The VOCs total-1,2-DCE, toluene, ethylbenzene, and total xylenes were detected infrequently (1 of 29 samples) in the subsurface soil. Therefore, these contaminants were not retained as COPCs. The presence of acetone (maximum concentration of 210 µg/kg) in the subsurface soil was less than the concentration level in the investigation related blank sample (230 µg/kg).

Several SVOCs were infrequently detected in the twenty-nine subsurface soil samples collected in the HPIA. Infrequent detection (1 of 29 samples) of PAH compounds benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and benzo(g,h,i)perylene did not warrant their retention as COPCs in the subsurface soil.

Pesticides 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE were detected in 4 of 44 subsurface soil samples. Because of the selective sampling strategy used for the collection of the subsurface soils in this area, the occurrence of these pesticides in the subsurface soil does not meet the five percent criteria. Therefore, these pesticides were not retained as COPCs. In addition, dieldrin was infrequently detected (1 of 4 samples) and was not retained as a COPC.

Inorganics were frequently detected in the sixteen subsurface soils collected within Site 78. However, the reported concentration levels were less than two times the base-specific background concentrations. Therefore, no inorganics were retained as COPCs in the subsurface soil.

Tables 6-9 and 6-10 present the analytical summaries for the subsurface soil organics and inorganics, respectively.

#### 6.2.2.3 Groundwater COPC Selection

Groundwater-bearing zones at OU No. 1 have not been segregated for the selection of COPCs. Groundwater samples were collected from new and existing shallow, intermediate, and deep monitoring wells in and around OU No. 1. Table 6-11 presents a comparison of the organic and inorganic groundwater findings to the applicable State and Federal groundwater criteria.

Groundwater samples collected from 51 monitoring wells were analyzed for VOCs. Except for vinyl chloride, infrequently detected (1 in 51 samples) VOCs were not retained as COPCs. Vinyl chloride was retained because of its toxicity. Infrequently detected contaminants not retained for further quantitative evaluation included: dichlorofluoromethene, trichlorofluoromethane, 1,1-DCE, 1,2-DCA, bromodichloromethane, 1,2-dichloropropane, and 1,1,2-TCA. Volatile contaminants that were prevalent in the groundwater and retained as COPCs include: total 1,2-DCE, TCE, benzene, PCE, toluene, ethylbenzene, and total xylenes. The presence of chloroform (maximum concentration of 8 µg/l) and methylene chloride (maximum concentration of 3.3 µg/l) are attributable to sampling or laboratory induced contamination. Therefore, chloroform (30 µg/l) and methylene chloride (40 µg/l) and were not retained as COPCs.

Phenol (8 of 51 samples) and naphthalene (6 of 51 samples) were detected in the groundwater. Therefore, phenol and naphthalene were retained as COPCs. The prevalence of the other SVOCs (1 of 51 samples) did not warrant their retention as COPCs. In addition, the presence of bis(2-ethylhexyl)phthalate (5 of 51 samples) was attributed to laboratory or sampling related contamination.

Few pesticides were detected in the groundwater. The prevalence of dieldrin and alpha chlordane (1 of 54 samples) does not warrant their retention as COPCs. Although infrequently detected, heptachlor epoxide (3 of 54 samples) was retained as a COPC due to its toxicity potential.

Several inorganics were frequently detected in the groundwater. Inorganic constituents arsenic, barium, beryllium, chromium, manganese, mercury, nickel, vanadium, and zinc were frequently detected above State and/or Federal groundwater criteria. Therefore, they were retained as groundwater COPCs. Although toxicity values have not been published for lead, it was retained as a COPC due to its frequent occurrence in groundwater at concentrations above established state groundwater criteria. Although detected above the five percent criteria, copper, selenium, and thallium were not retained as COPCs because concentrations of these inorganics in the groundwater were below federal or state groundwater criteria, and toxicity values have not been published to estimate their adverse impact.

### 6.2.2.4 Surface Water

*Cogdels Creek*

VOCs were infrequently detected in the twenty samples collected from Cogdels Creek. The organic and inorganic surface water contaminants are compared to applicable State and Federal criteria in Table 6-12. Methylene chloride (1 of 20 samples), acetone (2 in 19 samples), total-1,2-DCE (1 of 20 samples) and toluene (1 of 20 samples) were not retained, due to frequency, as COPCs. TCE was detected in 4 of 20 samples and was retained as a COPC due to its toxic potential.

Phthalate esters were detected infrequently at low concentrations in the surface water. Because the infrequent occurrence and the presence of these phthalate esters in investigation-related blanks, they were not retained as COPCs.

Infrequent detection of pesticides 4,4'-DDD (2 of 20 samples) and 4,4'-DDT (1 of 20 samples) did not warrant the retention of these contaminants as COPCs.

Inorganic constituents arsenic, barium, beryllium, chromium, manganese, vanadium, and zinc were retained as COPCs based on their prevalence in the sediment and their potential toxicity. Inorganic constituents copper and lead were retained as COPCs based on their prevalence and for comparison to applicable surface water criteria.

### *Beaver Dam Creek*

Organic contamination (VOCs, SVOCs, and pesticides/PCBs) was not detected in 40 samples collected from Beaver Dam Creek. Therefore, organics were not retained as COPCs.

Inorganic contaminants arsenic, barium, beryllium, cadmium, chromium, manganese, vanadium, and zinc were retained as COPCs based on their frequency of occurrence and potential toxicity. Inorganic contaminants copper, lead, and selenium were retained as COPCs for comparison to applicable surface water criteria.

Table 6-13 presents the inorganic surface water findings as compared to the applicable State and Federal criteria.

### *Site 21*

The surface water samples collected from the depression surrounding Lot 140 were not used to estimate potential risks. The water which was present at the time of sampling was not a true surface water feature or the result of a gain or loss of groundwater, but rather was present do to the ponding of site runoff from rain events.

### 6.2.2.5 Sediment

*Cogdels Creek*

A total of forty sediment samples were collected for VOC analysis. Table 6-14 presents the sediment organic and inorganic analytical results from Cogdels Creek. Two samples, from varying depths, were collected at each station. The infrequent detection of methylene chloride (3 of 40 samples), 2-butanone (3 of 40 samples), and ethylbenzene (1 of 40 samples) did not warrant the retention of these contaminants as COPCs. In addition, the prevalence of acetone (10 of 40 samples) was attributed to sampling or laboratory induced contamination.

SVOCs infrequently detected (maximum 3 of 40 samples) in the Cogdels Creek sediment included: 4-methylphenol, naphthalene, acenaphthene, dibenzofuran, fluorene, anthracene, carbazole, and dibenz(a,h)anthracene. Due to the prevalence of these compounds, they were not retained as COPCs. Several PAHs including phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and benzo(g,h,i)perylene were prevalent in the sediment. Due to the prevalence of these compounds and their toxic potential, they were retained as COPCs.

Pesticide contaminants 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, alpha chlordane, and gamma chlordane were detected at frequencies that exceeded the five percent prevalence criteria. This prevalence along with the toxic potential of these organics warranted their retention as COPCs.

The prevalence of inorganic constituents arsenic, barium, beryllium, cadmium, chromium, manganese, vanadium, and zinc warranted retention as COPCs. Although retained as COPCs due to prevalence, copper and lead were not used in the estimation of risk because toxicity values have not been published for these inorganics. The infrequent detection of cobalt, selenium, and thallium did not warrant that these inorganics be retained as COPCs.

*Beaver Dam Creek*

Infrequent detection of VOCs, methylene chloride and carbon disulfide (1 of 20 samples), did not warrant the retention of these compounds as COPCs. Organic and inorganic analytical results for Beaver Dam Creek sediments are presented on Table 6-15. The presence of acetone in 6 of 13 samples was attributable to investigation- or laboratory-related activities (see QA/QC blanks) and therefore, was not retained as a COPC.

Of the PAHs detected in the fourteen sediment samples, only phenanthrene, fluoranthene, pyrene, and chrysene were detected at a frequency which warranted retention of these compounds as COPCs. Detection of the other PAHs (1 of 14 samples) was not sufficient to warrant these compounds as COPCs.

Pesticide contaminants 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, alpha chlordane, and gamma chlordane were retained as COPCs based on their frequency of detection in the sediment and toxic potential. PCB-1260 was detected in 1 of 14 samples at a concentration of 30 µg/kg. The limited occurrence and low concentration of this organic does not warrant its retention of COPCs.

Inorganic constituents arsenic, barium, beryllium, chromium, manganese, vanadium, and zinc were prevalent in the fourteen sediment samples. Therefore, these inorganics were retained as COPCs. In addition, copper and lead were frequently detected and were retained as COPCs but could not be quantitatively evaluated due to insufficient toxicological information.

#### 6.2.2.6 Summary of COPCs

Table 6-16 presents a detailed summary of the potential COPCs identified in each environmental medium sampled at OU No. 1 (Sites 21, 24, and 78). Work sheets used in the selection of COPCs are presented in Appendix J.

## 6.3 Exposure Assessment

This section develops the potential human exposure pathways at OU No. 1 and the rationale for their evaluation. Potential source areas and potential migration routes in conjunction with contaminant fate and transport information are combined to produce a site conceptual model. Exposure pathways to be retained for quantitative evaluation are subsequently selected, based on the conceptual site model.

### 6.3.1 Site Conceptual Model of Potential Exposure

A site conceptual model of potential sources, migration pathways and human receptors was developed to encompasses all current and future potential routes of exposure. Figure 6-1 presents the conceptual site model for OU No. 1. Inputs to the site conceptual site model included qualitative descriptions of current and future land use patterns in the vicinity of OU No. 1. All available analytical data and meteorological data were considered in addition to general understanding demographics of surrounding habitats. For this information, the following list of potential receptors were developed for inclusion in the quantitative health risk analysis:

- On-site military personnel
- Future recreational users (child and adult) of Cogdels Creek and Beaver Dam Creek
- Future on-site residents (child and adult)

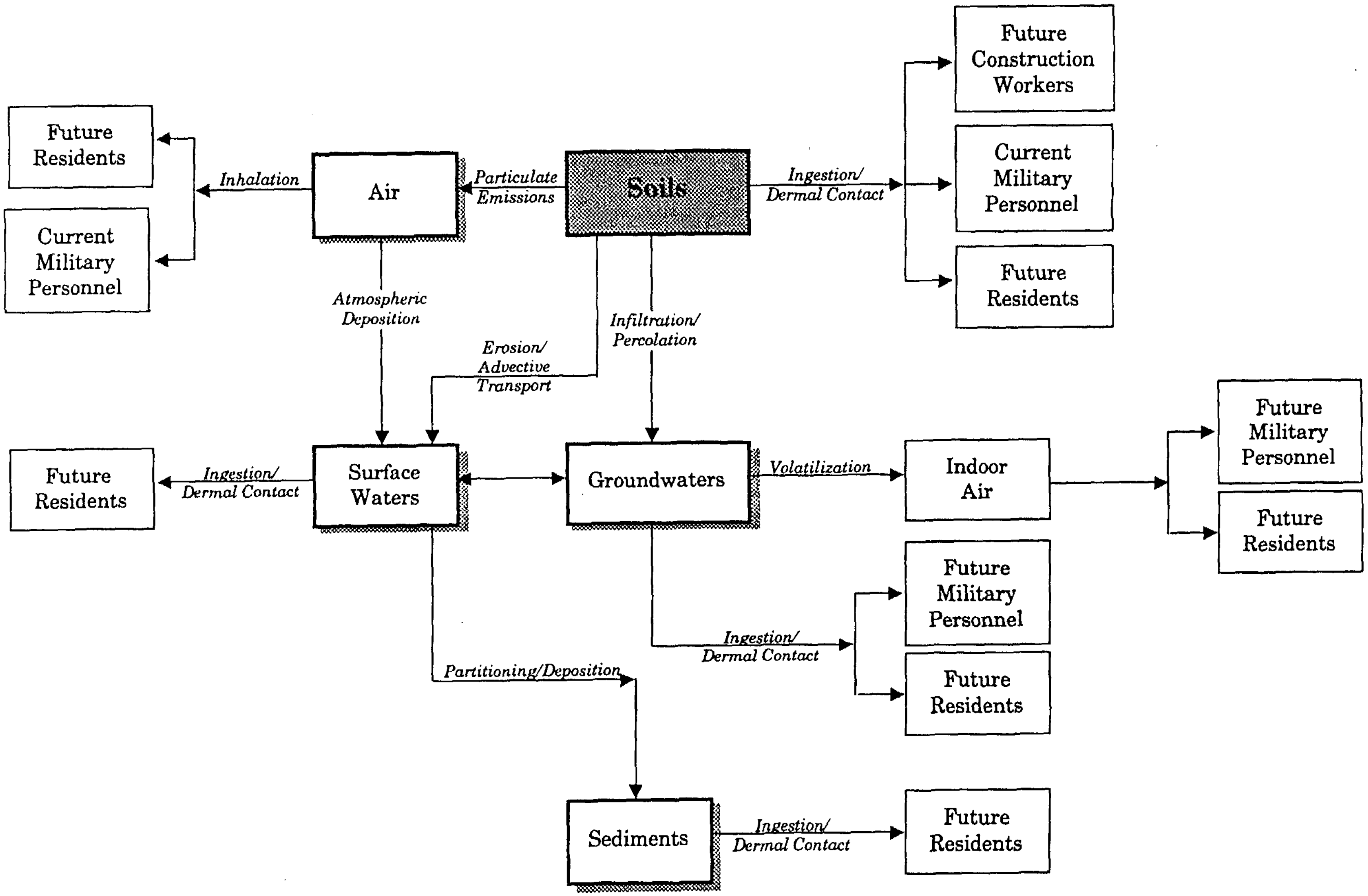
Contaminants detected in the surface and subsurface soils were discussed in Section 4.0 (Nature and Extent of Contamination) and in the selection of COPCs section. The migration of COPCs from these sources could potentially occur by the following routes:

- Vertical migration of potential contaminants from surficial soils to subsurface soils.
- Leaching of potential contaminants from subsurface soils to the water-bearing zones.
- Vertical migration from shallow water-bearing zones to deeper flow systems.
- Horizontal migration in groundwater in the direction of groundwater flow.
- Groundwater discharge into local streams.
- Wind erosion and subsequent deposition of windblown dust.

The potential for a contaminant to migrate spatially and persist in environmental media are important in the estimation of potential exposure.

**FIGURE 6-1**

**CONCEPTUAL SITE MODEL**
**OPERABLE UNIT NO. 1**
**REMEDIAL INVESTIGATION CTO-0177**
**MCB CAMP LEJEUNE, NORTH CAROLINA**



### 6.3.2 Exposure Pathways

This section describes the potential exposure pathways presented on Figure 6-1 associated with each medium and each potential human receptor group, then qualitatively evaluates each pathway for further consideration in the quantitative risk analysis. Tables 6-17, 6-18, and 6-19 present the matrices of potential human exposure scenarios for each of the three sites included under OU No. 1.

#### 6.3.2.1 Surface Soils

Surface soil samples were collected on-site from each area of concern (Sites 21, 24 and 78). Potential exposures to these soils may possibly occur through incidental ingestion, absorption via dermal contact, and inhalation of airborne particulates of surface soil containing COPCs. Dermal intakes will also result following dermal contact with soils containing COPCs. Incidental ingestion of soil may also occur by oral contact with hands, arms, or food items which soil particles have adhered.

Receptors most likely to be exposed via dermal contact, incidental ingestion and inhalation of air-borne particulates differ in each area of concern due to the current and future potential land use.

- Site 21, which is located within the boundaries of Site 78, is currently used as a storage area for IDW wastes. This area resides within a heavily industrialized zone, and according to the Base Master Plan it is unlikely that activities associated with current land use would change in the future. Therefore, future residential land use is not justifiable since the probability that the site will support residential use in the future is small.

  However, current potential human health risks will be estimated for all current receptors (i.e., military personnel).

- Site 24 is a heavily wooded area no longer used for disposal. Activities associated with current land use have the potential to differ under an alternate future land use (i.e., residential housing). Therefore, both current and future potential exposures will be estimated for all potential receptors.

- Site 78 is a heavily industrialized area. According to the Base Master Plan activities associated with current land use are not likely to differ under future land use scenarios. Although residential land use is the most conservative assumption for this area of concern, it is not justifiable in that this area will not be used for future residential purposes.

#### 6.3.2.2 Subsurface Soils

Potential exposure to subsurface soils is limited to potential site construction workers. In the event of construction in the areas of concern, workers may be exposed to subsurface soil. Therefore, future potential exposures via ingestion and dermal contact were retained for evaluation.

#### 6.3.2.3 Groundwater

Currently the shallow groundwater in this area is not used as a potable supply for residents or base personnel. However, under a future scenario (albeit unlikely due to poor transmissivity and insufficient flow) the major potential exposure pathways for the use of on-site groundwater are ingestion, dermal contact, and the inhalation of volatile contaminants by residents or base personnel while showering.

#### 6.3.2.4 Surface Water/Sediments

The two surface water bodies which were sampled during the field investigation showed evidence of COPCs. Currently, these waters are not used by military or base personnel for recreational purposes. Future potential exposures to surface waters and sediments considered in the BRA include:

- Accidental ingestion of surface water and sediments during recreational use (future residential child and adult).

- Dermal contact of surface water and sediments during recreational usage (future residential child and adult).

#### 6.3.2.5 Air

A potential human exposure pathway exists in air through the inhalation of airborne particulates from surface soils containing COPCs. Airborne particulate emissions may result from the wind erosion and the entrainment of soil particles in ambient air. COPCs adhering to these airborne soil particles may be inhaled by potential future on-site residents (i.e., child and adult) and current military personnel.

Therefore, inhalation of airborne particulate emissions by potential future residents and current military personnel was retained for quantitative evaluation. Off-site receptors would be exposed to concentrations much lower than those detected in on-site air samples as a result of the dilution characteristics of ambient air and the wooded areas which separate the facility from the nearby communities. Therefore, nearby residents were not evaluated.

#### 6.3.2.6 Biota

Recreational fishing does not occur in Cogdels Creek or Beaver Dam Creek. Furthermore future exposure by recreational fisher persons is unlikely. Therefore, ingestion of fish by current or future fisher persons was not retained for quantitative evaluation.

### 6.3.3 Quantification of Exposure

The concentrations used in the estimation of chronic daily intakes (CDIs) must be representative of the type of exposure being considered.

Exposure to groundwaters, sediments and surface waters can occur discretely or at a number of sampling locations. These media are transitory in that concentrations change frequently over time. Averaging transitory data obtained from multiple locations is difficult and requires many more data points at discrete locations than exist within OU No. 1. As a result, the best way to represent groundwater, sediment, and surface water contaminants from an exposure standpoint is to use a representative exposure concentration.

Soils are less transitory than the aforementioned media and in most cases, exposure occurs over a wider area (i.e., residential exposure). Therefore, an upper confidence interval was used to represent a soil exposure concentration.

Soil data collected from each of these areas was used separately in estimating the potential human health risks under current and future exposure scenarios.

The human health assessment for future groundwater use considered groundwater data collected from all of the monitoring wells within OU No. 1 area and not individual areas of concern.

Future residential human exposure to surface water and sediments were assessed separately for Cogdels Creek and Beaver Dam Creek.

Since all the data sets originate from a skewed underlying distribution and since log-normal distribution best fits the majority of environmental data sets, the lognormal distribution was used to represent all facility media. This ensures conservatism in the estimation of chronic daily intake associated with potential exposures. Ninety-five percent upper confidence levels (95 percent U.C.L.) derived for lognormal data sets produce concentrations in excess of the 95 percent interval derived assuming normality. For the sake of conservatism, the 95 percent U.C.L. for the lognormal distribution was used for each contaminant in a given data set for quantifying potential exposure. For exposure areas with limited amounts of data or extreme variability in measured data, the 95 percent U.C.L. can be greater than the maximum measured concentration, therefore, in cases where the 95 percent U.C.L. for a contaminant exceeds the maximum detected value in a given data set, the maximum result was used in the estimate of exposure of the 95 percent U.C.L. However, the true mean may still be higher than this maximum value (i.e., the 95 percent U.C.L. indicates a higher mean is possible), especially if the most contaminated portion of the site has not been sampled.

Maximum values, arithmetic means, geometric means, standard deviations, and 95 percent U.C.L.s are presented in Appendices K and L.

### 6.3.4 Calculation of Chronic Daily Intakes

In order to numerically estimate the risks for current and future human receptors at OU No. 1, a CDI must be estimated for each COPC in every retained exposure pathway.

Appendix M contains the specific CDI equations for each exposure scenario of interest. These equations were adopted from USEPA's Risk Assessment Guidance for Superfund, Volume I (USEPA, 1989b).

The following paragraphs present the general equations and input parameters used in the calculation of CDIs for each potential exposure pathway. Input parameters were taken from USEPA's default exposure factors guidelines where available and applicable. All inputs not defined by USEPA were derived from USEPA documents concerning exposure or best professional judgment. All exposure assessments incorporate the representative contaminant concentrations in the estimation of intakes. Therefore, only one exposure scenario was developed for each exposure route/receptor combination.

Carcinogenic risks were calculated as an incremental lifetime risk, and therefore incorporate terms describing to represent the exposure duration (years) over the course of a lifetime (70 years, or 25,550 days).

Noncarcinogenic risks, on the other hand, were estimated using the concept of an average annual exposure. The intake incorporates terms describing the exposure time and/or frequency that represent the number of hours per day and the number of days per year that exposure occurs. In general, noncarcinogenic risks for many exposure routes (e.g., soil ingestion) are greater for children than adults because of the differences in body weights, similar exposure frequencies and higher ingestion rates.

Future residential exposure scenarios consider 1 to 6 year old children weighing 15 kg, and adults weighing 70 kg on average. For current/future military personnel an exposure duration of 4 years was used to estimate a military residence. A one year duration was used for future construction worker scenarios.

### 6.3.4.1 Incidental Ingestion of Soil

The CDI for COPCs detected in soil was estimated for all potential human receptors and was expressed as:

$$\text{CDI} = \frac{\text{C x IR x CF x Fi x EF x ED}}{\text{BW x AT}}$$

Where:

C = Contaminant concentration in soil (mg/kg)
IR = Ingestion rate (mg/day)
CF = Conversion factor (1E-6 kg/mg)
Fi = Fraction ingested from source (dimensionless)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

The following paragraphs discuss the exposure assumptions used in the estimation of potential COPCs associated with the potential ingestion of soils.

*Military Personnel*

During the course of daily activities at OU No. 1, military personnel could potentially be exposed to potential COPCs by the incidental ingestion of surface soils.

The IR for military personnel exposed to surficial soils was assumed to be 100 mg/day (USEPA, 1989) and that 100 percent of the exposure was with facility soils containing COPCs. An exposure frequency (EF) of 350 days per year was used in conjunction with an exposure duration of 4 years.

An averaging time (AT) of 70 years or 25,550 days was used for exposure to potentially carcinogenic compounds while an averaging time of 1,460 (4 years x 365 days/year) days was used for noncarcinogenic exposures. An adult average body weight (BW) of 70 kg was used (USEPA, 1989b).

*Future On-Site Residents*

Future on-site residents could potentially be exposed to COPCs in the surficial soils during recreational activities or landscaping activities around their homes. Children and adults could potentially be exposed to COPCs in soils by incidental ingestion occurring through hand to mouth behavior.

Ingestion rates (IR) for adults and children in this scenario were assumed to be 100 mg/day and 200 mg/day, respectively. EFs for both receptor groups was assumed to be 350 days per year. The residential exposure duration (ED) was divided into two parts. First, a six-year exposure duration was evaluated for young children which accounts for the period of highest soil ingestion (200 mg/day), and second a 24-year exposure was assessed for older children and adults by using a lower soil ingestion rate (100 mg/day) (USEPA, 1991c).

The BW, for a resident child was assumed to be 15 kg, representing younger individuals than those considered to be potential trespassers. The rationale was that the younger child (1 to 6 years), as a resident, will have access to affected on-site soils. The body weight for the future resident adult is assumed to be 70 kg.

ATs of 25,550 days for potential carcinogens and 8,760 days (24 years x 365 days/year) for noncarcinogenic constituents was used for estimating potential CDIs for adults. An AT of 2,190 days (6 years x 365 days/year) was used to estimate potential CDIs for children potentially exposed to noncarcinogens.

*Future Construction Worker*

During the course of excavation activities construction workers could potentially be exposed to potential COPCs through the incidental ingestion of subsurface soil. The IR for future construction workers exposed to subsurface soils was assumed to be 480 mg/day (USEPA, 1991c). An exposure frequency of 90 days per year was used in conjunction with an exposure duration of one year (USEPA, 1991c). An adult BW of 70 kg was used (USEPA, 1989). A summary of the exposure factors used in the estimation of soil CDIs associated with incidental ingestion are presented in Table 6-20.

#### 6.3.4.2 Dermal Contact with Soil

Chronic daily intakes associated with potential dermal contact of soils containing COPCs was expressed using the following equation:

$$CDI = \frac{C \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Where:

C = Contaminant concentration in soil (mg/kg)
CF = Conversion factor (kg/mg)
SA = Skin surface available for contact ($cm^2$)
AF = Soil to skin adherence factor ($mg/cm^2$)
ABS = Absorption factor (dimensionless)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

The following paragraphs discuss the exposure assumptions used in the estimation of potential COPCs with the potential dermal contact with soils.

*Military Personnel*

During construction activities, there is a potential for base personnel to absorb COPCs by dermal contact.

It was assumed that military personnel have approximately 5,800 $cm^2$ (USEPA, 1992e) of skin surface (SA) available for dermal exposure with COPCs. Exposed body parts are the hands, head, forearms and lower legs are 25% of the total body surface area (23,000 $cm^2$). Thus, applying 25% to the upper-bound total body surface area results in a default of 5,800 $cm^2$ for military personnel.

Values for exposure duration (ED), exposure frequency (EF), body weight (BW), and averaging time (AT) were the same as those used for the incidental ingestion of soil scenario.

*Future On-Site Residents*

Future on-site residents could also be potentially exposed to COPCs in on-site soil through dermal contact experienced during activities near their home.

Skin surface areas (SA) used in the on-site resident exposure scenario were developed for a reasonable worst case scenario for an individual wearing a short sleeve shirt, shorts, and shoes. The exposed skin surface area was limited to the head, hands, forearms, and lower legs. Thus, applying 25 percent of the total body surface area results in a default of 5,800 $cm^2$ for adults and 2,300 $cm^2$ for children. The child SA was calculated using information presented in Dermal Exposure Assessment: Principles and Applications (USEPA, 1992e).

Exposure duration, exposure frequencies, body weights and averaging times were the same as those discussed for the incidental ingestion scenario presented previously.

Data on soil adherence (AF) are limited. A value of 1.0 $mg/cm^2$ (USEPA, Region IV, 1992) was used in this assessment.

*Future Construction Worker*

Dermal contact with subsurface soil COPCs could potentially occur during excavation activities.

Skin surface area (SA) used for the construction worker exposure scenario were developed for an individual wear a short-sleeve shirt, long pants, and boots. The exposed skin surface area (4,300 $cm^2$) was limited to the head (1,180 $cm^2$), arms (2,280$cm^2$), and hands (840 $cm^2$) (USEPA, 1992).

The exposure frequency and exposure duration are the same as those discussed for incidental ingestion of subsurface soil.

Data on soil adherence (AF) are limited. A value of 1.0 $mg/cm^2$ (USEPA Region IV, 1992) is used in this assessment.

A summary of the soil exposure assessment input parameters for dermal contact are presented in Table 6-21.

#### 6.3.4.3 Inhalation of Fugitive Particulates

Exposure to fugitive particulates were estimated for future residents and civilian base personnel. These populations may be exposed during daily recreational or work-related activities. The chronic daily intake of contaminants associated with the inhalation of particulates was estimated using the following equation:

$$\mathrm{CDI} = \frac{\mathrm{C \times IR \times ET \times EF \times ED \times 1/PEF}}{\mathrm{BW \times AT}}$$

Where:

C = Contaminant concentration in soil (mg/kg)
IR = Inhalation rate ($m^3$/hr)
ET = Exposure time (hr/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
1/PEF = Particulate emission factor ($m^3$/kg)
BW = Body weight (kg)
AT = Averaging time (days)

The PEF relates the concentration in soil with the concentration of respirable particles in the air due to fugitive dust emissions from surface contamination. This relationship is derived by Cowherd (1985). The particulate emissions from contaminated sites are due to wind erosion, and, therefore, depend on erodibility of the surface material. A default PEF obtained from USEPA, 1989b was used in this assessment.

The following paragraphs discuss the exposure assumptions used in the estimation of potential COPCs with the potential inhalation of particulates.

### *Military Personnel*

During work related activities, there is a potential for military personnel to inhale COPCs emitted as fugitive dust. An inhalation rate 20 $m^3$/day will be used for military personnel (USEPA, 1991c). Values for exposure duration, exposure frequency, body weight, and averaging time were the same as those used for the incidental ingestion scenario.

### *Future On-Site Residents*

Future on-site residents could also be potentially exposed to COPCs in on-site soil through inhalation of particulates during activities near their home.

Inhalation rates (IR) used in the on-site resident exposure scenario were 20 $m^3$/day and 10 $m^3$/day for adults and children, respectively (USEPA, 1989b). Exposure frequencies, duration, body weight, and averaging time were the same as those used for the incidental ingestion scenario. Table 6-22 presents the exposure factors used to estimate CDIs associated with the particulate inhalation scenario.

### 6.3.4.4 Ingestion of Groundwater

Shallow groundwater is not currently being used as a potable supply at OU No. 1. Development of the shallow aquifer for potable use is unlikely because of the general water quality in the shallow zone and poor flow rates. However, there remains the possibility that upon closure of this facility, residential housing could be constructed and deep groundwater used for potable purposes in the future. Deep groundwater from OU No. 1 is currently used for potable purposes. However, supply wells which have been determined to be contaminated have been permanently abandoned. In addition, current operating wells are periodically monitored for control purposes.

The CDI of contaminants associated with the future potential consumption of groundwater were estimated using the following general equation:

$$\text{CDI} = \frac{\text{C} \times \text{IR} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

Where:

C = Contaminant concentration is groundwater (mg/l)
IR = Ingestion rate (L/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

The following paragraphs discuss the exposure assumptions used in the estimation of potential COPCs with the potential ingestion of groundwater.

*Future On-Site Residents*

Exposure to COPCs via ingestion of groundwater was retained as a potential future exposure pathway for both children and adults.

An IR of 1.0 L/day was used for the amount of water consumed by a 1 to 6 year old child weighing 15 kg. This ingestion rate provides a health conservative exposure estimate (for systemic, noncarcinogenic toxicants) designed to protect young children who could potentially be more affected than adolescents, or adults. This value assumes that children obtain all the tap water they drink from the same source for 350 days/year [which represents the exposure frequency (EF)]. An averaging time (AT) of 2,190 days (6 years x 265 days/year) is used for noncarcinogenic compound exposure.

The ingestion rate (IR) for adults was 2 liters/day (USEPA, 1989b). The ED used for the estimation of adult CDIs was 30 years (USEPA, 1989b), which represents the national upper-bound (90th percentile) time at one residence. The averaging time for noncarcinogens was 10,950 days. An averaging time (AT) of 25,550 days (70 years x 365 days/year) was used to evaluate exposure for both children and adults to potential carcinogenic compounds.

Table 6-23 presents a summary of the input parameters for the ingestion of groundwater scenarios.

### 6.3.4.5 Dermal Contact with Groundwater

Shallow groundwater is not currently being used as a potable supply at OU No. 1. However, there remains the possibility that upon closure of this facility residential housing could be constructed and groundwater used for residential purposes in the future.

The CDI associated with the dermal contact with groundwater was estimated using the following general equation:

$$\text{CDI} = \frac{\text{C x SA x PC x ET x EF x ED x CF}}{\text{BW x AT}}$$

Where:
C = Contaminant concentration is groundwater (mg/l)
SA = Surface area available for contact ($cm^2$)
PC = Dermal permeability constant (cm/hr)
ET = Exposure time (hour/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
CF = Conversion factor (1 L/1000$cm^3$)
BW = Body weight (kg)
AT = Averaging time (days)

The following paragraphs discuss the exposure assumptions used in the estimation of potential COPCs with potential dermal contact with groundwater.

*Future On-Site Residents*

Children and adults could contact COPCs through dermal contact with groundwater while bathing or showering.

It was assumed that bathing would take place 350 days/year using site groundwater as the sole source. The whole body skin surface area (SA) available for dermal absorption was estimated to be 10,000 $cm^2$ for children and 23,000 $cm^2$ for adults (USEPA, 1992). The permeability constant (PC) reflects the movement of a chemical across the skin and into the blood stream. The permeability of a chemical is an important property in evaluating actual absorbed dose, yet many compounds do not have literature PC values. For contaminants in which a PC value has not been established, the permeability constant for water (1.55E-03 cm/hr), was used (USEPA, 1992). This value may in fact be a realistic estimate of the adsorption rate of a chemical when COPC concentrations are in the part-per-billion range.

An exposure time (ET) of 0.25 hour/day was used to conservatively estimate the duration of bathing or showering. The exposure duration, body weight, and averaging time were the same as those used for the ingestion of groundwater scenario. Table 6-24 presents the exposure factors used to estimate CDIs associated with the future dermal contact with COPCs in groundwater.

### 6.3.4.6 Inhalation of Volatile Organics While Showering

In order to quantitatively assess the inhalation of contaminants volatilized from shower water, the model developed by Foster and Chrostowski (1986) was utilized. Contaminant concentrations in air, due to VOCs while showering, were modeled by estimating the following: the rate of chemical releases into air (generation rate), the buildup of VOCs in the shower room air while the shower was on, the decay of VOCs in the shower room after the shower was turned off, and the quantity of airborne VOCs inhaled while the shower was both on and off. The contaminant concentrations calculated to be in the air were then used as the concentration term.

The CDI associated with the inhalation of airborne (vapor phase) VOCs from groundwater while showering was estimated using the following general equation:

$$\text{CDI} = \frac{C \times IR \times ET \times EF \times ED}{BW \times AT}$$

Where:

C = Contaminant concentration in air ($mg/m^3$)
IR = Inhalation rate ($m^3/hr$)
ET = Exposure time (hr/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
$AT_c$ = Averaging time carcinogen (days)
$AT_{nc}$ = Averaging time noncarcinogen (days)

*Future On-Site Residents*

Both children and adults could inhale vaporized volatile organic COPCs during showering. It was assumed that showering would take place 350 days/year, using site groundwater as the sole source, for children weighing 15 kg, and adults weighing 70 kg (USEPA, 1992). An inhalation rate of 0.6 $m^3/hr$ was used for both receptors (USEPA, 1989b). An exposure time of 0.25 hrs/day was used for both receptors (USEPA, 1992). The exposure duration and averaging times remained the same as for groundwater ingestion.

Table 6-25 presents the exposure factors used to estimate CDIs associated with the inhalation of VOCs from groundwater while showering.

### 6.3.4.7 Incidental Ingestion of Surface Water

The CDI for contaminants associated with incidental ingestion of affected surface water was expressed using the following equation:

$$\text{CDI} = \frac{C \times IR \times ET \times EF \times ED}{BW \times AT}$$

Where:

C = Contaminant concentration in surface water (mg/l)
IR = Ingestion rate (liters/hour)
ET = Exposure time (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

The following paragraphs discuss the exposure assumptions used in the estimation of potential COPCs with potential incidental ingestion of surface water.

*Future On-Site Residents*

Adults and children who may potentially come into contact with the surface water were assumed to conservatively ingest surface water at a rate of 50 ml/hour; (USEPA, 1989b). In addition, a recommended exposure time (ET) of 2.6 hours/day, an exposure frequency (EF) of 20 days/year (4 days/month x 5 months) and an exposure duration (ED) of 6 years (age 1-6) for a child, and 30 years for an adult were used (USEPA, 1989b).

A summary of the surface water exposure factors associated with incidental ingestion of surface water are presented in Table 6-26.

### 6.3.4.8 Dermal Contact with Surface Water

The CDI of contaminants associated with the dermal contact of affected surface water was expressed using the following general equation:

Where:

$$CDI = \frac{CxCFxSAxPCxETxEFxED}{BWxAT}$$

C = Contaminant concentration in the surface water (mg/l)
CF = Conversion factor (1 L/1000cm$^3$)
SA = Surface area available for contact (cm$^2$)
PC = Permeability constant (cm/hour)
ET = Exposure time (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

The following paragraphs discuss the exposure assumptions used in the estimation of potential COPCs with potential dermal contact with surface water.

Because the surface water bodies associated with OU No. 1 are not sufficient in size to allow for swimming (whole-body immersion), a skin surface area for both adults and children was developed to quantify the risk.

The surface areas of the head, arms, hands, forearms, and lower extremities were used to estimate the risk to adults (11,500 $cm^2$) and children (4,600 $cm^2$) (USEPA, 1992b). Exposure time, frequency, and duration were the same as for the surface water ingestion scenario. The exposure factors for this potential exposure pathway are summarized in Table 6-27.

### 6.3.4.9 Incidental Ingestion of Sediment

The CDI of COPCs associated with the accidental ingestion of affected sediment was expressed using the following general equation:

$$CDI = \frac{C \times IR \times Fi \times EF \times ED \times CF}{BW \times AT}$$

Where:

C = Contaminant concentration in sediment (mg/kg)
IR = Ingestion rate of sediment (mg/day)
Fi = Fraction ingested from source (dimensionless)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
CF = Conversion factor (kg/mg)
BW = Body weight (kg)
AT = Averaging time (days)

The following paragraphs discuss the exposure assumptions used in the estimation of potential COPCs with potential incidental ingestion of sediments.

*Future On-Site Residents*

Accidental ingestion of COPCs in sediments is also possible during activities occurring in the surface water bodies at OU No. 1.

An ingestion rate (IR) of 100 mg/day was used in calculating the chronic daily intake for children and adults. The exposure frequency (EF) of 20 days/year (4 days/month x 5 months) was used as a conservative site-specific assumption. An exposure duration (ED) of 6 years was used in the estimation of potential COPCs for a child. A summary of exposure factors for this scenario are presented in Table 6-28.

### 6.3.4.10 Dermal Contact with Sediment

The CDI of contaminants associated with the dermal contact of affected sediments was expressed using the following general equation:

$$CDI = \frac{C \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Where:

$C$ = Contaminant concentration in sediment (mg/kg)
$CF$ = Conversion factor (kg/mg)
$SA$ = Surface area available for contact ($cm^2$/day)
$AF$ = Adherence factor (mg/$cm^2$)
$ABS$ = Absorption factor (dimensionless)
$EF$ = Exposure frequency (day/year)
$ED$ = Exposure duration (years)
$BW$ = Body weight (kg)
$AT$ = Averaging time (days)

The following paragraphs discuss the exposure assumptions used in the estimation of potential COPCs with potential dermal contact with sediment.

*Future On-Site Residents*

If surface water within the OU No. 1 were encountered, direct contact with sediments could occur.

Recreational activities in the surface water bodies within OU No. 1 would not involve swimming. Consequently, the body surface area potentially exposed would include the head, arms, hands, forearms, and lower extremities. Body surface areas of 4,600 $cm^2$ and 11,500 $cm^2$ (USEPA, 1992) were used to estimate risks to children and adults, respectively. Using professional site-specific assumptions, an exposure frequency was estimated to be 20 days/year (4 days/month x 5 months). An averaging time (AT) of 70 years or 25,550 days was used for exposure to potentially carcinogenic compounds. An averaging time of 365 days/year times the exposure duration was used for exposure to noncarcinogenic COPCs (USEPA, 1989b).

Table 6-29 provides a complete summary of the input parameters used in the estimation of CDIs for this scenario.

## 6.4 Toxicity Assessment

Section 6.3 identified potential exposure pathways and potentially affected populations for this BRA. This section will review the available toxicological information for the potential COPCs.

### 6.4.1 Toxicological Evaluation

The purpose of this section is to define the toxicological values used to evaluate the potential exposure to the potential COPCs identified in Section 6.2. A toxicological evaluation characterizes the inherent toxicity of a compound. It consists of the review of scientific data to determine the nature and extent of the potential human health and environmental effects associated with potential exposure to various contaminants.

Human data from occupational exposures are often insufficient for determining quantitative indices of toxicity because of uncertainties in exposure estimates, and inherent difficulties in determining causal relationships established by epidemiological studies. For this reason, animal bioassays are conducted under controlled conditions and their results are extrapolated to humans. There are several stages to this extrapolation. First, to account for species differences, conversion factors are used to extrapolate from test animals to humans. Second, the relatively high doses administered to test animals must be extrapolated to the lower doses more typical of human exposures. For potential noncarcinogens, safety factors and modifying factors are applied to animal results when developing acceptable human doses. For potential carcinogens, mathematical models are used to extrapolate effects at high doses to effects at lower doses. Epidemiological data can be used for inferential purposes to establish the credibility of the experimentally derived indices.

The available toxicological information indicates that many of the potential COPCs have both potential carcinogenic and noncarcinogenic health effects in humans and/or experimental animals. Although the potential COPCs may potentially cause adverse health and environmental impacts, dose-response relationships and the potential for exposure must be evaluated before the risk to receptors can be determined. Dose-response relationships correlate the magnitude of the dose with the probability of toxic effects, as discussed in the following section.

### 6.4.2 Dose-Response Evaluation

An important component of the risk assessment is the relationship between the dose of a compound (amount to which an individual or population is potentially exposed) and the potential for adverse health effects resulting from the exposure to that dose. Dose-response relationships provide a means by which potential public health impacts may be evaluated. The published information on doses and responses is used in conjunction with information on the nature and magnitude of exposure to develop an estimate of risk.

Standard carcinogenic slope factors (CSFs) and/or reference doses (RfDs) have been developed for many of the COPCs. This section provides a brief description of these parameters.

#### 6.4.2.1 Carcinogenic Slope Factor

CSFs are used to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen (USEPA, 1989b). This factor is generally reported in units of $(mg/kg/day)^{-1}$ and is derived through an assumed low-dosage linear multistage model and an extrapolation from high to low dose-responses determined from animal studies. The value used in reporting the slope factor is the upper 95th percent confidence limit.

These slope factors are also accompanied by USEPA WOE classifications which designate the strength of the evidence that the COPC is a potential human carcinogen.

In assessing the carcinogenic potential of a chemical, the Human Health Assessment Group (HHAG) of USEPA classifies the chemical into one of the following groups, according to the weight of evidence from epidemiologic and animal studies:

Group A - Human Carcinogen (sufficient evidence of carcinogenicity in humans)

Group B - Probable Human Carcinogen (B1 - limited evidence of carcinogenicity in humans; B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)

Group C - Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data)

Group D - Not Classifiable as to Human Carcinogenicity (inadequate or no evidence)

Group E - Evidence of Noncarcinogenicity for Humans (no evidence of carcinogenicity in adequate studies)

### 6.4.2.2 Reference Dose

The RfD is developed for chronic and/or subchronic human exposure to chemicals and is based solely on the noncarcinogenic effects of chemical substances. It is defined as an estimate of a daily exposure level for the human population, including sensitive populations, that is likely to be without an appreciable risk of adverse effects during a lifetime. The RfD is usually expressed as dose (mg) per unit body weight (kg) per unit time (day). It is generally derived by dividing a no-observed-(adverse)-effect-level (NOAEL or NOEL) or a lowest observed-adverse-effect-level (LOAEL) for the critical toxic effect by an appropriate "uncertainty factor (UF)". Effect levels are determined from laboratory or epidemiological studies. The UF is based on the availability of toxicity data.

UFs usually consist of multiples of 10, where each factor represents a specific area of uncertainty naturally present in the extrapolation process. These UFs are presented below and were taken from the "Risk Assessment Guidance Document for Superfund, Volume I, Human Health Evaluation Manual (Part A) (USEPA, 1989b):

- A UF of 10 is to account for variation in the general population and is intended to protect sensitive populations (e.g., elderly, children).

- A UF of 10 is used when extrapolating from animals to humans. This factor is intended to account for the interspecies variability between humans and other mammals.

- A UF of 10 is used when a NOAEL derived from a subchronic instead of a chronic study is used as the basis for a chronic RfD.

- A UF of 10 is used when a LOAEL is used instead of a NOAEL. This factor is intended to account for the uncertainty associated with extrapolating from LOAELs to NOAELs.

In addition to UF's, a modifying factor (MF) is applied to each reference dose and is defined as:

- A MF ranging from >0 to 10 is included to reflect a qualitative professional assessment of additional uncertainties in the critical study and in the entire data base for the chemical not explicitly addressed by the preceding uncertainty factors. The default for the MF is 1.

Thus, the RfD incorporates the uncertainty of the evidence for chronic human health effects. Even if applicable human data exist, the RfD still maintains a margin of safety so that chronic human health effects are not underestimated.

Toxicity factors and the USEPA WOE classifications are presented in Table 6-30. The hierarchy (USEPA, 1989b) for choosing these values was as follows:

- Integrated Risk Information System (IRIS);

- Health Effects Assessment Summary Table (HEAST).

The IRIS data base is updated monthly and contains both verified CSFs and RfDs. The USEPA has formed the Carcinogen Risk Assessment Verification Endeavor (CRAVE) Workgroup to review and validate toxicity values used in developing CSFs. Once the slope factors have been verified via extensive peer review, they appear in the IRIS data base. Like the CSF Workgroup, the USEPA has formed a RfD Workgroup to review existing data used to derive RfDs. Once the reference doses has been verified, they also appear in IRIS.

HEAST on the other hand, provides both interim (unverified) and verified CSFs and RFDs. This document is published quarterly and incorporates any applicable changes to its data base.

## 6.5 Risk Characterization

This section presents and discusses the estimated incremental lifetime cancer risks (ICRs) and hazard indices (HIs) for identified potential receptor groups which could be exposed to COPCs via the exposure pathways presented in Section 6.3.

These quantitative risk calculations for potentially carcinogenic compounds estimate ICRs levels for an individual in a specified population. This unit risk refers to the cancer risk that is over and above the background cancer risk in unexposed individuals. For example, an ICR of 1E-06 indicates that, for a lifetime exposure, one additional case of cancer may occur per one million exposed individuals.

The ICR to individuals was estimated from the following relationship:

$$ICR = \sum_{i=1}^{n} CDI_i \, x CSF_i$$

where CDIi is the chronic daily intake (mg/kg/day) for compound i and CSFi is the cancer slope [(mg/kg/day)-1] for contaminant i. The CSF is defined in most instances as an upper 95th percentile confidence limit of the probability of a carcinogenic response based on experimental animal data, and the CDI is defined as the exposure expressed as a mass of a substance contracted per unit body weight per unit time, averaged over a period of time (i.e., six years to a lifetime). The above equation was derived assuming that cancer is a non-threshold process and that the potential excess risk level is proportional to the cumulative intake over a lifetime.

In contrast to the above approach for potentially carcinogenic effects, quantitative risk calculations for noncarcinogenic compounds assume that a threshold toxicological effect exists. Therefore, the potential for noncarcinogenic effects are calculated by comparing CDIs with threshold levels (reference doses).

Noncarcinogenic effects were estimated by calculating the hazard index (HI) which is defined as:

$$HI = HQ_1 + HQ_2 + \ldots HQ_n$$

$$= \sum_{i=1}^{n} HQ_i$$

$$\text{where } HQ_i = CDI_i \, RfD_i$$

HQi is the hazard quotient for contaminant i, CDIi is the chronic daily intake (mg/kg/day) of contaminant i, and RfDi is the reference dose (mg/kg/day) of the contaminant i over a prolonged period of exposure.

### 6.5.1 Human Health Risks

The following paragraphs present the quantitative results of the human health evaluation for each medium and area of concern at OU No. 1.

Estimated ICRs were compared to the target risk range of 1E-04 to 1E-06. A value of 1.0 was used for examination of the HI. The HI was calculated by comparing estimated CDIs with threshold levels below which, noncarcinogenic health effects are not expected to occur. Any HI equal to or exceeding 1.0 suggested that noncarcinogenic health effects were possible. If the HI was less than 1.0, then systemic human health effects were considered unlikely.

#### 6.5.1.1 Soil

*Site 21*

Table 6-31 presents the ICR and HI values derived for the potential direct contact (dermal contact, incidental ingestion, and inhalation) of on-site surface and subsurface soils for Site 21 with the exception of future construction worker, soil ICR values for current receptors (military personnel) exceeded the upper bound value of the target risk range. Soil HI values estimated for current military personnel exceeded unity, suggesting that the occurrence of adverse systemic effects are likely. The ICR and HI values were driven primarily by the presence of PCBs at Site 21.

*Site 24*

The ICR and HI values estimated for potential exposures (dermal contact, incidental ingestion, and inhalation) of surface and subsurface are presented on Table 6-32. ICR values for current and future receptors (military personnel, residential children and adults, and construction workers) were either below or within the USEPA's target risk range. The HI estimated for future residential children (1.0) was the only HI to approach unity, suggesting that adverse systemic human health effects may occur. The HI values were driven primarily by arsenic, manganese, and vanadium.

#### 6.5.1.2 Groundwater

Table 6-33 presents the ICR and HI values derived for the potential exposure (ingestion, dermal contact, and inhalation) to groundwater. ICR values estimated for each potential receptor group (future residential children and adults) exceeded the USEPA's upper bound target risk value of 1E-04. The HI values estimated for both potential receptors exceeded unity, suggesting that the occurrence of adverse systemic health effects are likely. The ICR and HI values were driven by vinyl chloride, total arsenic, vanadium, and chromium.

#### 6.5.1.3 Surface Water/Sediments

*Cogdels Creek*

Table 6-34 presents the corresponding ICR and HI values associated with the ingestion and dermal contact of surface water and sediment within Cogdels Creek by potential future residential receptor groups (children and adults). Future potential exposure to residents contacting surface water/sediments produced ICR values within USEPA's target risk range. Similarly, HI values did not exceed or approach 1.0. No adverse health effects are, therefore, predicted.

*Beaver Dam Creek*

The ICR and HI values estimated for future potential receptors (children and adults) to ingestion and dermal contact of surface water and sediments within Beaver Dam Creek are presented on Table 6-35. Total ICR values for children and adults fell within the USEPA target risk range of 1E-04 to 1E-06. In addition, the HI values were well below unity, suggesting no adverse systemic human health effects are likely to occur subsequent to exposure.

### 6.6 Sources of Uncertainty

Uncertainties may be encountered throughout the process of performing a BRA. This section discusses the sources of uncertainty involved with the following:

- Analytical data;

- Exposure Assessment;
- Toxicity Assessment; and
- Compounds Not Qualitatively Evaluated

### 6.6.1 Analytical Data

The development of a BRA depends on the reliability of and uncertainties with the analytical data available to the risk assessor. Analytical data are limited by the precision and accuracy of the analytical method of analysis. For example, Contract Laboratory Program (CLP) methods have, in general, a precision of approximately plus or minus 50 percent depending on the sample media and the presence of interfering compounds. A value of 100 µg/kg could be as high as 150 µg/kg or as low as 50 µg/kg. In addition, the statistical methods used to compile and analyze the data (mean concentration, standard deviation, and detection frequencies) are subject to the uncertainty in the ability to acquire data.

Data validation serves to reduce some of the inherent uncertainty associated with the analytical data by establishing the usability of the data to the risk assessor who may or may not choose to include the data point in the estimation of risk. Data qualified as "J" (estimated) were retained for the estimation of risk at OU No. 1. Data can be qualified as estimated for many reason including a slight exceedance of holding times, high or low surrogate recovery, or intra sample variability. Organic data qualified "B" (detected in blank) or "R" (unreliable) were not used in the estimation of risk due to the unusable nature of the data. Due to the comprehensive sampling and analytical program at OU No. 1, the loss of some data points qualified "B" or "R" did not significantly increase the uncertainty in the estimation of risk.

### 6.6.2 Exposure Assessment

In performing exposure assessments, uncertainties can arise from two main sources. First, the chemical concentration to which a receptor may be exposed must be estimated for every medium of interest. Second, uncertainties can arise in the estimation of contaminant intakes resulting from contact by a receptor with a particular medium.

Estimating the contaminant concentration in a given medium to which a human receptor could potentially be exposed can be as simple as deriving the 95th percent upper confidence limit of the mean for a data set. More complex methods of deriving the contaminant concentration is necessary when exposure to COPCs in a given medium occurs subsequent to release from another medium, or analytical data are not available to characterize the release. In this case, modeling is usually employed to estimate the potential human exposure.

The potential inhalation of fugitive dusts from affected soils was estimated in the BRA using USEPA's Rapid Assessment of Exposure to Particulate Emissions from Surface Contaminated Sites (Cowherd et al. 1985). The Cowherd model employs the use of a site-specific PEF for a wind erosion based on source area and vegetative cover. A conservative estimate of the PEF was derived for OU No. 1 by assuming that the entire area was not covered with vegetation and was unlimited in its erosion potential. Modeling results for fugitive dust emission exposure suggested that the potential risk associated with this pathway was not significant.

Groundwater samples were analyzed for total (unfiltered) and dissolved (filtered) inorganic contaminants. These samples were obtained from wells which were constructed using USEPA Region IV monitoring well design specifications. Groundwater taken from monitoring wells cannot be considered representative of potable groundwater or groundwater which is obtained from a domestic well "at the tap". The use of total inorganic analytical results overestimates the potential human health risks associated with potable use scenarios. However, for the sake of conservatism, total organic results were used to estimate the potential intake associated with groundwater use.

Currently, the shallow groundwater is not used as a potable source. Current receptors (military personnel, military dependents, and civilian base personnel) are exposed to groundwater drawn from the deep zone via ingestion, dermal contact, and inhalation. Therefore, assessing current risks to contaminants detected in the shallow aquifer for current receptors is unnecessary and if estimated may present an unlikely risk. Therefore, groundwater exposures to current receptors was not estimated for this investigation.

Current and/or future potential exposure via ingestion of surface water while swimming was not assessed. The surface water bodies included in this investigation are not sufficient in size or depth to support recreational swimming, therefore, the probability of exposure via this route is very small and estimation of risk, via this route, may unnecessarily produce an unacceptable risk.

To estimate an intake, certain assumptions must be made about exposure events, exposure durations, and the corresponding assimilation of contaminants by the receptor. Exposure factors, have been generated by the scientific community and have undergone review by the

USEPA. Regardless of the validity of these exposure factors, they have been derived from a range of values generated by studies of limited number of individuals. In all instances, values used in the risk assessment, scientific judgments, and conservative assumptions agree with those of the USEPA. Conservative assumptions designed not to underestimate daily intakes were employed throughout the BRA and should error conservatively, thus adequately protecting human health and allowing the establishment of reasonable clean-up goals.

### 6.6.3 Toxicity Assessment

In making quantitative estimates of the toxicity of varying doses of a compound to human receptors, uncertainties arise from two sources. First, data on human exposure and the subsequent effects are usually insufficient, if they are available at all. Human exposure data usually lack adequate concentration estimations and suffer from inherent temporal variability. Therefore, animal studies are often used and therefore new uncertainties arise from the process of extrapolating animal results to humans. Second, to obtain observable effects with a manageable number of experimental animals, high doses of a compound are used over a relatively short time period. In this situation, a high dose means that experimental animal exposures are much greater than human environmental exposures. Therefore, when applying the results of the animal experiment to the human condition, the effects at the high doses must be extrapolated to approximate effects at lower doses.

In extrapolating effects from animals to humans and high doses to low doses, scientific judgment and conservative assumptions are employed. In selecting animal studies for use in dose response calculations, the following factors are considered:

- studies are preferred where the animal closely mimics human pharmacokinets,
- studies are preferred where dose intake most closely mimics the intake route and duration for humans, and
- studies are preferred which demonstrate the most sensitive response to the compound in question.

For compounds believed to cause threshold effects (i.e., noncarcinogens), safety factors are employed in the extrapolation of effects from animals to humans, and from high to low doses.

The use of conservative assumptions results in quantitative indices of toxicity that are not expected to underestimate potential toxic effects, but may overestimate these effects by an order of magnitude or more.

### 6.6.4 Compounds Not Quantitatively Evaluated

The following contaminants were not quantitatively evaluated in the BRA for OU No. 1 because toxicity information has not been promulgated by the USEPA:

- Phenanthene
- Copper
- Lead

The toxicity indices for TCE are under review by the USEPA. Updated values will be available in the future.

## 6.7 Conclusions of the BRA for OU No. 1

The BRA highlights the media of interest from the human health standpoint at OU No. 1 by identifying areas with elevated ICR and HI values. Current and future potential receptors at the site include current military personnel, future residents (i.e., children and adults), and future construction workers. The total risk from each site for the these receptors was estimated by logically summing the multiple pathways likely to affect the receptor during a given activity. The following algorithms defined the total site risk for the current and future potential receptor groups assessed in a quantitative manner. The risk associated with each site was derived using the estimated risk from multiple areas of interest.

1. Current Military Personnel

    a. Incidental ingestion of COPCs in surface soil + dermal contact with COPCs in surface soil + inhalation of airborne COPCs

2. Future Residents (Children and Adults)

    a. Incidental ingestion of COPCs in surface soil + dermal contact with COPCs in surface soil + inhalation of COPCs

   b. Ingestion of COPCs in groundwater + dermal contact with COPCs in groundwater + inhalation of volatile COPCs

   c. Incidental ingestion of COPCs in site related surface water + dermal contact with COPCs in site related surface water + incidental ingestion of site related sediment + dermal contact with site related sediment

3. Future Construction Worker

   a. Incidental ingestion of COPCs in subsurface soil + dermal contact with COPCs in subsurface soil

The total ICRs and HIs associated with current and future potential receptors at Site 21 are presented in Table 6-36. Exposures to soil (i.e., incidental ingestion and dermal contact) and groundwater (i.e., ingestion and dermal contact) were considered in the overall site risk. All total risks fell within the USEPA's acceptable risk range. Therefore, the contaminants detected at Site 21 do not appear to present an unacceptable risk to human health.

Future potential residential exposure (i.e., children and adults) to surface water and sediments (Beaver Dam Creek) did not produce ICRs in excess of the target risk range or HIs exceeding unity. Therefore, derivation of remediation levels for protection of human health is not necessary.

Table 6-37 presents the total ICRs and HIs associated with Site 24 potential current and future receptors. With the exception of future adult and child resident total site risk associated with groundwater exposure, all total site risks fall within the USEPA's acceptable risk range. The majority of the total site risk (greater than 90 percent) was associated with the ingestion and dermal contact of Operable Unit groundwater by future residents. Future potential exposure to OU NO. 1 groundwater produced ICRs and HIs for future adult residents of 2E-03 and 13, respectively. The ICRs and HIs for future child residents were 7E-04 and 29, respectively. Therefore, OU No. 1 must be considered a medium of interest for which remediation levels for protection of human health will be needed.

Future potential residential exposure (i.e., children and adults) to surface water and sediments (Cogdels Creek) did not produce ICRs in excess of the target risk range or HIs exceeding unity. Therefore, derivation of remediation levels for protection of human health is not necessary.

It is important to note that although lead could not be quantitatively evaluated in the BRA, lead was mainly detected in the shallow groundwater and not the deeper portions of the aquifer. Exposure is unlikely since the shallow groundwater is not conducive to usage.

# Section 6.0 Tables

## TABLE 6-1

## SURFACE SOIL ORGANIC DATA SUMMARY
## OPERABLE UNIT NO. 1 - SITE 21
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Surface Soil | |
|---|---|---|
| | Range of Positive Detections | No. of Positive Detects/ No. of Samples |
| Acetone | 300 | 1/9 |
| Xylenes (Total) | 1,100 | 1/9 |
| Naphthalene | 3,200 | 1/9 |
| 2-Methylnaphthalene | 13,000 | 1/9 |
| Fluorene | 1,300 | 1/9 |
| Phenanthrene | 41 - 1,800 | 5/9 |
| Anthracene | 47 | 1/9 |
| Fluoranthene | 51 - 560 | 5/9 |
| Pyrene | 69 - 520 | 5/9 |
| 3,3'-Dichlorobenzidine | 82 | 1/9 |
| Benzo(a)anthracene | 73 - 510 | 4/9 |
| Chrysene | 46 - 450 | 6/9 |
| Bis(2-ethylhexyl)phthalate | 51 - 650 | 2/9 |
| Benzo(b)fluoranthene | 80 - 560 | 5/9 |
| Benzo(k)fluoranthene | 48 - 320 | 5/9 |
| Benzo(a)pyrene | 60 - 310 | 5/9 |
| Indeno(1,2,3-cd)pyrene | 40 - 180 | 5/9 |
| Dibenz(a,h)anthracene | 62 | 1/9 |
| Benzo(g,h,i)perylene | 44 - 160 | 5/9 |
| 4,4'-DDE | 4.5 - 160 | 12/27 |
| 4,4'-DDD | 3.6 - 34,000 | 14/27 |
| 4,4'-DDT | 15 - 4,100 | 11/27 |
| Alpha-Chlordane | 6.2 - 1,800 | 4/27 |
| Gamma-Chlordane | 4.6 - 2,200 | 6/27 |
| PCB 1260 | 34 - 4,600 | 10/30 |

Notes: Concentrations expressed in microgram per kilogram (µg/kg)

## TABLE 6-2

## SURFACE SOIL INORGANIC DATA SUMMARY
## OPERABLE UNIT NO. 1 - SITE 21
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Inorganic | Surface Soil (0-6 inches) | | | | |
|---|---|---|---|---|---|
| | Average Base-Specific Background Concentration Range(1) | Twice the Average Base-Specific Maximum Concentration | Range of Positive Detections | No. of Positive Detects/ No. of Samples | No. of Times Exceeded Twice the Average Background Concentration |
| Aluminum | 729.65 | 1459.3 | 1,120 - 7,320 | 9/9 | 8 |
| Arsenic | 0.40 | 0.80 | 0.76 - 3.9 | 9/9 | 8 |
| Barium | 6.53 | 13.1 | 9.1 - 31.6 | 9/9 | 7 |
| Beryllium | 0.07 | 0.1 | 0.21 - 0.22 | 4/9 | 4 |
| Cadmium | 0.38 | 0.8 | 1 | 1/9 | 1 |
| Calcium | 2465.8 | 4931.6 | 14,000-183,000 | 9/9 | 9 |
| Chromium | 1.02 | 2.0 | 5.8 - 19.9 | 9/9 | 9 |
| Cobalt | 0.79 | 1.6 | 2.1 - 2.4 | 2/9 | 2 |
| Copper | 1.4 | 2.8 | 3.1 - 16.3 | 9/9 | 9 |
| Iron | 525.4 | 1050.8 | 2,030 - 6,730 | 9/9 | 9 |
| Lead | 22.68 | 45.4 | 10.9 - 252 | 9/9 | 2 |
| Magnesium | 73.15 | 146.3 | 344 - 2,700 | 9/9 | 9 |
| Manganese | 7.14 | 14.3 | 13.8 - 70 | 9/9 | 8 |
| Mercury | 0.04 | 0.1 | 0.54 | 1/9 | 1 |
| Nickel | 1.40 | 2.80 | 4.8 - 6 | 2/9 | 0 |
| Potassium | 52.23 | 104.5 | 121 - 451 | 9/9 | 9 |
| Selenium | 0.45 | 0.9 | 0.32 - 0.59 | 6/9 | 0 |
| Silver | 0.53 | 1.1 | ND | 0/9 | 0 |
| Sodium | 24.34 | 48.7 | 67.8 - 429 | 9/9 | 9 |
| Vanadium | 2.31 | 4.6 | 4.2 - 17.4 | 9/9 | 8 |
| Zinc | 11.47 | 22.9 | 14.5 - 67.7 | 9/9 | 4 |

Notes: Concentrations expressed in milligram per kilogram (mg/kg).

(1) Soil background concentrations are based on reference background soil samples collected from MCB Camp Lejeune investigations.

## TABLE 6-3

## SURFACE SOIL ORGANIC DATA SUMMARY
## OPERABLE UNIT NO. 1 - SITE 24
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Surface Soil | |
|---|---|---|
| | Range of Positive Detections | No. of Positive Detects/ No. of Samples |
| Acetone | 14 - 780 | 8/25 |
| Styrene | 5 | 1/25 |
| 2-Methylnaphthalene | 110 | 1/25 |
| Acenaphthene | 68 | 1/25 |
| Fluorene | 47 | 1/25 |
| Phenanthrene | 380 | 1/25 |
| Anthracene | 73 | 1/25 |
| Carbazole | 36 | 1/25 |
| Fluoranthene | 39 - 520 | 4/25 |
| Pyrene | 57 - 870 | 3/25 |
| Butyl Benzyl Phthalate | 39 | 1/25 |
| Benzo(a)anthracene | 330 | 1/25 |
| Chrysene | 63 - 260 | 2/25 |
| Bis(2-ethylhexyl)phthalate | 36 - 60 | 2/25 |
| Benzo(b)fluoranthene | 91 - 350 | 2/25 |
| Benzo(k)fluoranthene | 140 | 1/25 |
| Benzo(a)pyrene | 240 | 1/25 |
| Indeno(1,2,3-cd)pyrene | 240 | 1/25 |
| Benzo(g,h,i)perylene | 140 | 1/25 |
| Heptachlor | 1.8 | 1/25 |
| Heptachlor epoxide | 5 | 1/25 |
| Dieldren | 4.1 - 13 | 5/25 |
| 4,4'-DDE | 8.4 - 350 | 9/25 |
| 4,4'-DDD | 4.9 - 130 | 9/25 |
| 4,4'-DDT | 5.2 - 320 | 10/25 |
| Alpha-chlordane | 2.2 - 26 | 8/25 |
| Gamma-chlordane | 2.2 - 24 | 7/25 |
| PCB 1254 | 85 | 1/25 |
| PCB 1260 | 130 | 1/25 |

Notes: Concentrations expressed in microgram per kilogram (µg/kg)

## TABLE 6-4

## SURFACE SOIL INORGANIC DATA SUMMARY
## OPERABLE UNIT NO. 1 - SITE 24
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Inorganic | Surface Soil (0-6 inches) | | | | |
|---|---|---|---|---|---|
| | Average Base-Specific Background Concentration Range(1) | Twice the Average Base-Specific Maximum Concentration | Range of Positive Detections | No. of Positive Detects/ No. of Samples | No. of Times Exceeded Twice the Average Background Concentration |
| Aluminum | 729.65 | 1459.3 | 88.2 - 18,700 | 38/38 | 29 |
| Arsenic | 0.40 | 0.80 | 0.43 - 35.2 | 31/38 | 21 |
| Barium | 6.53 | 13.1 | 4.4 - 502 | 38/38 | 22 |
| Beryllium | 0.07 | 0.1 | 0.2 - 4 | 18/38 | 18 |
| Cadmium | 0.38 | 0.8 | 1.6 - 1.9 | 2/38 | 2 |
| Calcium | 2465.8 | 4931.6 | 73.2 - 356,000 | 37/38 | 8 |
| Chromium | 1.02 | 2.0 | 2 - 23 | 30/38 | 30 |
| Cobalt | 0.79 | 1.6 | 2 - 14.4 | 7/38 | 7 |
| Copper | 1.4 | 2.8 | 0.45 - 314 | 38/38 | 23 |
| Iron | 525.4 | 1050.8 | 249 - 13,900 | 38/38 | 22 |
| Lead | 22.68 | 45.4 | 1.5 - 393 | 38/38 | 2 |
| Magnesium | 73.15 | 146.3 | 22.7 - 3,330 | 38/38 | 22 |
| Manganese | 7.14 | 14.3 | 3 - 93.4 | 38/38 | 18 |
| Mercury | 0.04 | 0.1 | 0.15 - 1.2 | 7/38 | 7 |
| Nickel | 1.40 | 2.80 | 6 - 80.8 | 6/38 | 6 |
| Potassium | 52.23 | 104.5 | 24.8 - 1,890 | 36/38 | 22 |
| Selenium | 0.45 | 0.9 | 0.25 - 18 | 18/38 | 4 |
| Silver | 0.53 | 1.1 | 1.3 | 1/38 | 1 |
| Sodium | 24.34 | 48.7 | 16.5 - 373 | 36/38 | 24 |
| Vanadium | 2.31 | 4.6 | 1.3 - 634 | 38/38 | 29 |
| Zinc | 11.47 | 22.9 | 2.4 - 93.8 | 36/38 | 7 |

Notes: Concentrations expressed in milligram per kilogram (mg/kg).

(1) Soil background concentrations are based on reference background soil samples collected from MCB Camp Lejeune investigations.

## TABLE 6-5

## SUBSURFACE SOIL ORGANIC DATA SUMMARY
## OPERABLE UNIT NO. 1 - SITE 21
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Subsurface Soil | |
|---|---|---|
| | Range of Positive Detections | No. of Positive Detects/ No. of Samples |
| Methylene Chloride | 12 | 1/15 |
| Acetone | 470 | 1/15 |
| Toluene | 37 | 1/15 |
| Ethylbenzene | 570 | 1/15 |
| Xylenes (Total) | 3,400 | 1/15 |
| Naphthalene | 2,100 | 1/15 |
| 2-Methylnaphthalene | 10,000 | 1/15 |
| Bis(2-ethylhexyl)phthalate | 57 - 190 | 3/15 |
| 4,4'-DDD | 5.7 - 2,800 | 3/33 |
| 4,4'-DDT | 4.6 - 12 | 3/33 |
| Alpha-Chlordane | 59 | 1/33 |
| Gamma-Chlordane | 90 | 1/33 |

Notes: Concentrations expressed in microgram per kilogram (µg/kg)

# TABLE 6-6

## SUBSURFACE SOIL INORGANIC DATA SUMMARY
## OPERABLE UNIT NO. 1 - SITE 21
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Inorganic | Subsurface Soil (6 inches and below) | | | | |
|---|---|---|---|---|---|
| | Average Base-Specific Background Concentration Range(1) | Twice the Average Base-Specific Maximum Concentration | Range of Positive Detections | No. of Positive Detects/ No. of Samples | No. of Times Exceeded Twice the Average Background Concentration |
| Aluminum | 4473.17 | 8946.3 | 1,150 - 14,500 | 15/15 | 3 |
| Arsenic | 0.28 | 0.6 | 0.48 - 5.2 | 15/15 | 13 |
| Barium | 5.94 | 11.9 | 2.1 - 15.6 | 15/15 | 5 |
| Beryllium | 0.10 | 0.20 | 0.23 - 0.26 | 8/15 | 8 |
| Cadmium | 0.52 | 1.0 | 1.5 | 1/15 | 1 |
| Calcium | 754.13 | 1508.3 | 44.6 - 37,200 | 14/15 | 2 |
| Chromium | 4.34 | 8.7 | 2.6 - 19.7 | 15/15 | 9 |
| Cobalt | 0.80 | 1.6 | 1.8 - 2.2 | 4/15 | 4 |
| Copper | 0.81 | 1.6 | 0.96 - 3.4 | 15/15 | 8 |
| Iron | 8.89 | 1778 | 791 - 9,720 | 15/15 | 15 |
| Lead | 4.57 | 9.1 | 2.6 - 24.8 | 15/15 | 3 |
| Magnesium | 115.6 | 231.2 | 33.3 - 926 | 15/15 | 12 |
| Manganese | 3.10 | 6.2 | 2.9 - 40.6 | 15/15 | 6 |
| Mercury | 0.04 | 0.1 | ND | 0/15 | 0 |
| Nickel | 1.98 | 4.0 | 4.6 - 5.8 | 2/15 | 2 |
| Potassium | 111.40 | 222.8 | 49.2 - 574 | 15/15 | 11 |
| Selenium | 0.41 | 0.8 | 0.23 - 0.46 | 11/15 | 0 |
| Sodium | 20.29 | 40.6 | 41.4 - 108 | 13/15 | 13 |
| Vanadium | 50.4 | 10.1 | 3.6 - 22.4 | 15/15 | 11 |
| Zinc | 2.81 | 5.6 | 2.5 - 18.1 | 15/15 | 8 |

Notes: Concentrations expressed in milligram per kilogram (mg/kg).

(1) Soil background concentrations are based on reference background soil samples collected from MCB Camp Lejeune investigations.

## TABLE 6-7

## SUBSURFACE SOIL ORGANIC DATA SUMMARY
## OPERABLE UNIT NO. 1 - SITE 24
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Subsurface Soil | |
|---|---|---|
| | Range of Positive Detections | No. of Positive Detects/ No. of Samples |
| Methylene Chloride | 33 - 120 | 3/44 |
| Acetone | 12 - 1,800 | 15/44 |
| Carbon Disulfide | 4 - 8 | 4/44 |
| 2-Butanone | 480 | 1/44 |
| Di-n-butyl phthalate | 74 | 1/44 |
| Fluoranthene | 45 | 1/44 |
| Bis(2-ethylhexyl)phthalate | 44 - 1,000 | 8/44 |
| 4,4'-DDD | 4.4 - 19 | 7/44 |
| 4,4'-DDT | 4 - 220 | 10/44 |

Notes: Concentrations expressed in microgram per kilogram (µg/kg)

## TABLE 6-8

## SUBSURFACE SOIL INORGANIC DATA SUMMARY
## OPERABLE UNIT NO. 1 - SITE 24
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| | Subsurface Soil (6 inches and below) | | | | |
|---|---|---|---|---|---|
| Inorganic | Average Base-Specific Background Concentration Range$^{(1)}$ | Twice the Average Base-Specific Maximum Concentration | Range of Positive Detections | No. of Positive Detects/ No. of Samples | No. of Times Exceeded Twice the Average Background Concentration |
| Aluminum | 4473.17 | 8946.3 | 964 - 19,800 | 59/59 | 14 |
| Arsenic | 0.28 | 0.6 | 0.46 - 15 | 39/59 | 31 |
| Barium | 5.94 | 11.9 | 3 - 628 | 59/59 | 17 |
| Beryllium | 0.10 | 0.20 | 0.2 - 3.8 | 29/59 | 29 |
| Cadmium | 0.52 | 1.0 | ND | 0/59 | 0 |
| Calcium | 754.13 | 1508.3 | 20.9 - 62,200 | 46/59 | 8 |
| Chromium | 4.34 | 8.7 | 2.1 - 32.8 | 57/59 | 22 |
| Cobalt | 0.80 | 1.6 | 1.8 - 13.8 | 12/59 | 12 |
| Copper | 0.81 | 1.6 | 0.44 - 55 | 59/59 | 19 |
| Iron | 889 | 1778 | 411 - 17,300 | 59/59 | 21 |
| Lead | 4.57 | 9.1 | 1.3 - 19.3 | 59/59 | 4 |
| Magnesium | 115.6 | 231.2 | 29.8 - 2,950 | 57/59 | 23 |
| Manganese | 3.1 | 6.2 | 1.6 - 113 | 52/59 | 13 |
| Mercury | 0.04 | 0.1 | 0.11 - 0.29 | 4/59 | 4 |
| Nickel | 1.98 | 4.0 | 8 - 96.2 | 4/59 | 4 |
| Potassium | 111.40 | 222.8 | 51.6 - 1,710 | 59/59 | 41 |
| Selenium | 0.41 | 0.8 | 0.25 - 11.9 | 19/59 | 5 |
| Sodium | 20.29 | 40.6 | 16.6 - 729 | 58/59 | 38 |
| Vanadium | 50.4 | 10.1 | 2 - 594 | 59/59 | 27 |
| Zinc | 2.81 | 5.6 | 1.3 - 20.1 | 46/59 | 17 |

Notes: Concentrations expressed in milligram per kilogram (mg/kg).

(1) Soil background concentrations are based on reference background soil samples collected from MCB Camp Lejeune investigations.

## TABLE 6-9

## SUBSURFACE SOIL ORGANIC DATA SUMMARY
## OPERABLE UNIT NO. 1 - SITE 78
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Subsurface Soil | |
|---|---|---|
| | Range of Positive Detections | No. of Positive Detects/ No. of Samples |
| Acetone | 14 - 210 | 15/29 |
| Total 1,2-Dichloroethene | 6 - 16 | 2/29 |
| Toluene | 3 | 1/29 |
| Ethylbenzene | 55 | 1/29 |
| Xylenes (total) | 450 | 1/29 |
| Naphthalene | 74 - 850 | 2/29 |
| 2-Methyl naphthalene | 890 | 1/29 |
| Acenaphthene | 97 | 1/29 |
| Phenanthrene | 220 - 590 | 2/29 |
| Anthracene | 150 | 1/29 |
| Carbazole | 89 | 1/29 |
| Di-n-butyl phthalate | 83 - 100 | 2/29 |
| Fluoranthene | 160 - 700 | 2/29 |
| Pyrene | 110 - 480 | 2/29 |
| Benzo(a)anthracene | 320 | 1/29 |
| Chrysene | 300 | 1/29 |
| Bis(2-ethylhexyl)phthalate | 81 - 120 | 2/29 |
| Benzo(b)fluoranthene | 170 | 1/29 |
| Benzo(k)fluoranthene | 190 | 1/29 |
| Benzo(a)pyrene | 170 | 1/29 |
| Indeno(1,2,3-cd)pyrene | 100 | 1/29 |
| Benzo(g,h,i)perylene | 95 | 1/29 |
| Dieldren | 1.3 | 1/44 |
| 4,4'-DDE | 2.1 - 34 | 4/44 |
| 4,4'-DDD | 4 - 48 | 4/44 |
| 4,4'-DDT | 3.1 - 9.7 | 4/44 |

Notes: Concentrations expressed in microgram per kilogram (µg/kg)

## TABLE 6-10

## SUBSURFACE SOIL INORGANIC DATA SUMMARY
## OPERABLE UNIT NO. 1 - SITE 78
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| | Subsurface Soil (6 inches and below) | | | | |
|---|---|---|---|---|---|
| Inorganic | Average Base-Specific Background Concentration Range(1) | Twice the Average Base-Specific Maximum Concentration | Range of Positive Detections | No. of Positive Detects/ No. of Samples | No. of Times Exceeded Twice the Average Background Concentration |
| Aluminum | 4473.17 | 8946.3 | 2,730 - 14,100 | 16/16 | 3 |
| Arsenic | 0.28 | 0.6 | 0.49 - 6.2 | 10/16 | 8 |
| Barium | 5.94 | 11.9 | 2.8 - 13 | 16/16 | 2 |
| Beryllium | 0.10 | 0.20 | 0.26 | 1/16 | 1 |
| Cadmium | 0.52 | 1.0 | ND | 0/16 | 0 |
| Calcium | 754.13 | 1508.3 | 29.1 - 297 | 16/16 | 0 |
| Chromium | 4.34 | 8.7 | 4.2 - 18.5 | 15/16 | 4 |
| Cobalt | 0.80 | 1.6 | ND | 0/16 | 0 |
| Copper | 0.81 | 1.6 | 0.51 - 3.4 | 16/16 | 3 |
| Iron | 889 | 1778 | 462 - 5,890 | 16/16 | 9 |
| Lead | 4.57 | 9.1 | 1 - 6.5 | 16/16 | 0 |
| Magnesium | 115.6 | 231.2 | 101 - 458 | 16/16 | 4 |
| Manganese | 3.1 | 6.2 | 1.6 - 9.2 | 16/16 | 2 |
| Mercury | 0.04 | 0.1 | ND | 0/16 | 0 |
| Nickel | 1.98 | 4.0 | ND | 0/16 | 0 |
| Potassium | 111.40 | 222.8 | 88 - 280 | 16/16 | 6 |
| Selenium | 0.41 | 0.8 | 0.26 - 1.2 | 5/16 | 1 |
| Sodium | 20.29 | 40.6 | 30.2 - 93 | 16/16 | 8 |
| Vanadium | 5.04 | 10.1 | 2.2 - 19.2 | 16/16 | 5 |
| Zinc | 2.81 | 5.6 | 1.4 - 7.9 | 16/16 | 1 |

Notes: Concentrations expressed in milligram per kilogram (mg/kg).

(1) Soil background concentrations are based on reference background soil samples collected from MCB Camp Lejeune investigations.

## TABLE 6-11

## GROUNDWATER DATA SUMMARY
## OPERABLE UNIT NO. 1
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| | Groundwater Criteria | | | | Frequency/Range | | Comparison to Criteria | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Federal Health Advisories(3) | | | | | | No. of Detects Above Health Advisories | |
| Contaminant | NCWQS(1) | MCL(2) | 10 kg Child | 70 kg Adult | No. of Positive Detects/ No. of Samples | Concen-tration Range | No. of Detects Above NCWQS | No. of Detects Above MCL | 10 kg Child | 70 kg Adult |
| Vinyl Chloride | 0.015 | 2.0 | 3,000 | 50 | 1/51 | 97 | 1 | 1 | 0 | 1 |
| Dichlorodifluoromethane | 0.19 | -- | 9,000 | 30,000 | 1/51 | 2 | 1 | NA | 0 | 0 |
| Trichlorofluoromethane | -- | -- | -- | -- | 1/51 | 1 | NA | NA | NA | NA |
| Dichloromethane | 5.0 | 5.0 | -- | -- | 6/51 | 1 - 2 | 0 | 0 | NA | NA |
| 1,1-Dichloroethene | 7.0 | 7.0 | 1,000 | 4,000 | 1/51 | 7 | 0 | 0 | 0 | 0 |
| cis-1,2-Dichloroethene | 70 | 70 | 3,000 | 11,000 | 5/51 | 1 - 14,000 | 1 | 1 | 1 | 1 |
| trans-1,2-Dichloroethene | 70 | 100 | 2,000 | 6,000 | 3/51 | 1 - 190 | 2 | 2 | 0 | 0 |
| Chloroform | 0.19 | 100 | 100 | 400 | 2/51 | 1 - 8 | 2 | 0 | 0 | 0 |
| 1,2-Dichloroethane | 0.38 | 5.0 | 700 | 2,600 | 1/51 | 1 | 1 | 0 | 0 | 0 |
| Bromodichloromethane | -- | 100 | 7,000 | 13,000 | 1/51 | 1 | NA | 0 | 0 | 0 |
| 1,2-Dichloropropane | 0.56 | 5.0 | -- | -- | 1/51 | 1 | 1 | 0 | NA | NA |
| Trichloroethene | 2.8 | 5.0 | -- | -- | 9/51 | 1 - 440 | 5 | 4 | NA | NA |
| Benzene | 1.0 | 5.0 | -- | -- | 7/51 | 5 - 9,200 | 7 | 7 | NA | NA |
| 1,1,2-Trichloroethane | -- | 5.0 | 600 | 1,000 | 1/51 | 2 | NA | 0 | 0 | 0 |
| Tetrachloroethene | 0.7 | 5.0 | 2,000 | 5,000 | 3/51 | 1 | 1 | 0 | 0 | 0 |
| Toluene | 1,000 | 1,000 | 2,000 | 7,000 | 3/51 | 2 - 18,000 | 1 | 1 | 1 | 1 |
| Ethylbenzene | 29 | 700 | 30,000 | 3,000 | 3/51 | 5 - 3,000 | 2 | 1 | 0 | 1 |
| Total Xylenes | 400 | 10,000 | 40,000 | 100,000 | 4/51 | 1 - 16,000 | 2 | 1 | 0 | 0 |
| Phenol | -- | -- | 6,000 | 20,000 | 8/51 | 2 - 8 | NA | NA | 0 | 0 |
| 2-Methylphenol | -- | -- | -- | -- | 1/51 | 2 | NA | NA | NA | NA |
| 4-Methylphenol | -- | -- | -- | -- | 1/51 | 2 | NA | NA | NA | NA |

Notes: Concentrations expressed in microgram per liter (µg/l)
(1) NCWQS = North Carolina Water Quality Standards for Groundwater
(2) MCL = Safe Drinking Water Act Maximum Contaminant Level
(3) Longer Term Health Advisories for a 10kg Child and 70 kg Adult
(4) SMCL = Secondary Maximum Contaminant Level
(5) -- = No Criteria Published
(6) NA = Not Applicable

## TABLE 6-11 (Continued)

### GROUNDWATER DATA SUMMARY
### OPERABLE UNIT NO. 1
### REMEDIAL INVESTIGATION CTO-0177
### MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Groundwater Criteria | | | | Frequency/Range | | Comparison to Criteria | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | NCWQS(1) | MCL(2) | Federal Health Advisories(3) 10 kg Child | Federal Health Advisories(3) 70 kg Adult | No. of Positive Detects/ No. of Samples | Concentration Range | No. of Detects Above NCWQS | No. of Detects Above MCL | No. of Detects Above Health Advisories 10 kg Child | No. of Detects Above Health Advisories 70 kg Adult |
| 2-4-Dimethylphenol | -- | -- | -- | -- | 1/51 | 6 | NA | NA | NA | NA |
| Naphthalene | -- | -- | 400 | 1,000 | 6/51 | 2 - 260 | NA | NA | 0 | 0 |
| 2-Methylnaphthalene | -- | -- | -- | -- | 2/51 | 20 - 36 | NA | NA | NA | NA |
| Acenaphthene | -- | -- | -- | -- | 1/51 | 3 | NA | NA | NA | NA |
| Phenanthrene | -- | -- | -- | -- | 1/51 | 2 | NA | NA | NA | NA |
| Carbazole | -- | -- | -- | -- | 2/51 | 3 - 12 | NA | NA | NA | NA |
| Fluoranthene | -- | -- | -- | -- | 1/51 | 2 | NA | NA | NA | NA |
| Butyl Benzyl Phthalate | -- | -- | -- | -- | 1/51 | 3 | NA | NA | NA | NA |
| Bis(2-ethylhexyl)phthalate | -- | 6 | -- | -- | 5/51 | 2 - 18 | NA | 1 | NA | NA |
| Di-n-octyl phthalate | -- | -- | -- | -- | 1/51 | 2 | NA | NA | NA | NA |
| Benzo(b)fluoranthene | -- | -- | -- | -- | 1/51 | 2 | NA | NA | NA | NA |
| Heptachlor Epoxide | 0.038 | 0.2 | 0.1 | 0.1 | 3/54 | 0.078 - 0.13 | 3 | 0 | 1 | 1 |
| Dieldren | -- | -- | 0.5 | 2.0 | 1/54 | 0.2 | NA | NA | 0 | 0 |
| Alpha-Chlordane | 0.027 | 2.0 | -- | -- | 1/54 | 0.11 | 1 | 0 | NA | NA |
| Antimony | -- | 6.0 | 15 | 15 | 7.33 | 3.3 - 169 | NA | 3 | 2 | 2 |
| Arsenic | 50 | 50 | -- | -- | 44/48 | 2.3 - 405 | 8 | 8 | NA | NA |
| Barium | 1,000 | 2,000 | -- | -- | 59/59 | 17 - 1,250 | 4 | 0 | NA | NA |
| Beryllium | -- | 4.0 | 30,000 | 20,000 | 52/59 | 1 - 19 | NA | 18 | 0 | 0 |
| Cadmium | 5.0 | 5.0 | 40 | 20 | 9/59 | 5 - 21 | 9 | 9 | 0 | 1 |
| Chromium | 5.0 | 100 | 1,000 | 800 | 46/59 | 10-858 | 27 | 26 | 0 | 1 |

Notes: Concentrations expressed in microgram per liter (µg/l)
(1) NCWQS = North Carolina Water Quality Standards for Groundwater
(2) MCL = Safe Drinking Water Act Maximum Contaminant Level
(3) Longer Term Health Advisories for a 10kg Child and 70 kg Adult
(4) SMCL = Secondary Maximum Contaminant Level
(5) -- = No Criteria Published
(6) NA = Not Applicable

## TABLE 6-11 (Continued)

## GROUNDWATER DATA SUMMARY
## OPERABLE UNIT NO. 1
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| | Groundwater Criteria | | | | Frequency/Range | | Comparison to Criteria | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Federal Health Advisories(3) | | | | | | No. of Detects Above Health Advisories | |
| Contaminant | NCWQS(1) | MCL(2) | 10 kg Child | 70 kg Adult | No. of Positive Detects/ No. of Samples | Concentration Range | No. of Detects Above NCWQS | No. of Detects Above MCL | 10 kg Child | 70 kg Adult |
| Cobalt | -- | -- | -- | -- | 25/59 | 8-170 | NA | NA | NA | NA |
| Copper | 1,000 | 1,300 | -- | -- | 58/59 | 3-699 | 0 | 0 | NA | NA |
| Lead | 50 | 15 | -- | -- | 50/59 | 2.9-2000 | 20 | 37 | NA | NA |
| Manganese | 50 | 50(4) | -- | -- | 57/59 | 2-714 | 44 | 44 | NA | NA |
| Mercury | 1.1 | 2.0 | -- | 2.0 | 24/52 | 0.23-3.2 | 5 | 3 | NA | 3 |
| Nickel | 150 | 100 | 500 | 1,700 | 31/59 | 20-234 | 2 | 7 | 0 | 0 |
| Thallium | -- | 2 | 7 | 20 | 16/59 | 1-7.3 | NA | 3 | 1 | 0 |
| Selenium | 10 | 50 | -- | -- | 41/54 | 1.1-99.5 | 12 | 1 | NA | NA |
| Vanadium | -- | -- | -- | -- | 55/59 | 4-1700 | NA | NA | NA | NA |
| Zinc | 5,000 | 5,000 | 6,000 | 12,000 | 57/59 | 6-967 | 0 | 0 | 0 | 0 |

Notes: Concentrations expressed in microgram per liter (µg/l)

(1) NCWQS = North Carolina Water Quality Standards for Groundwater
(2) MCL = Safe Drinking Water Act Maximum Contaminant Level
(3) Longer Term Health Advisories for a 10kg Child and 70 kg Adult
(4) SMCL = Secondary Maximum Contaminant Level
(5) -- = No Criteria Published
(6) NA = Not Applicable

## TABLE 6-12

## SURFACE WATER DATA SUMMARY
## OPERABLE UNIT NO. 1 - COGDELS CREEK
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Surface Water Criteria | | | Contaminant Frequency/Range | | Comparison to Criteria | | |
|---|---|---|---|---|---|---|---|---|
| | NCWQS(1) | Federal Health AWQCs(2) | | No. of Positive Detects/ No. of Samples | Contaminant Range | Positive Detects Above NCWQS | Positive Detects Above AWQC | |
| | | Acute | Chronic | | | | Acute | Chronic |
| Methylene Chloride | -- | -- | -- | 1/20 | 5 | NA | NA | NA |
| Acetone | -- | -- | -- | 2/19 | 11-16 | NA | NA | NA |
| Total 1,2-dichloroethene | -- | -- | -- | 1/20 | 6 | NA | NA | NA |
| Trichloroethene | -- | 2,000(3) | -- | 4/20 | 3-47 | NA | 0 | NA |
| Toluene | -- | 6,300(3) | 5,000(3) | 1/20 | 3 | NA | 0 | 0 |
| Di-n-butylphthalate | -- | -- | -- | 2/20 | 2 | NA | NA | NA |
| Bis (2-ethylhexyl) phthalate | -- | -- | -- | 4/20 | 2-33 | NA | NA | NA |
| 4,4'-DDD | -- | -- | -- | 2/20 | 0.13-0.19 | NA | NA | NA |
| 4,4'-DDT | 0.001 | 0.13 | 0.001 | 1/20 | 0.18 | 1 | 1 | 1 |
| Arsenic | 50 | -- | -- | 3/20 | 2.2-4.9 | 0 | NA | NA |
| Barium | -- | -- | -- | 20/20 | 13-68 | NA | NA | NA |
| Beyllium, | -- | -- | -- | 3/20 | 1 | NA | NA | NA |
| Chromium | 20 | 1,100 | 50 | 3/20 | 12-30 | 1 | 0 | 0 |
| Copper | 3 | 2.9 | -- | 20/20 | 2-42 | 15 | 18 | NA |
| Lead | 25 | 220 | 8.5 | 10/20 | 2-42 | 3 | 0 | 4 |
| Manganese | -- | -- | -- | 20/20 | 15-162 | NA | NA | NA |
| Nickel | 83 | 75 | 8.3 | 1/20 | 29 | 0 | 0 | 1 |
| Selenium | 71 | 300 | 71 | 2/20 | 1-2 | 0 | 0 | 0 |
| Vanadium | -- | -- | -- | 9/20 | 4-33 | NA | NA | NA |
| Zine | 86 | 95 | 86 | 14/20 | 11-152 | 2 | 2 | 2 |

Notes: (1) NCWQS = North Carolina Water Quality Standards for Surface Water
(2) AWQC = Ambient Water Quality Standard
(3) Insufficient data to develop criteria. Value presented is Lowest Observed Effect Level (LOEL).
Concentrations expressed in microgram per liter (µg/L)

# TABLE 6-13

# SURFACE WATER DATA SUMMARY
# OPERABLE UNIT NO. 1 - BEAVER DAM CREEK
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Surface Water Criteria | | | Contaminant Frequency/Range | | Comparison to Criteria | | |
|---|---|---|---|---|---|---|---|---|
| | NCWQS[1] | Federal Health AWQCs[2] | | No. of Positive Detects/ No. of Samples | Contaminant Range | Positive Detects Above NCWQS | Positive Detects Above AWQC | |
| | | Acute | Chronic | | | | Acute | Chronic |
| Arsenic | 50 | -- | -- | 2/7 | 4.3-11.8 | 0 | NA | NA |
| Barium | -- | -- | -- | 7/7 | 34-75 | NA | NA | NA |
| Beryllium | -- | -- | -- | 1/7 | 1 | NA | NA | NA |
| Chromium | 20 | 1,100 | 50 | 1/7 | 18 | 0 | 0 | 0 |
| Copper | 3 | 2.9 | -- | 7/7 | 3-17 | 7 | 7 | 7 |
| Lead | 25 | 220 | 8.5 | 2/7 | 7.4-22.2 | 0 | 0 | 2 |
| Manganese | -- | -- | -- | 7/7 | 24-262 | NA | NA | NA |
| Zinc | 86 | 95 | 86 | 7/7 | 25-96 | 1 | 1 | 1 |

Notes: (1) NCWQS = North Carolina Water Quality Standards for Surface Water
(2) AWQC = Ambient Water Quality Standard
Concentrations expressed in microgram per liter (µg/L)

## TABLE 6-14

## SEDIMENT DATA SUMMARY
## OPERABLE UNIT NO. 1 - COGDELS CREEK
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Sediment | |
|---|---|---|
| | Range of Positive Detections | No. of Positive Detects/ No. of Samples |
| Methylene Chloride | 14-56 | 3/40 |
| Acetone | 50-250 | 10/40 |
| 2-Butanone | 14-60 | 3/40 |
| Ethylbenzene | 16 | 1/40 |
| 4-Methylphenol | 1,800 | 1/40 |
| Naphthalene | 240 | 1/40 |
| Acenaphthene | 65-550 | 2/40 |
| Dibenzofuran | 380 | 1/40 |
| Fluorene | 51-600 | 2/40 |
| Phenanthrene | 60-4,500 | 10/40 |
| Anthracene | 70-1,000 | 3/40 |
| Carbazole | 42-660 | 3/40 |
| Di-n-butyl phthalate | 120 | 1/40 |
| Fluoranthene | 79-6,800 | 14/40 |
| Pyrene | 50-4,500 | 14/40 |
| Butyl benzyl phthalate | 45-100 | 3/40 |
| Benzo(a)arthracene | 70-2,500 | 10/40 |
| Chrysene | 51-2,400 | 13/40 |
| Bis(2-ethylhexyl) phthalate | 75-620 | 10/40 |
| Benzo(b) fluoranthene | 59-2,800 | 12/40 |
| Benzo(k) fluoranthene | 72-1,800 | 10/40 |
| Benzo(a)pyrene | 84-1,700 | 11/40 |
| Indeno(1,2,3-cd)pyrene | 66-630 | 11/40 |
| Dibenz(a,h)anthracene | 65-160 | 3/40 |
| Benzo(ghi)perylene | 88-500 | 8/40 |

Notes: Organic concentrations expressed in microgram per Kilogram (µg/Kg)
Inorganic concentrations expressed in milligram per Kilogram (mg/Kg)

## TABLE 6-14 (continued)

## SEDIMENT DATA SUMMARY
## OPERABLE UNIT NO. 1 - COGDELS CREEK
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Sediment | |
|---|---|---|
| | Range of Positive Detections | No. of Positive Detects/ No. of Samples |
| 4,4'-DDE | 5-33 | 8/40 |
| 4,4'-DDD | 4.4-400 | 20/40 |
| 4,4'-DDT | 4.6-150 | 11/40 |
| Alpha-Chlordane | 2.5-5.9 | 5/40 |
| Gamma-Chlordane | 3.2-6.3 | 3/40 |
| Arsenic | 0.57-6.5 | 21/40 |
| Barium | 1-109 | 40/40 |
| Beryllium | 0.28-1.5 | 6/40 |
| Cadmium | 1.3-11.9 | 9/40 |
| Chromium | 2.5-4.2 | 29/40 |
| Cobalt | 2.1-3.2 | 2/40 |
| Copper | 0.77-116 | 40/40 |
| Lead | 2-359 | 40/40 |
| Manganese | 1.8-72.3 | 40/40 |
| Mercury | 0.73 | 1/40 |
| Nickel | ND | 0/40 |
| Vanadium | 1-59.4 | 36/40 |
| Zinc | 2.4-363 | 40/40 |

Notes: Organic concentrations expressed in microgram per Kilogram (µg/Kg)
Inorganic concentrations expressed in milligram per Kilogram (mg/Kg)

## TABLE 6-15

## SEDIMENT DATA SUMMARY
## OPERABLE UNIT NO. 1 - BEAVER DAM CREEK
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Sediment | |
|---|---|---|
| | Range of Positive Detections | No. of Positive Detects/ No. of Samples |
| Methylene Chloride | 140 | 1/13 |
| Acetone | 33-260 | 6/13 |
| Carbon Disulfide | 68 | 1/13 |
| Naphthalene | 280 | 1/14 |
| Acenaphthene | 340 | 1/14 |
| Dibenzofuran | 200 | 1/14 |
| Fluorene | 270 | 1/14 |
| Phenanthrene | 160-1,900 | 3/14 |
| Anthracene | 410 | 1/14 |
| Carbazole | 340 | 1/14 |
| Fluoranthene | 74-2,100 | 6/14 |
| Pyrene | 70-1,500 | 4/14 |
| Benzo(a)anthracene | 170-950 | 2/14 |
| Chrysene | 74-920 | 3/14 |
| Bis(2-ethylhexyl)phthalate | 60-220 | 9/14 |
| Benzo(b)fluoranthene | 120-600 | 2/14 |
| Benzo(k)fluoranthene | 94-390 | 2/14 |
| Benzo(a)pyrene | 100-510 | 2/14 |
| Indeno(1,2,3-cd)pyrene | 86-520 | 2/14 |
| Benzo(ghi)perylene | 85-540 | 2/14 |
| 4,4'-DDE | 4.8-93 | 6/14 |
| 4,4'-DDD | 33-39 | 2/14 |
| 4,4'-DDT | 8-47 | 3/14 |
| Alpha-Chlordane | 2.5-7.3 | 4/14 |
| Gamma-Chlordane | 2.4-5.6 | 6/214 |
| PCB1260 | 70 | 1/14 |

Notes: Organic concentrations expressed in microgram per Kilogram (µg/Kg)
Inorganic concentrations expressed in milligram per Kilogram (mg/Kg)

## TABLE 6-15 (continued)

## SEDIMENT DATA SUMMARY
## OPERABLE UNIT NO. 1 - BEAVER DAM CREEK
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Sediment | |
|---|---|---|
| | Range of Positive Detections | No. of Positive Detects/ No. of Samples |
| Arsenic | 0.53-12.1 | 12/14 |
| Barium | 3.9-49.1 | 14/14 |
| Beryllium | 0.24-1.1 | 10/14 |
| Chromium | 3.4-41.2 | 12/14 |
| Cobalt | 3-7.6 | 4/14 |
| Copper | 1.3-24.7 | 14/14 |
| Lead | 4.4-50.7 | 14/14 |
| Manganese | 2.2-30.9 | 14/14 |
| Nickel | 6.2-10.1 | 3/14 |
| Vanadium | 2.1-50.5 | 14/14 |
| Zinc | 7.9-37.4 | 14/14 |

Notes: Organic concentrations expressed in microgram per Kilogram (µg/Kg)
Inorganic concentrations expressed in milligram per Kilogram (mg/Kg)

## TABLE 6-16

## SUMMARY OF COPCs IN ENVIRONMENTAL MEDIA OF INTEREST
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Soil | | | Groundwater | Surface Water | | Sediment | | Air | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 21 | 24 | 78 | OU No. 1 | CC | BD | CC | BD | 21 | 24 | 78 |
| Benzene | | | | X | | | | | | | |
| 1,2-Dichloroethane | | | | X | | | | | | | |
| T-1,2-Dichloroethene | | | | X | | | | | | | |
| Tetrachloroethene | | | | X | X | | | | | | |
| Ethylbenzene | | | | X | | | | | | | |
| Total Xylenes | | | | | | | | | | | |
| Trichloroethene | | | | X | | | | | | | |
| Vinyl Chloride | | | | X | | | | | | | |
| Toluene | | | | X | | | | | | | |
| Chrysene | X | X | | | | | X | X | | | |
| Fluoranthene | X | | | | | | X | X | | | |
| Pyrene | X | | | | | | X | X | | | |
| Benzo(a)anthracene | X | | | | | | X | | | | |
| Benzo(b)fluoranthene | X | X | | | | | X | X | | | |
| Benzo(k)fluoranthene | X | | | | | | X | X | | | |
| Benzo(a)pyrene | X | | | | | | X | | | | |
| Benzo(g,h,i)perylene | | | | | | | X | | | | |
| Indeno(1,2,3-cd)pyrene | X | | | | | | X | | | | |
| Napthalene | | | | X | | | | | | | |
| Phenol | | | | X | | | | | | | |
| 4,4'-DDD | X | X | | | | | X | X | | | |
| 4,4'-DDE | X | X | | | | | X | X | | | |
| 4,4'-DDT | X | X | | | | | X | X | X | X | |
| Dieldrin | | X | | | | | | | | X | |
| Selenium | | | | X | | | | | | | |
| Total PCBs | X | X | | | | | | | | | |
| Arsenic | X | X | | X | X | X | X | X | X | X | |
| Barium | | | | X | | X | X | X | | | |
| Beryllium | | X | | X | X | | X | X | | X | |
| Cadmium | | | | | | | X | | | | |
| Chromium | X | X | | X | X | | X | X | X | X | |
| Copper | | | | X | | | | | | | |
| Lead | | | | X | | | | | | | |
| Manganese | X | X | | X | X | X | | X | X | X | |
| Mercury | | | | X | | | | | | | |
| Nickel | | | | X | | | | | | | |
| Total Chlordane | X | X | | | | | X | X | | | |
| Vanadium | X | X | | X | X | X | X | X | | | |
| Zinc | X | X | | X | X | X | X | X | | | |

Notes: CC = Cogdels Creek
BD = Beaver Dam Creek
X = Contaminant Retained as COPC

# TABLE 6-16

## SUMMARY OF COPCs IN ENVIRONMENTAL MEDIA OF INTEREST
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Soil | | | Groundwater | Surface Water | | Sediment | | Air | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 21 | 24 | 78 | OU No. 1 | CC | BD | CC | BD | 21 | 24 | 78 |
| 1,2-Dichloroethane | | | | X | | | | | | | |
| T-1,2-Dichloroethene | | | | X | | | | | | | |
| Tetrachloroethene | | | | X | X | | | | | | |
| Ethylbenzene | | | | X | | | | | | | |
| Total Xylenes | | | | | | | | | | | |
| Trichloroethene | | | | X | | | | | | | |
| Vinyl Chloride | | | | X | | | | | | | |
| Toluene | | | | X | | | | | | | |
| Chrysene | X | X | | | | | X | X | | | |
| Fluoranthene | X | | | | | | X | X | | | |
| Pyrene | X | | | | | | X | X | | | |
| Benzo(a)anthracene | X | | | | | | X | | | | |
| Benzo(b)fluoranthene | X | X | | | | | X | X | | | |
| Benzo(k)fluoranthene | X | | | | | | X | X | | | |
| Benzo(a)pyrene | X | | | | | | X | | | | |
| Indeno(1,2,3-cd)pyrene | X | | | | | | X | | | | |
| Naphthalene | | | | X | | | | | | | |
| Phenol | | | | X | | | | | | | |
| 4,4'-DDD | X | X | | | | | X | X | | | |
| 4,4'-DDE | X | X | | | | | X | X | | | |
| 4,4'-DDT | X | X | | | | | X | X | X | X | |
| Dieldrin | | X | | | | | | | | X | |
| Total PCBs | X | X | | | | | | | | | |
| Arsenic | X | X | | X | X | X | X | X | X | X | |
| Barium | | | | X | | X | X | X | | | |
| Beryllium | | X | | X | X | | X | X | | X | |
| Cadmium | | | | | | | X | | | | |
| Chromium | X | X | | X | X | | X | X | X | X | |
| Copper | | | | X | | | | | | | |
| Lead | | | | X | | | | | | | |
| Manganese | X | X | | X | X | X | | X | X | X | |
| Mercury | | | | X | | | | | | | |
| Nickel | | | | X | | | | | | | |
| Vanadium | X | X | | X | X | X | X | X | | | |
| Zinc | X | X | | X | X | X | X | X | | | |
| Total Chlordane | X | X | | | | | X | X | | | |
| Benzene | | | | X | | | | | | | |
| Benzo(g,h,i)perylene | | | | | | | X | | | | |
| Selenium | | | | X | | | | | | | |

Notes: CC = Cogdels Creek
BD = Beaver Dam Creek
X = Contaminant Retained as COPC

# TABLE 6-17

# MATRIX OF POTENTIAL HUMAN EXPOSURE
## OPERABLE UNIT NO. 1 - SITE 21
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Exposure Medium/ Exposure Route | Current Military Personnel | Future Construction Worker | Future Residential Population |
|---|---|---|---|
| **Soil** | | | |
| Incidental Ingestion | M | W | -- |
| Dermal Contact | M | W | -- |
| **Groundwater*** | | | |
| Ingestion | -- | -- | L, C |
| Dermal Contact | -- | -- | L, C |
| **Surface Water** | | | |
| Ingestion | -- | -- | L, C |
| Dermal Contact | -- | -- | L, C |
| **Sediment** | | | |
| Incidental Ingestion | -- | -- | L, C |
| Dermal Contact | -- | -- | L, C |
| **Air** | | | |
| Inhalation of Vapor Phase Chemicals Indoor | -- | -- | -- |
| Inhalation of Particulates Outdoor | M | -- | -- |

L = Lifetime exposure
C = Exposure in children may be significantly greater than in adults
M = Military lifetime exposure
W = Construction duration exposure
-- = Exposure to population not likely via this route
* = Exposure to groundwater assessed for the entire Operable Unit

## TABLE 6-17 (Continued)

## MATRIX OF POTENTIAL HUMAN EXPOSURE
## OPERABLE UNIT NO. 1 - SITE 21
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Receptor Group | Exposure Route and Medium | Retained/ Not Retained | Rationale |
|---|---|---|---|
| **Current Land Use** | | | |
| Military Personnel | Direct contact with surface soil | Retained | Area of concern is approximately 50 percent fenced. Area of concern is away from residential areas. Exposure to surface soils would predominate as a result of day-to-day activities. |
| | Incidental ingestion of surface soil | Retained | |
| | Inhalation of surface soil particulates | Retained | |
| | Direct contact with surface water/ sediment | Not Retained | Surface water body is not classifiable, and is due to ponding from site runoff. Surface water is intermittent in ditches around site. Limited frequency and duration of exposure during working activities. |
| | Ingestion of surface water/sediment | Not Retained | |
| **Future Land Use**<br>Child and Adult Residents | Direct contact with groundwater | Retained | Groundwater from this site evaluated as part of the Operable Unit. |
| | Ingestion of groundwater | Retained | |
| | Inhalation of volatilized contaminants | Retained | |
| Child and Adult Residents | Direct contact with surface soil | Retained | According to Base Master Plan, area is to remain as an open storage lot within the industrialized Hadnot Point Industrial area. |
| | Incidental ingestion of surface soil | Retained | |
| | Inhalation of surface soil particulates | Retained | |
| Construction Worker | Direct contact with subsurface soil | Retained | Potential excavation for future industrial structures. |
| | Incidental ingestion of subsurface soil | Retained | |
| Child and Adult Residents | Direct contact with surface water/ sediment | Retained | Excavation of soils is not expected but future potential exists. |
| | Incidental ingestion of surface water/ sediment | Retained | Surface water in the immediate area is not classifiable, and is due to site runoff. Surface water is intermittent in ditches around site. However, Beaver Dam Creek is a future potential source. |

# TABLE 6-18

# MATRIX OF POTENTIAL HUMAN EXPOSURE
# OPERABLE UNIT NO. 1 - SITE 24
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE, NORTH CAROLINA

| Exposure Medium/ Exposure Route | Current Military Personnel | Future Construction Worker | Future Residential Population |
|---|---|---|---|
| **Soil** | | | |
| Incidental Ingestion | M | W | L, C |
| Dermal Contact | M | W | L, C |
| **Groundwater*** | | | |
| Ingestion | -- | -- | L, C |
| Dermal Contact | -- | -- | L, C |
| **Surface Water** | | | |
| Ingestion | -- | -- | -- |
| Dermal Contact | -- | -- | -- |
| **Sediment** | | | |
| Incidental Ingestion | -- | -- | -- |
| Dermal Contact | -- | -- | -- |
| **Air** | | | |
| Inhalation of Vapor Phase Chemicals Indoor | -- | -- | L, C |
| Inhalation of Particulates Outdoor | M | -- | L, C |

L = Lifetime exposure
C = Exposure in children may be significantly greater than in adults
M = Military lifetime exposure
W = Construction duration exposure
-- = Exposure to population not likely via this route
* = Exposure to groundwater assessed for the entire Operable Unit

## TABLE 6-18 (Continued)

## MATRIX OF POTENTIAL HUMAN EXPOSURE
## OPERABLE UNIT NO. 1 - SITE 24
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Receptor Group | Exposure Route and Medium | Retained/ Not Retained | Rationale |
|---|---|---|---|
| **Current Land Use** | | | |
| Military Personnel | Direct contact with surface soil | Retained | Area is used for conducting military exercises. |
| | Incidental ingestion of surface soil | Retained | |
| | Inhalation of surface soil particulates | Retained | |
| **Future Land Use**<br>Child and Adult Residents | Direct contact with surface soil | Retained | Area could be developed in the future as a residential area. |
| | Incidental ingestion of surface soil | Retained | |
| | Inhalation of surface soil particulates | Retained | |
| Child and Adult Residents | Direct contact with groundwater | Retained | Shallow zone of aquifer could potentially be developed for potable use |
| | Ingestion of groundwater | Retained | |
| | Inhalation of volatilized contaminants | Retained | |
| Construction Worker | Direct contact with subsurface soil | Retained | Excavation of soils is not planned but future potential exists. |
| | Incidental ingestion of subsurface soil | Retained | |
| Military Personnel/ Child and Adult Residents | Direct contact with surface water/ sediment | Retained | Surface water bodies may be associated with this immediate area. |
| | Incidental ingestion of surface water/ sediment | Retained | |

## TABLE 6-19

## MATRIX OF POTENTIAL HUMAN EXPOSURE
## OPERABLE UNIT NO. 1 - SITE 78
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Exposure Medium/ Exposure Route | Current Military Personnel | Future Construction Worker | Future Residential Population |
|---|---|---|---|
| **Soil** | | | |
| Incidental Ingestion | -- | W | -- |
| Dermal Contact | -- | W | -- |
| **Groundwater*** | | | |
| Ingestion | -- | -- | L, C |
| Dermal Contact | -- | -- | L, C |
| **Surface Water** | | | |
| Ingestion | -- | -- | -- |
| Dermal Contact | -- | -- | -- |
| **Sediment** | | | |
| Incidental Ingestion | -- | -- | -- |
| Dermal Contact | -- | -- | -- |
| **Air** | | | |
| Inhalation of Vapor Phase Chemicals Indoor | -- | -- | L, C |
| Inhalation of Particulates Outdoor | -- | -- | -- |

L = Lifetime exposure
C = Exposure in children may be significantly greater than in adults
W = Construction duration exposure
-- = Exposure to population not likely via this route
* = Exposure to groundwater assessed for the entire Operable Unit

## TABLE 6-19 (Continued)

## MATRIX OF POTENTIAL HUMAN EXPOSURE
## OPERABLE UNIT NO. 1 - SITE 78
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Receptor Group | Exposure Route and Medium | Retained/ Not Retained | Rationale |
|---|---|---|---|
| **Current Land Use** | | | |
| Military Personnel | Direct contact with surface soil | Not Retained | Area is heavily industrialized with majority of area covered with asphalt. Exposed soil areas are vegetated. Exposure to soils not expected to predominate as a result of daily activities. |
| | Incidental ingestion of surface soil | Not Retained | |
| | Inhalation of surface soil particulates | Not Retained | |
| Trespassing Sportsmen | Direct contact with surface water/ sediment | Not Retained | Hunting not permitted in surface water areas. Surface water bodies not used for recreational fishing. |
| | Incidental ingestion with surface water/sediment | Not Retained | |
| **Future Land Use** | | | |
| Military Personnel/ Child and Adult Residents | Direct contact with surface soil | Not Retained | According to Base Master Plan, area is to remain heavily industrialized with limited exposed soil areas. |
| | Incidental ingestion of surface soil | Not Retained | |
| | Inhalation of surface soil particulates | Not Retained | |
| Child and Adult Residents | Direct contact with groundwater | Retained | Groundwater from this site is evaluated as part of the Operable Unit. |
| | Incidental ingestion of groundwater | Retained | |
| | Inhalation of volatilized contaminants | Retained | |
| Military Personnel | Direct contact with surface water/ sediment | Not Retained | Surface water areas are not encountered as result of daily activities. |
| | Incidental ingestion of surface water/ sediment | Not Retained | |
| Child and Adult Residents | Direct contact with surface water/ sediment | Not Retained | Surface water bodies are not within proximity of area. |
| | Incidental ingestion of surface water/ sediment | Not Retained | |
| Construction Worker | Direct contact with subsurface soil | Retained | Potential excavation for new industrial structures. |
| | Incidental ingestion of subsurface soil | Retained | |

## TABLE 6-20

## EXPOSURE ASSESSMENT SUMMARY
## INCIDENTAL INGESTION OF SOIL CONTAMINANTS
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Future Residential Child and Adult, Current Military Personnel, Future Construction Worker | | | | |
|---|---|---|---|---|
| Input Parameter | Description | Value | | Reference |
| C | Exposure Concentration | 95% UCL | (mg/kg) | USEPA, 1992h |
| IR | Ingestion Rate | Child<br>Adult<br>Military Personnel<br>Construction Worker | 200 mg/day<br>100 mg/day<br>100 mg/day<br>480 mg/day | USEPA, 1989b<br>USEPA, 1991a |
| CF | Conversion Factor | 1E-6 kg/mg | | USEPA, 1989b |
| Fi | Fraction Ingested from Contaminated Source | 100% | | Conservative Professional Judgement |
| EF | Exposure Frequency | Child<br>Adult<br>Military Personnel<br>Construction Worker | 350 days/yr<br>350 days/yr<br>350 days/yr<br>90 days/yr | USEPA, 1989b<br>USEPA, 1991a |
| ED | Exposure Duration | Child<br>Adult<br>Military Personnel<br>Construction Worker | 6 years<br>24 years<br>4 years<br>1 year | USEPA, 1991a<br>USEPA, 1989b |
| BW | Body Weight | Child<br>Adult<br>Military Personnel<br>Construction Worker | 15 kg<br>70 kg<br>70 kg<br>70 kg | USEPA, 1989b |
| $AT_c$ | Averaging Time Carcinogen | All | 25,550 days | USEPA, 1989b |
| $AT_{nc}$ | Averaging Time Noncarcinogen | Child<br>Adult<br>Military Personnel<br>Construction Worker | 2,190 days<br>8,760 days<br>1,460 days<br>365 days | USEPA, 1989b |

### TABLE 6-21

## EXPOSURE ASSESSMENT SUMMARY
## DERMAL CONTACT WITH SOIL CONTAMINANTS
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Future Residential Child and Adult, Current Military Personnel, Future Construction Worker | | | |
|---|---|---|---|
| Input Parameter | Description | Value | Reference |
| C | Exposure Concentration | 95% UCL (mg/kg) | USEPA, 1992h |
| CF | Conversion Factor | 1E-6 kg/mg | USEPA, 1989b |
| SA | Exposed Surface Area of Skin Available for Contact | Child 2,300 cm$^2$<br>Adult 5,800 cm$^2$<br>Military Personnel 5,800 cm$^2$<br>Construction Worker 4,300 cm$^2$ | USEPA, 1992e<br>Reasonable worst case: individual skin area limited to head, hands, forearms, lower legs |
| AF | Soil-to-Skin Adherence Factor | 1.0 mg/cm$^2$ | USEPA, Region IV, 1992 |
| ABS<br>— | Absorption Factor (dimensionless) | Organics 1.0<br>Inorganics 0.1 | USEPA, Region IV, 1992 |
| EF | Exposure Frequency | Child 350 days/yr<br>Adult 350 days/yr<br>Military Personnel 350 days/yr<br>Construction Worker 90 days/yr | USEPA, 1989b<br>USEPA, 1991a |
| ED | Exposure Duration | Child 6 years<br>Adult 24 years<br>Military Personnel 4 years<br>Construction Worker 1 year | USEPA, 1991a<br>USEPA, 1989b |
| BW | Body Weight | Child 15 kg<br>Adult 70 kg<br>Military Personnel 70 kg<br>Construction Worker 70 kg | USEPA, 1989b |
| $AT_c$ | Averaging Time Carcinogen | All 25,550 days | USEPA, 1989b |
| $AT_{nc}$ | Averaging Time Noncarcinogen | Child 2,190 days<br>Adult 8,760 days<br>Military Personnel 1,460 days<br>Construction Worker 365 days | USEPA, 1989b |

# TABLE 6-22

# EXPOSURE ASSESSMENT SUMMARY
# INHALATION OF SURFACE SOIL PARTICULATES
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE, NORTH CAROLINA

| Future Residential Child and Adult, Current Military Personnel | | | | |
|---|---|---|---|---|
| Input Parameter | Description | Value | | Reference |
| C | Exposure Concentration | 95% UCL | (mg/kg) | USEPA, 1992h |
| EF | Exposure Frequency | Child<br>Adult<br>Military Personnel | 350 days/yr<br>350 days/yr<br>350 days/yr | USEPA, 1989b |
| ED | Exposure Duration | Child<br>Adult<br>Military Personnel | 6 years<br>24 years<br>4 years | USEPA, 1991a |
| IR | Inhalation Rate | Child<br>Adult<br>Military Personnel | 10 $m^3$<br>20 $m^3$<br>20 $m^3$ | USEPA, 1991a<br>USEPA, 1989c |
| BW | Body Weight | Child<br>Adult<br>Military Personnel | 15 kg<br>70 kg<br>70 kg | USEPA, 1989b |
| $AT_c$ | Averaging Time Carcinogen | All | 25,550 days | USEPA, 1989b |
| $AT_{nc}$ | Averging Time Noncarcinogen | Child<br>Adult<br>Military Personnel | 2,190 days<br>8,760 days<br>1,460 days | USEPA, 1989b |
| PEF | Site-specific Particulate Emission Factor | $4.63 \times 10^9$ $m^3$/kg | | USEPA, 1989b<br>Cowherd, 1985 |

# TABLE 6-23

# EXPOSURE ASSESSMENT SUMMARY
# INGESTION OF CONTAMINANTS IN GROUNDWATER
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE, NORTH CAROLINA

| Future Residential Child and Adult | | | | |
|---|---|---|---|---|
| Input Parameter | Description | Value | | Reference |
| C | Exposure Concentration | 95% UCL | (mg/L) | USEPA, 1992h |
| IR | Ingestion Rate | Child<br>Adult | 1 L/day<br>2 L/day | USEPA, 1991a<br>USEPA, 1989b |
| EF | Exposure Frequency | Child<br>Adult | 350 days/yr<br>350 days/yr | USEPA, 1989b |
| ED | Exposure Duration | Child<br>Adult | 6 years<br>30 years | USEPA, 1991a |
| BW | Body Weight | Child<br>Adult | 15 kg<br>70 kg | USEPA, 1989b |
| $AT_c$ | Averaging Time Carcinogen | All | 25,550 days | USEPA, 1989b |
| $AT_{nc}$ | Averaging Time Noncarcinogen | Child<br>Adult | 2,190 days<br>10,950 days | USEPA, 1989b |

## TABLE 6-24

## EXPOSURE ASSESSMENT SUMMARY
## DERMAL CONTACT WITH GROUNDWATER CONTAMINANTS
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Future Residential Child and Adult | | | | |
|---|---|---|---|---|
| Input Parameter | Description | Value | | Reference |
| C | Exposure Concentration | 95% UCL | (mg/L) | USEPA, 1992h |
| SA | Exposed Surface Area of Skin Available for Contact | Child<br>Adult | 10,000 $cm^2$<br>23,000 $cm^2$ | USEPA, 1992e |
| PC | Permeability Constant | Chemical Specific | | USEPA, 1992e |
| ET | Exposure Time | All | 0.25 hr/day | USEPA, 1992e |
| EF | Exposure Frequency | Child<br>Adult | 350 days/yr<br>350 days/yr | USEPA, 1991a |
| ED | Exposure Duration | Child<br>Adult | 6 years<br>30 years | USEPA, 1989b |
| CF | Conversion Factor | 1L/1000 $cm^3$ | | USEPA, 1989b |
| BW | Body Weight | Child<br>Adult | 15 kg<br>70 kg | USEPA, 1989b |
| $AT_c$ | Averaging Time Carcinogen | All | 25,550 days | USEPA, 1989b |
| $AT_{nc}$ | Averaging Time Noncarcinogen | Child<br>Adult | 2,190 days<br>10,950 days | USEPA, 1989b |

# TABLE 6-25

# EXPOSURE ASSESSMENT SUMMARY
# INHALATION OF GROUNDWATER VOLATILE CONTAMINANTS
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE, NORTH CAROLINA

| Future Residential Child and Adult | | | | |
|---|---|---|---|---|
| Input Parameter | Description | Value | | Reference |
| C | Exposure Concentration | 95% UCL | (mg/m$^3$) | USEPA, 1992h |
| IR | Inhalation Rate | Child<br>Adult | 0.6 m$^3$/hr<br>0.6 m$^3$/hr | USEPA, 1989b |
| ET | Exposure Time | All | 0.25 hr/day | USEPA, 1992e |
| EF | Exposure Frequency | All | 350 day/yr | USEPA, 1989b |
| ED | Exposure Duration | Child<br>Adult | 6 years<br>30 years | USEPA, 1989b |
| BW | Body Weight | Child<br>Adult | 15 kg<br>70 kg | USEPA, 1989b |
| $AT_c$ | Averaging Time Carcinogen | All | 25,550 days | USEPA, 1989b |
| $AT_{nc}$ | Averaging Time Noncarcinogens | Child<br>Adult | 2,190 days<br>10,950 days | USEPA, 1989b |

# TABLE 6-26

# EXPOSURE ASSESSMENT SUMMARY
# INGESTION OF SURFACE WATER CONTAMINANTS
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE, NORTH CAROLINA

| Future Residential Child and Adult | | | | |
|---|---|---|---|---|
| Input Parameter | Description | Value | | Reference |
| C | Exposure Concentration | 95% UCL | (mg/L) | USEPA, 1992h |
| IR | Ingestion Rate | 0.05 L/hr | | USEPA, 1989b |
| ET | Exposure Time | All | 2.6 hr/day | USEPA, 1992e |
| EF | Exposure Frequency | All | 20 days/yr | Site-specific professional judgement (4 days/month x 5 months/yr) |
| ED | Exposure Duration | Child<br>Adult | 6 years<br>30 years | USEPA, 1989b |
| BW | Body Weight | Child<br>Adult | 15 kg<br>70 kg | USEPA, 1989b |
| $AT_c$ | Averaging Time Carcinogen | All | 25,550 days | USEPA, 1989b |
| $AT_{nc}$ | Averaging Time Noncarcinogen | Child<br>Adult | 2,190 days<br>10,950 days | USEPA, 1989b |

# TABLE 6-27

# EXPOSURE ASSESSMENT SUMMARY DERMAL CONTACT WITH SURFACE WATER REMEDIAL INVESTIGATION CTO-0177 MCB CAMP LEJEUNE, NORTH CAROLINA

| Future Residential Child and Adult | | | | |
|---|---|---|---|---|
| Input Parameter | Description | Value | | Reference |
| C | Exposure Concentration | 95% UCL | (mg/L) | USEPA, 1992h |
| SA | Exposed Surface Area of Skin Available for Contact | Child<br>Adult | 4,600 $cm^2$<br>11,500 $cm^2$ | 50 percent whole body (head, arms, hands, forearms, lower extremities)<br>USEPA, 1992e |
| PC | Permeability Constant | Chemical Specific | cm/hour | USEPA, 1992e |
| ET | Exposure Time | All | 2.6 hr/day | USEPA, 1992e |
| EF | Exposure Frequency | All | 20 days/yr | Site-specific professional judgement (4 days/month x 5 months/yr) |
| ED | Exposure Duration | Child<br>Adult | 6 years<br>30 years | USEPA, 1989b |
| CF | Conversion Factor | 1 l/1,000 $cm^3$ | | USEPA, 1989b |
| BW | Body Weight | Child<br>Adult | 15 kg<br>70 kg | USEPA, 1989b |
| $AT_c$ | Averaging Time Carcinogen | All | 25,550 days | USEPA, 1989b |
| $AT_{nc}$ | Averaging Time Noncarcinogen | Child<br>Adult | 2,190 days<br>10,950 days | USEPA, 1989b |

# TABLE 6-28

# EXPOSURE ASSESSMENT SUMMARY
# INCIDENTAL INGESTION OF SEDIMENT
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE, NORTH CAROLINA

| Future Residential Child and Adult | | | |
|---|---|---|---|
| Input Parameter | Description | Value | Reference |
| C | Exposure Concentration | 95% UCL (mg/kg) | USEPA, 1992h |
| IR | Ingestion Rate | Child 100 mg/day<br>Adult 100 mg/day | USEPA, 1989b |
| Fi | Fraction Ingestion from Contaminated Source | 100% | Conservative Professional Judgement |
| EF | Exposure Frequency | All 20 days/yr | Site-specific professional judgement (4 days/month x 5 months/yr) |
| ED | Exposure Duration | Child 6 years<br>Adult 30 years | USEPA, 1989b |
| CF | Conversion Factor | 1E-06 kg/mg | USEPA, 1989b |
| BW | Body Weight | Child 15 kg<br>Adult 70 kg | USEPA, 1989b |
| $AT_c$ | Averaging Time Carcinogen | All 25,550 days | USEPA, 1989b |
| $AT_{nc}$ | Averaging Time Noncarcinogen | Child 2,190 days<br>Adult 10,950 days | USEPA, 1989b |

## TABLE 6-29

# EXPOSURE ASSESSMENT SUMMARY
# DERMAL CONTACT WITH SEDIMENT
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE, NORTH CAROLINA

| Future Residential Child and Adult | | | |
|---|---|---|---|
| Input Parameter | Description | Value | Reference |
| C | Exposure Concentration | 95% UCL (mg/kg) | USEPA, 1992h |
| SA | Exposed Surface Area of Skin Available for Contact | Child 4,600 $cm^2$/day<br>Adult 11,500 $cm^2$/day | 50 percent whole body (head, arms, hands, forearms, lower extremities) (USEPA, 1992e |
| AF | Soil-to-Skin Adherence Factor | 1.0 mg/$cm^2$ | USEPA, Region IV, 1992 |
| ABS | Absorption Factor (dimensionless) | Organics 1.0<br>Inorganics 0.1 | USEPA, Region IV, 1992 |
| EF | Exposure Frequency | All 20 day/yr | Site-specific professional judgement (4 days/month x 5 months) |
| ED | Exposure Duration | Child 6 years<br>Adult 30 years | USEPA, 1989b |
| CF | Conversion Factor | 1.0 E-6 kg/mg | USEPA, 1989b |
| BW | Body Weight | Child 15 kg<br>Adult 70 kg | USEPA, 1989b |
| $AT_c$ | Averaging Time Carcinogen | All 25,550 days | USEPA, 1989b |
| $AT_{nc}$ | Averaging Time Noncarcinogen | Child 2,190 days<br>Adult 10,950 days | USEPA, 1989b |

## TABLE 6-30

## TOXICITY FACTORS
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| | RfD | RfC | CSF | CSFI | WOE | Reference |
|---|---|---|---|---|---|---|
| **Volatiles:**<br>1,1-Dichloroethene | 9.0E-03 | -- | 6.0E-01 | 1.75E-01 | C | IRIS, 1993 |
| 1,1,2-Trichloroethane | 4.0E-03 | -- | 5.7E-02 | 5.6E-02 | C | IRIS, 1993 |
| 1,1,2,2-Tetrachloroethane | -- | -- | 2.0E-01 | 2.03E-01 | C | IRIS, 1993 |
| 1,2-Dichloroethane | ND | ND | 9.1E-02 | 9.1E-02 | B2 | IRIS, 1993 |
| Benzene | PDG | PDG | 2.9E-02 | 2.9E-02 | A | IRIS, 1993 |
| Bromodichloromethane | 2.0E-02 | -- | 6.2E-02 | -- | B2 | IRIS, 1993 |
| Chlorobenzene | 2.0E-02 | 2.0E-02 | -- | -- | D | IRIS, 1993, HEAST 1993 |
| Ethylbenzene | 1.0E-01 | 1.0E+00 | -- | -- | D | IRIS, 1993 |
| T-1,2-Dichloroethene | 2.0E-2 | -- | -- | -- | -- | IRIS, 1993 |
| Tetrachloroethene | 1.0E-02 | ND | 5.2E-02 | 2.0E-03 | -- | IRIS, 1993, USEPA, 1992 |
| Toluene | 2.0E-01 | 4.0E-01 | -- | -- | D | IRIS, 1993 |
| Trichloroethene | 6E-03 | PDG | 1.1E-02 | 6.0E-03 | B2 | IRIS, 1993, USEPA 1992 |
| Vinyl Chloride | -- | -- | 1.9E+00 | 2.9E-01 | A | HEAST, 1992 |
| Xylenes (total) | 2.0E+00 | PDG | -- | -- | D | IRIS, 1993 |
| **Semivolatiles:**<br>1,4-Dichlorobenzene | -- | 8.0E-01 | 2.4E-02 | -- | C | HEAST, 1992 |
| Benzo(a)anthracene | -- | -- | 7.3E-01 | -- | B2 | USEPA - Region IV, 1992 |
| Benzo(b)fluoranehtne | -- | -- | 7.3E-01 | -- | B2 | USEPA - Region IV, 1992 |
| Benzo(k)fluoranthene | -- | -- | 7.3E-01 | -- | B2 | USEPA - Region IV, 1992 |
| Benzo(a)pyrene | -- | -- | 7.3E+00 | -- | B2 | USEPA - Region IV, 1992 |
| Chrysene | -- | -- | 7.3E-02 | -- | B2 | USEPA - Region IV, 1992 |
| Fluoranthene | 4.0E-02 | ND | -- | -- | D | IRIS, 1993 |
| Indeno(1,2,3-cd)pyrene | -- | -- | 7.3E-01 | -- | B2 | USEPA - Region IV, 1992 |
| Naphthalene | 4E-2 | ND | -- | -- | D | IRIS, 1993; HEAST, 1993 |
| Phenanthrene | ND | ND | ND | ND | D | IRIS, 1993 |
| Phenol | 6.0E-01 | -- | -- | -- | D | IRIS, 1993 |
| Pyrene | 3.0E-02 | ND | -- | -- | D | IRIS, 1993 |

## TABLE 6-30 (Continued)

## TOXICITY FACTORS
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| | RfD | RfC | CSF | CSFI | WOE | Reference |
|---|---|---|---|---|---|---|
| **Pesticides/PCBs:** | | | | | | |
| 4,4'-DDD | ND | ND | 2.4E-01 | -- | B2 | IRIS, 1993 |
| 4,4'-DDE | ND | ND | 3.4E-01 | -- | B2 | IRIS, 1993 |
| 4,4'-DDT | 5.0E-04 | ND | 3.4E-01 | 3.4E-01 | B2 | IRIS, 1993 |
| Dieldrin | 5.0E-05 | -- | 1.6E+01 | 1.61E+01 | B2 | IRIS, 1993 |
| Endrin | 3.0E-04 | -- | -- | -- | D | IRIS, 1993 |
| Total Chlordane | 6E-5 | UR | 1.3E+00 | 1.3E+00 | B2 | IRIS, 1993 |
| Total PCB | 7.0E-05 | ND | 7.7E+00 | -- | B2 | IRIS, 1993 |
| **Inorganics:** | | | | | | |
| Arsenic | 3.0E-04 | ND | 1.7E+00 | 5.0E+01 | $A_I$ | IRIS, 1993 |
| Barium | 7.0E-02 | -- | -- | -- | -- | IRIS, 1993 |
| Beryllium | 5.0E-03 | ND | 4.3E+00 | 8.4E+00 | B2 | IRIS, 1993 |
| Cadmium | 5.0E-04 | PDG | -- | 6.3E+00 | B1 | IRIS, 1993 |
| Chromium VI | 5.0E-03 | PDG | -- | 4.2E+01 | $A_I$ | IRIS, 1993 |
| Manganese | 5.0E-03 | 5.0E-05 | -- | -- | D | IRIS, 1993 |
| Mercury | 3.0E-04 | 3.0E-04 | -- | -- | D | HEAST, 1993 |
| Nickel | 2.0E-02 | PDG | -- | -- | -- | IRIS, 1993 |
| Vanadium | 7.0E-03 | -- | -- | -- | -- | HEAST, 1993 |
| Zinc | 3.0E-01 | -- | -- | -- | D | IRIS, 1993 |

Notes:
RfD - Oral Reference Dose (mg/kg - day)
RfC - Inhalation Reference Concentration (mg/cu m)
CSF - Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$
CSFI - Inhalation Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$
WOE - Weight of Evidence
IRIS - Integrated Risk Information System
HEAST - Health Effects Assessment Summary Tables
USEPA - United States Environmental Protection Agency
ND - Not Determined
PDG - Pending
WOE - Weight of Evidence
PDG - Pending
UR - Under Review by USEPA
A - Human Carcinogen
B1 - Probable Human Carcinogen - Limited Evidence
B2 - Probable Human Carcinogen - Sufficient Evidence
C - Possible Human Carcinogen
D - Not Classifiable as to Human Carcinogenicity
I - Ingestion

# TABLE 6-31

# INCREMENTAL LIFETIME CANCER RISKS (ICRs) AND HAZARD INDICES (HIs)
## OPERABLE UNIT NO. 1 - SITE 21
## SOIL
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| | Receptor Group | | | |
|---|---|---|---|---|
| | Current Military Personnel | | Future Construction Worker | |
| Exposure Medium/Route | ICR | HI | ICR | HI |
| <u>Soil</u><br>Incidental Ingestion | 4E-06 | 0.13 | 9E-08 | 0.01 |
| Dermal Contact | 2.0E-06 | 0.06 | 3E-08 | <0.01 |
| Inhalation of Particulates | 3E-09 | <0.01 | NA | NA |
| Total | 6E-06 | 0.19 | 1E-07 | 0.01 |

# TABLE 6-32

# INCREMENTAL LIFETIME CANCER RISKS (ICRs) AND HAZARD INDICES (HIs)
## OPERABLE UNIT NO. 1 - SITE 24
## SOIL
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Exposure Medium/Route | Receptor Group | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Current Military Personnel | | Future Residential Child | | Future Residential Adult | | Future Construction Worker | |
| | ICR | HI | ICR | HI | ICR | HI | ICR | HI |
| <u>Soil</u><br>Incidental Ingestion | 7E-07 | 0.03 | 10E-06 | 0.3 | 4E-06 | 0.03 | 1E-07 | 0.02 |
| Dermal Contact | 7E-08 | <0.01 | 2E-07 | <0.01 | 4E-07 | <0.01 | 1E-09 | <0.01 |
| Inhalation of Particulates | 2E-09 | <0.01 | 7E-09 | <0.01 | 1E-08 | <0.01 | NA | NA |
| Total | 8E-07 | 0.03 | 1E-05 | 0.3 | 4E-06 | 0.03 | 1E-09 | 0.02 |

# TABLE 6-33

# INCREMENTAL LIFETIME CANCER RISKS (ICRs) AND HAZARD INDICES (HIs)
# OPERABLE UNIT NO. 1
# GROUNDWATER
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE, NORTH CAROLINA

| Exposure Medium/Route | Receptor Group | | | |
|---|---|---|---|---|
| | Future Residential Child | | Future Residential Adult | |
| | ICR | HI | ICR | HI |
| <u>Groundwater</u><br>Ingestion | **7E-04** | **29** | **2E-03** | **13** |
| Dermal Contact | 4E-06 | 0.1 | 10E-06 | 0.05 |
| Inhalation of Vapors | 2E-05 | <0.01 | 2E-05 | <0.01 |
| Total | **7E-04** | **29** | **2E-03** | **13** |

# TABLE 6-34

# INCREMENTAL LIFETIME CANCER RISKS (ICRs) AND HAZARD INDICES (HIs)
# OPERABLE UNIT NO. 1 - COGDELS CREEK
# SURFACE WATER/SEDIMENT
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE, NORTH CAROLINA

| Exposure Medium/Route | Receptor Group | | | |
|---|---|---|---|---|
| | Future Residential Child | | Future Residential Adult | |
| | ICR | HI | ICR | HI |
| <u>Surface Water</u> | | | | |
| Ingestion | 3E-07 | 0.01 | 3E-07 | <0.01 |
| Dermal Contact | 1E-07 | <0.01 | 3E-07 | <0.01 |
| <u>Sediment</u> | | | | |
| Ingestion | 3E-07 | <0.01 | 3E-07 | <0.01 |
| Dermal Contact | 7E-08 | <0.01 | 2E-07 | <0.01 |
| Total | 8E-07 | 0.06 | 1E-06 | <0.01 |

# TABLE 6-35

# INCREMENTAL LIFETIME CANCER RISKS (ICRs) AND HAZARD INDICES (HIs)
# OPERABLE UNIT NO. 1 - BEAVER DAM CREEK
# SURFACE WATER/SEDIMENT
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE, NORTH CAROLINA

| Exposure Medium/Route | Receptor Group | | | |
|---|---|---|---|---|
| | Future Residential Child | | Future Residential Adult | |
| | ICR | HI | ICR | HI |
| <u>Surface Water</u> | | | | |
| Ingestion | 9E-07 | 0.08 | 10E-07 | 0.02 |
| Dermal Contact | 1E-07 | <0.01 | 3E-07 | <0.01 |
| <u>Sediment</u> | | | | |
| Ingestion | 4E-07 | 0.01 | 4E-07 | <0.01 |
| Dermal Contact | 3E-08 | <0.01 | 7E-08 | <0.01 |
| Total | 1E-06 | 0.09 | 2E-06 | 0.02 |

# TABLE 6-36

## TOTAL SITE RISK
## OPERABLE UNIT NO. 1 - SITE 21
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Receptors | Soil | | Groundwater | | Surface Water | | Sediment | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ICR | HI | ICR | HI | ICR | HI | ICR | HI | ICR | HI |
| Current Military Personnel | 6E-06<br>(100) | 0.19<br>(100) | NA | NA | NA | NA | NA | NA | 6E-06 | 0.19 |
| Future Child Resident | NA | NA | NA | NA | 1E-06<br>(71) | 0.08<br>(89) | 4E-07<br>(29) | 0.01<br>(11) | 1E-06 | 0.09 |
| Future Adult Resident | NA | NA | NA | NA | 1E-06<br>(67) | 0.02<br>(100) | 5E-07<br>(34) | <0.01<br>(<1) | 2E-06 | 0.02 |
| Future Construction Worker | 1E-07<br>(100) | 0.01<br>(100) | NA | NA | NA | NA | NA | NA | 1E-07 | 0.01 |

Notes: ICR = Incremental Lifetime Cancer Risk
HI = Hazard Index
( ) = Approximate percent contribution to the total ICR or HI values
Total = Soil + Groundwater + Beaver Dam Creek Surface Water + Beaver Dam Creek Sediment
NA = Not Applicable

# TABLE 6-37

# TOTAL SITE RISK
# OPERABLE UNIT NO. 1 - SITE 24
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE, NORTH CAROLINA

| Receptors | Soil | | Groundwater | | Surface Water | | Sediment | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ICR | HI | ICR | HI | ICR | HI | ICR | HI | ICR | HI |
| Current Military Personnel | 8E-07<br>(100) | 0.03<br>(100) | NA | NA | NA | NA | NA | NA | 8E-07 | 0.03 |
| Future Child Resident | 1E-05<br>(1.4) | 0.3<br>(1.0) | **7E-04**<br>**(98)** | **29**<br>**(98)** | 4E-07<br>(<1) | 0.01<br>(<1) | 4E-07<br>(<1) | 0.04<br>(<1) | **7E-04** | **29.35** |
| Future Adult Resident | 4E-06<br>(<1) | 0.03<br>(<1) | **2E-03**<br>**(99)** | **13**<br>**(99)** | 6E-07<br>(<1) | <0.01<br>(<1) | 5E-07<br>(<1) | <0.01<br>(<1) | **2E-03** | **13** |
| Future Construction Worker | 1E-09<br>(100) | 0.02<br>(100) | NA | NA | NA | NA | NA | NA | 1E-09 | 0.02 |

Notes: ICR = Incremental Lifetime Cancer Risk
HI = Hazard Index
( ) = Approximate percent contribution to the total ICR or HI values
Total = Soil + Groundwater + Cogdels Creek Surface Water + Cogdels Creek Sediment
NA = Not Applicable

# 7.0 ECOLOGICAL RISK ASSESSMENT

## 7.1 Introduction

This section presents the ecological risk assessment (ERA) conducted at OU No. 1 that assesses the potential impacts to ecological receptors from contaminants detected at the site.

### 7.1.1 Objectives of the Ecological Risk Assessment

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 directs USEPA to protect human health and the environment with respect to releases or potential releases of contaminants from abandoned hazardous waste sites (USEPA, 1989a). In addition, there are various Federal and State laws and regulations concerning environmental protection that are considered applicable or relevant and appropriate requirements (ARARs). For example, these ARARs include comparisons of contaminant concentrations in surface water to State Water Quality Standards.

The objective of this ERA was to evaluate whether past reported disposal practices at OU No. 1 potentially are adversely impacting the ecological integrity of the terrestrial and aquatic habitats on, or adjacent to the sites. This assessment also evaluates the potential effects of contaminants at OU No. 1 on sensitive environments including wetlands, protected species, and fish nursery areas. The conclusions of the ERA will be used in conjunction with the human health risk assessment to evaluate the appropriate remedial action for this site for the overall protection of public health and the environment.

### 7.1.2 Scope of the Ecological Risk Assessment

This ERA evaluated and analyzed the results from the RI and historical data collected during previous studies. The RI include sampling and chemical analysis of the surface water, sediments, soil, and groundwater. Information used to evaluate sensitive environments was obtained from historical data and previous studies conducted at MCB Camp Lejeune, North Carolina.

This ERA focuses on adverse impacts to aquatic and terrestrial receptors. If potential risks are characterized for the ecological receptors, further ecological evaluation of the site and surrounding areas may be warranted.

The risk assessment methodologies used in this evaluation are consistent with those outlined in the Framework for Ecological Risk Assessment (USEPA, 1992i). In addition, information found in the following documents was used to supplement the USEPA guidance document:

- U.S. EPA Supplemental Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual (USEPA, 1989c)
- Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference (USEPA, 1989e)
- Rapid Bioassessment Protocols for use in Streams and Rivers: Benthic Macroinvertebrates and Fish (USEPA, 1989f)

### 7.1.3 Organization of The Ecological Risk Assessment

Based on the USEPA Framework for Ecological Risk Assessment, an ERA consists of three main components: (1) Problem Formulation, (2) Analysis, and (3) Risk Characterization (USEPA, 1992i). The Problem Formulation section includes a preliminary characterization of exposure and effects of the stressors to the ecological receptors. During the Analysis, the data is evaluated to determine the exposure and potential effects on the ecological receptors from the stressors. Finally, in the risk characterization the likelihood of adverse effects occurring as a result of exposure to a stressor are evaluated. This section evaluates the potential impact on the ecological integrity at the site from the contaminants detected in the media.

## 7.2 Problem Formulation

Problem formulation is the first step of an ERA and should include a preliminary characterization of exposure and effects, as well as scientific data needs, policy and regulatory issues, and site-specific factors to define the feasibility, scope, and objectives for the ERA (USEPA, 1992i).

The results of the various site investigations indicate the presence of pesticides and/or other contaminants in the surface water, sediment, soil and groundwater. As discussed above, CERCLA directs EPA to protect the environment with respect to releases of contaminants. Due to the potential for ecological receptors to be exposed to the contaminants detected at OU No. 1, it was decided that an ERA should be performed.

Three types of information are needed to evaluate potential links between the COPCs and the ecological endpoints. First, chemical analyses of the appropriate media are necessary to establish the presence, concentrations, and variabilities of the COPCs. Second, ecological surveys are necessary to establish if adverse ecological effects have occurred. Finally, toxicological information is necessary to evaluate the potential effects of the COPCs on the ecological receptors. The combination of all three types of data allows the assessment of the relative contribution of other potential causes of the observed effects (as measured by the ecological endpoints) that may be unrelated to the toxic effects of the contaminants of concern (e.g., habitat alterations and natural variability). Therefore, confidence in cleanup and monitoring decisions is greatly enhanced when based on a combination of chemical, ecological, and toxicological data.

Chemical analyses were performed on samples collected from the surface water, sediment, soil and groundwater to evaluate the presence, concentrations, and variabilities of the COPCs. Ecological surveys were not conducted as part of the Baker's field activities; however, based on observations and available habitats, potential ecological receptors were identified. Finally, toxicological information for the COPCs detected in the media were obtained and used to evaluate the potential adverse ecological effects to the ecological receptors.

The components of the problem formulation include: stressor characteristics; ecosystems potentially at risk; ecological effects; endpoint selection; and a conceptual model. The following sections discuss each of these components, and how they were evaluated in this ERA.

### 7.2.1 Stressor Characteristics

One of the initial steps in the problem formulation stage of an ERA is identifying the stressor characteristics. For this ERA, the stressors that were evaluated include the contaminants detected in the surface water, sediment, and surface soils. Contaminants in the subsurface soils and groundwater were not evaluated because ecological receptors are not expected to be exposed to these contaminants at the operable unit, which is primarily industrial in nature.

The nature and extent of these contaminants were discussed in Section 7.3 of this report. Table 7-1 lists the contaminants that were detected in each media at Sites 21, 24, and 78. The location of samples was based on historical information available for the site and a site visit to evaluate potential ecosystems and ecological receptors.

### 7.2.1.1 Contaminants of Potential Concern

The COPCs for the ERA were selected following the same procedures (i.e., frequency of detection) as those used for selecting the COPCs for the Human Health Risk Assessment. Some of the COPCs included in the ERA were different than those included in the Human Health RA because they may adversely impact the ecological integrity at the site whereas they may not pose a risk to humans.

#### *Contaminants of Potential Concern - Surface Water*

Surface water samples were collected at at OU No.1 from Cogdels Creek, Beaver Dam Creek and a drainage ditch at Site 21. The ERA only will address the surface water samples collected from Cogdels Creek and Beaver Dam Creek. The surface water that was collected from the drainage ditch at Site 21 consisted of puddles of water. These puddles, which form after periods of heavy rainfall, do not constitute a risk to ecological receptors.

#### *Cogdels Creek*

The following TCL organics detected in the surface water samples were not addressed in the ERA because they are common laboratory and/or decontamination contaminants: acetone, methylene chloride, and bis(2-ethylhexyl)phthalate.

The following TAL inorganics detected in the surface water samples were not addressed in the ERA because they are common naturally occurring chemicals and they were not expected to be ecologically significant at the detected concentrations or they were infrequently detected: calcium, magnesium, nickel, potassium, selenium, silver, sodium and thallium.

The following TCL organics and TAL inorganics detected in the surface water samples at Cogdels Creek are included in the ERA: TCE, aluminum, arsenic, barium, beryllium, chromium, copper, iron, lead, manganese, vanadium, and zinc.

## TABLE 7-1

## OPERABLE UNIT NO. 1
## LIST OF CONTAMINANTS DETECTED IN THE SURFACE WATER, SEDIMENT, AND SURFACE SOIL
## BASELINE ECOLOGICAL RISK ASSESSMENT
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE

| | Surface Water | | | Sediments | | | Soils | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Site 78 | | | Site 78 | | | | |
| Analyte | Site 21 | CC/NR | BDC | Site 21 | CC/NR | BDC | Site 21 | Site 24 | Site 78 |
| **Volatiles** | | | | | | | | | |
| Chloromethane | | | | | | | | | X |
| Bromomethane | | | | | | | | | X |
| Methylene chloride | X | X | | X | X | X | | | X |
| Acetone | X | X | | X | X | X | X | X | X |
| Carbon disulfide | | | | | | X | | | |
| 1,1-Dichloroethane | | | | | | | | | X |
| 1,1-Dichloroethene | | | | | | | | | X |
| 1,2-Dichloroethene | | X | | | | | | | |
| 2-Butanone | | | | | X | | | | |
| Trichloroethene | | X | | | | | | | |
| Toluene | | X | | | | | | | X |
| Ethylbenzene | | | | | X | | | | |
| Styrene | | | | | | | | X | |
| Xylenes | | | | | | | X | | X |
| **Semivolatiles** | | | | | | | | | |
| 4-Methylphenol | | | | | X | | | | |
| Naphthalene | | | | | X | X | X | | X |
| 2-Methylnaphthalene | | | | | | | X | X | X |
| Acenaphthene | | | | | X | X | | X | X |
| Dibenzofuran | | | | | X | X | | | X |
| Fluorene | | | | | X | X | X | X | X |
| Phenanthrene | | | | | X | X | X | X | X |
| Anthracene | | | | | X | X | X | X | X |

CC/NR = Cogdels Creek and New River BDC = Beaver Dam Creek

Note: Surface water and sediments were not evaluated for Site 24.

## TABLE 7-1 (Continued)

## OPERABLE UNIT NO. 1
## LIST OF CONTAMINANTS DETECTED IN THE SURFACE WATER, SEDIMENT, AND SURFACE SOIL
## BASELINE ECOLOGICAL RISK ASSESSMENT
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE

| | Surface Water | | | Sediments | | | Soils | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Site 78 | | | Site 78 | | | | |
| Analyte | Site 21 | CC/NR | BDC | Site 21 | CC/NR | BDC | Site 21 | Site 24 | Site 78 |
| Carbazole | | | | | X | X | | X | X |
| Di-n-butyl phthalate | | X | | X | X | | | | X |
| Fluoranthene | | | | | X | X | X | X | X |
| Pyrene | | | | | X | X | X | X | X |
| Butyl benzyl phthalate | | | | X | X | | | X | X |
| 3,3'-Dichlorobenzidine | | | | | | | X | | |
| Benzo (a) anthracene | | | | | X | X | X | X | X |
| Chrysene | | | | | X | X | X | X | X |
| Bis (2-ethylhexyl) phthalate | | X | | X | X | X | X | X | X |
| Di-n-octyl phthalate | | | | X | | | | | |
| Benzo (b) fluoranthene | | | | | X | X | X | X | X |
| Benzo (k) fluoranthene | | | | | X | X | X | X | X |
| Benzo (a) pyrene | | | | | X | X | X | X | X |
| Indeno (1,2,3-cd) pyrene | | | | | X | X | X | X | X |
| Dibenz (a,h) anthracene | | | | | X | | X | | X |
| Benzo (g,h,i) perylene | | | | | X | X | X | X | X |
| **Inorganics** | | | | | | | | | |
| Aluminum | X | X | X | X | X | X | X | X | X |
| Antimony | | | | | X | | | X | X |
| Arsenic | | X | X | X | X | X | X | X | X |
| Barium | X | X | X | X | X | X | X | X | X |
| Beryllium | | X | X | X | X | X | X | X | X |
| Cadmium | | | | X | X | | X | X | X |
| Calcium | X | X | X | X | X | X | X | X | X |
| Chromium | | X | X | X | X | X | X | X | X |

CC/NR = Cogdels Creek and New River BDC = Beaver Dam Creek
Note: Surface water and sediments were not evaluated for Site 24.

## TABLE 7-1 (Continued)

## OPERABLE UNIT NO. 1
## LIST OF CONTAMINANTS DETECTED IN THE SURFACE WATER, SEDIMENT, AND SURFACE SOIL
## BASELINE ECOLOGICAL RISK ASSESSMENT
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE

| | Surface Water | | | Sediments | | | Soils | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Site 78 | | | Site 78 | | | | |
| Analyte | Site 21 | CC/NR | BDC | Site 21 | CC/NR | BDC | Site 21 | Site 24 | Site 7 |
| Cobalt | | X | | | X | X | X | X | X |
| Copper | X | X | X | X | X | X | X | X | X |
| Iron | X | X | X | X | X | X | X | X | X |
| Lead | | X | X | X | X | X | X | X | X |
| Magnesium | X | X | X | X | X | X | X | X | X |
| Manganese | X | X | X | X | X | X | X | X | X |
| Mercury | | | | | X | | X | X | X |
| Nickel | | X | | X | | X | X | X | X |
| Potassium | X | X | X | X | X | X | X | X | X |
| Selenium | X | X | | X | X | X | X | X | X |
| Silver | | X | | | X | | | X | |
| Sodium | X | X | X | X | X | X | X | X | X |
| Thallium | X | X | | | X | X | | X | |
| Vanadium | | X | X | X | X | X | X | X | X |
| Zinc | X | X | X | X | X | X | X | X | X |
| Cyanide | | | | | | | | X | |
| **Pesticides** | | | | | | | | | |
| Heptachlor | | | | | | | | X | X |
| Heptachlor epoxide | | | | X | | | | X | |
| Dieldrin | | | | | | | | X | X |
| 4,4'-DDE | | | | X | X | X | X | X | X |
| Endrin | | | | | | | | | X |
| 4,4-DDD | X | X | | X | X | X | X | X | X |
| 4,4-DDT | | X | | X | X | X | X | X | X |
| Endrin aldehyde | | | | | | | | | X |

CC/NR = Cogdels Creek and New River BDC = Beaver Dam Creek
Note: Surface water and sediments were not evaluated for Site 24.

## TABLE 7-1 (Continued)

## OPERABLE UNIT NO. 1
## LIST OF CONTAMINANTS DETECTED IN THE SURFACE WATER, SEDIMENT, AND SURFACE SOIL
## BASELINE ECOLOGICAL RISK ASSESSMENT
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE

| | Surface Water | | | Sediments | | | Soils | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Site 78 | | | Site 78 | | | | |
| Analyte | Site 21 | CC/NR | BDC | Site 21 | CC/NR | BDC | Site 21 | Site 24 | Site 78 |
| alpha-Chlordane | | | | X | X | X | X | X | X |
| gamma-Chlordane | | | | X | X | X | X | X | X |
| **PCBs** | | | | | | | | | |
| PCB - 1254 | | | | | | | | X | |
| PCB - 1260 | | | | X | | X | X | X | X |

CC/NR = Cogdels Creek and New River BDC = Beaver Dam Creek
Note: Surface water and sediments were not evaluated for Site 24.

*Beaver Dam Creek*

The following TAL inorganics detected in the surface water samples were not addressed in the ERA because they are common naturally occurring chemicals and they were not expected to be ecologically significant at the detected concentrations or they were infrequently detected: beryllium, chromium, calcium, magnesium, potassium, and sodium.

The following TAL inorganics detected in the surface water samples at Beaver Dam Creek are included in the ERA: aluminum, arsenic, barium, copper, iron, lead, manganese, vanadium, and zinc. There were no TCL organics detected in the surface water samples.

*Contaminants of Potential Concern - Sediments*

Sediment samples were collected at OU No. 1 from Cogdels Creek, Beaver Dam Creek and the drainage ditch at Site 21. The ERA only will address the sediment samples collected from Cogdels Creek and Beaver Dam Creek. The sediments that were collected from the drainage ditch at Site 21 are not expected to be a risk to ecological receptors. Because the ditch does not constitute a surface water body of concern, the sediments would not be considered an ecological concern either.

*Cogdels Creek*

The following TCL organics detected in the sediment samples were not addressed in the ERA because they are common laboratory and/or decontamination contaminants: acetone, methylene chloride, 2-butanone, di-n-butyl phthalate and bis(2-ethylhexyl)phthalate.

The following TAL inorganics detected in the sediment samples were not addressed in the ERA because they are common naturally occurring chemicals, they were not expected to be ecologically significant at the detected concentrations, or they were infrequently detected: antimony, calcium, cobalt, magnesium, mercury, potassium, sodium and thallium.

The following chemicals detected in the sediment samples were addressed in the ERA: phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, benzo(g,h,i)perylene, 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, alpha-chlordane, gamma-chlordane, aluminum, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, manganese, selenium, silver, vanadium, and zinc.

*Beaver Dam Creek*

The following TCL organics detected in the sediment samples were not addressed in the ERA because they are common laboratory and/or decontamination contaminants: acetone, methylene chloride, and bis(2-ethylhexyl)phthalate.

The following TAL inorganics detected in the sediment samples were not addressed in the ERA because they are common naturally occurring chemicals, they were not expected to be ecologically significant at the detected concentrations, or they were infrequently detected: calcium, magnesium, nickel, potassium, sodium and thallium.

The following chemicals detected in the sediment samples were addressed in the ERA: phenanthrene, fluoranthene, pyrene, chrysene, 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, alpha-chlordane, gamma-chlordane, aluminum, arsenic, barium, beryllium, chromium, cobalt, copper, iron, lead, manganese, selenium, vanadium, and zinc.

### *Contaminants of Potential Concern - Surface Soils*

Surface soil samples were collected at Sites 21, 24, and 78.

*Site 21*

The following TCL organics detected in the surface soil samples were not addressed in the ERA because they are common laboratory and/or decontamination contaminants: acetone and bis(2-ethylhexyl)phthalate.

The following TAL inorganics detected in the surface soil were not addressed in the ERA because they are common naturally occurring chemicals, they were not expected to be ecologically significant at the detected concentrations, they were infrequently detected or they were within typical background concentration found at the site: barium, calcium, cadmium, cobalt, magnesium, mercury, nickel, potassium, and sodium.

The following chemicals detected in the surface soil samples were addressed in the ERA: phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, benzo(g,h,i)perylene, 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, alpha-chlordane, gamma-chlordane, PCB-1260, aluminum, arsenic, beryllium, chromium, copper, iron, lead, manganese, selenium, vanadium, and zinc.

*Site 24*

The following TCL organics detected in the surface soil samples were not addressed in the ERA because they are common laboratory and/or decontamination contaminants: acetone and bis(2-ethylhexyl)phthalate.

The following TAL inorganics detected in the surface soil were not addressed in the ERA because they are common naturally occurring chemicals, they were not expected to be ecologically significant at the detected concentrations, they were infrequently detected or were within typical background concentrations found at the site: antimony, calcium, cadmium, magnesium, potassium, silver, and sodium.

The following chemicals detected in the surface soil samples were addressed in the ERA: fluoranthene, pyrene, chrysene, benzo(b)fluoranthene, dieldrin, 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, alpha-chlordane, gamma-chlordane, PCB-1254, PCB-1260, aluminum, arsenic, barium, beryllium, chromium, copper, cobalt, iron, lead, manganese, mercury, nickel, selenium, thallium, vanadium, and zinc.

*Site 78*

The following TCL organics detected in the surface soil samples were not addressed in the ERA because they are common laboratory and/or decontamination contaminants: acetone, methylene chloride, butylbenzyl phthalate, di-n-butyl phthalate and bis(2-ethylhexyl)phthalate.

The following TAL inorganics detected in the surface soil were not addressed in the ERA because they are common naturally occurring chemicals, they were not expected to be ecologically significant at the detected concentrations, or they were infrequently detected: antimony, calcium, cobalt, magnesium, mercury, nickel, potassium, and sodium.

The following chemicals detected in the surface soil samples were addressed in the ERA: phenanthrene, anthracene, carbazole, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, benzo(g,h,i)perylene, dieldrin, 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, alpha-chlordane, aluminum, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, manganese, selenium, vanadium, and zinc.

### 7.2.1.2 Physical/Chemical Characteristics

Table 7-2 contains values for bioconcentration factors, water solubility, organic carbon partition coefficient, and vapor pressure for the contaminants identified in the sediments, surface water and surface soil samples. Information from this table was used in the risk characterization to assess the fate and transport of the constituents and the potential risks to the environmental receptors. The following paragraphs discuss the significance of each parameter included in the table.

Bioconcentration measures the tendency for a chemical to partition from the water column or sediment and concentrate in aquatic organisms. Bioconcentration is important for ecological receptors because chemicals with high bioconcentration could accumulate in lower-order species and subsequently accumulate to toxic levels in higher-order species that consume the lower-order species. The bioconcentration is reported as the bioconcentration factor (BCF) which is the concentration of the chemical in the organism at equilibrium divided by the concentration of the chemical in the water. Therefore, the BCF is unitless. Bioconcentration factors among the metals range from 1 for chromium to 350,000 for manganese. The bioconcentration factors among the organics range from 17 for TCE to 4,400,000 for 4,4'-DDT. The pesticides have the highest potential to concentrate in the tissue of organisms exposed to the contaminants. Published BCF data were not available for some of the COPCs at OU No. 1.

Water solubility is important in the ecological environment because it measures the tendency for a chemical to remain dissolved in the water column, partition to soil or sediment, or bioconcentrate in aquatic organisms. Chemicals with high water solubilities tend to be more bioavailable to aquatic organisms. However, they will not significantly bioconcentrate in the organisms. On the other hand, chemicals with a low water solubility will remain bound to the sediment and soils but may bioconcentrate in organisms to a significant degree. The water

## TABLE 7-2

## OPERABLE UNIT NO. 1
## PHYSICAL/CHEMICAL CHARACTERISTICS OF THE CONTAMINANTS OF CONCERN
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| | BCF (l/kg) | Water Solubility (mg/l) | Organic Carbon Partition Coefficient (ml/g) | Vapor Pressure (mm Hg) |
|---|---|---|---|---|
| Aluminum | ND(1,3) | ND(1,3) | ND(1) | ND(1,3) |
| Arsenic | 4(3) | ND(1,3) | ND(1) | (1,2,3) |
| Barium | ND(1,3) | ND(1,3) | ND(1) | (1,2,3) |
| Beryllium | 19(3) | ND(1,3) | ND(1) | (1,2,3) |
| Cadmium | 3,800(3) | ND(1,3) | ND(1) | (1,2,3) |
| Chromium | 1(3) | ND(1,3) | ND(1) | (1,2,3) |
| Cobalt | ND(3) | ND(1,3) | ND(1) | 1,300(3) |
| Copper | 23,000(3) | ND(1,3) | ND(1) | (1,2,3) |
| Iron | ND(3) | ND(1,3) | ND(1) | ND(1,3) |
| Lead | 45(3) | ND(1,3) | ND(1) | (1,2,3) |
| Manganese | 350,000(3) | ND(1,3) | ND(1) | ND(1,3) |
| Mercury | 86,000(3) | ND(1,3) | ND(1) | 0.002(3) |
| Nickel | 8(3) | ND(1,3) | ND(1) | (1,2,3) |
| Selenium | 5,700(3) | ND(1,2) | ND(1) | (1,2,3) |
| Silver | 28(3) | ND(1,3) | ND(1) | (1,2,3) |
| Thallium | 130(3) | ND(1,3) | ND(1) | 880(3) |
| Vanadium | ND(3) | ND(1,3) | ND(1) | ND(3) |
| Zinc | 130(3) | ND(1,3) | ND(1) | (1,2,3) |

(1) USEPA, 1986.
(2) Negligible (less than 0.1).
(3) SCDM, 1991.
ND = No data
BCF = Bioconcentration Factors

## TABLE 7-2 (Continued)

## OPERABLE UNIT NO. 1
## PHYSICAL/CHEMICAL CHARACTERISTICS OF THE CONTAMINANTS OF CONCERN
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| | BCF (l/kg) | Water Solubility (mg/l) | Organic Carbon Partition Coefficient (ml/g) | Vapor Pressure (mm Hg) |
|---|---|---|---|---|
| Trichloroethene | 17(3) | 1,100(3) | 126(1) | 69(3) |
| Chlordane, total | ND(3) | 0.056(3) | 140,000(1) | (1,2,3) |
| Dieldrin | 6,800(3) | 0.2(3) | 1,700(1) | (1,2,3) |
| PCB, total | 61,000(3) | ND(1,3) | 530,000(1) | (1,3) |
| 4,4-'-DDE | 180,000(3) | 0.12(3) | 4,400,000(1) | (1,2,3) |
| 4,4-'-DDD | ND(3) | 0.09(3) | 770,000(1) | (1,2,3) |
| 4,4-'-DDT | 4,400,000(3) | 0.025(3) | 243,000(1) | (1,2,3) |
| Anthracene | 9,200(3) | 0.043(3) | 14,000(1) | (1,2,3) |
| Benzo(a)anthracene | ND(3) | (1,2,3) | 1,380,000(1) | (1,2,3) |
| Benzo(a)pyrene | 83,000(3) | (1,2,3) | 5,500,000(1) | (1,2,3) |
| Benzo(b)fluoranthene | ND | (1,2) | 550,000(1) | (2,3) |
| Benzo(k)fluoranthene | ND(3) | (1,2,3) | 550,000 | (1,2,3) |
| Benzo(g,h,i)perylene | ND | (1,2) | 1,600,000(1) | (1,2) |
| Carbazole | ND | ND | ND | ND |
| Chrysene | ND(3) | (1,2,3) | 200,000(1) | (1,2,3) |
| Fluoranthene | 1,150(1) | 0.206(1) | 38,000(1) | (1,2) |
| Indeno(1,2,3-cd)pyrene | ND(1) | (1,2) | 1,600,000(1) | (1,2) |
| Phenanthrene | 2,630(1) | 1.2(3) | 14,000(1) | (1,2,3) |
| Pyrene | 69(3) | (1,2,3) | 38,000(1) | (1,2,3) |

(1) USEPA, 1986.
(2) Negligible (less than 0.1).
(3) SCDM, 1991.
ND = No data
BCF = Bioconcentration Factors

solubility of the organics ranged from less than 0.01 mg/l for some pesticides and semivolatiles to 1,100 mg/l for TCE.

The organic carbon partition coefficient (Koc) measures the tendency for a chemical to partition between soil or sediment particles containing organic carbon and water. This coefficient is important in the ecological environment because it determines how strongly an organic chemical will be bound to the organics in the sediments. The Koc is highest for benzo(a)pyrene at 5.5 x $10^6$ ml/g and lowest for TCE at 126 ml/g. Koc values are negligible for metals.

The vapor pressure measures the tendency for a chemical to partition into air. This parameter is important for the ecological environment because it can be used to determine the concentrations of the constituents in air. The vapor pressure is highest for TCE, 69 mm Hg. The vapor pressure for the most other contaminants of concern are low or negligible.

### 7.2.2 Ecosystem Potentially at Risk

Based on the site-specific and regional ecology, many ecological receptors are potentially at risk from contaminants at the site. Contaminants were identified in the surface water, sediment, soil and groundwater. Potential receptors of contaminants in surface water and sediment include fish, benthic macroinvertebrates, other aquatic flora and fauna and some terrestrial faunal species. Potential receptors of contaminants in soils include: deer, rabbits, birds and other terrestrial flora and fauna. Ecological receptors are not expected to be exposed to contaminants detected in the subsurface soil or the groundwater. Therefore, these pathways will not be evaluated.

### 7.2.3 Ecological Effects

The ecological effects data that were used to assess potential risks to aquatic and/or terrestrial receptors in this ERA include: North Carolina Water Quality Standards, USEPA Water Quality Screening Values, Ambient Water Quality Criteria Documents, the Aquatic Information Retrieval Database, NOAA Sediment Screening Values, and terrestrial reference values. The following paragraphs discuss each of the above data sources.

The North Carolina Department of Environment, Health, and Natural Resources (NC DEHNR) has promulgated Water Quality Standards (WQS). These WQS meet the requirements of both federal and state law. These standards are regulatory values and are enforceable. They are used to evaluate the quality of waters in North Carolina.

The USEPA Region IV Waste Management Division (Region IV) has adopted Water Quality Screening Values (WQSV) for chemicals detected at hazardous waste sites (USEPA, 1992f). These values are intended as preliminary screening tools to review chemical data from hazardous waste sites. Exceedences of the screening level values indicate that there may be a need for further investigation of the site.

Section 304(a)(1) of the Clean Water Act of 1977 (P.L. 95-217) requires the Administrator of the USEPA to publish criteria for water quality accurately reflecting the latest scientific knowledge on the type and extent of all identifiable effects on health and welfare which may be expected from the presence of pollutants in any body of water, including groundwater. In accordance with the Clean Water Act, the USEPA Office of Water Regulations and Standards, Criteria and Standards Division have published Ambient Water Quality Criteria (AWQC) documents for several chemicals. These documents can be used to evaluate potential risks to aquatic organisms. In addition, potential risks to aquatic plants from contaminants also can be evaluated using these documents.

The Aquatic Information Retrieval (AQUIRE) database is an online system that contains information on acute, chronic, bioaccumulative, and sublethal effects data from tests performed on freshwater and saltwater organisms excluding bacteria, birds, and aquatic mammals. This database can be accessed to evaluate potential risks to aquatic organisms.

Currently, promulgated sediment quality criteria do not exist. Until these criteria are developed, USEPA Region IV is using Sediment Screening Values (SSV) compiled by National Oceanic and Atmospheric Administration for evaluating the potential for chemical constituents in sediments to cause adverse biological effects (USEPA, 1992f). The lower ten percentile (Effects Range-Low [ER-L]) and the median percentile (Effects Range-Median [ER-M]) of biological effects have been developed for several of the chemicals identified during the sediment investigations at OU No. 1. If sediment contaminant concentrations are above the ER-M, adverse effects on the biota are considered probable. If contaminant concentrations are between the ER-M and ER-L, adverse effects on the biota are considered possible, and EPA recommends conducting toxicity tests as a follow-up. Finally, if contaminant concentrations are below the ER-L, adverse effects on the biota are considered unlikely (USEPA, 1992f).

There are no standards, criteria, or other screening values for assessing potential impacts to terrestrial ecological receptors from contaminants in soils. A literature search was conducted to identify levels of inorganic contaminants in the soil that could cause adverse effects to terrestrial flora and invertebrates. However, this data cannot be used to evaluate potential risks to other terrestrial fauna (e.g., birds, deer, rabbits), since the exposure doses for these species are different than invertebrates and plants, which are in constant direct contact with the contaminants in the soil. In addition, the sensitivity of the organisms to the COPCs are not similar.

Terrestrial reference values (TRVs) for evaluating estimated chronic daily intakes (CDIs) were calculated from available toxicity data. TRVs were developed from No-Observed-Adverse-Effect-Levels (NOAELs) or Lowest-Observed-Adverse-Effect-Levels (LOAELs) obtained from the Integrated Risk Information System (IRIS) or toxicological profiles. These values also are used to assess the potential effects of contaminants on terrestrial fauna.

### 7.2.4 Ecological Endpoints

The information compiled during the first stage of problem formulation (stressor characteristics, ecosystems potentially at risk, and ecological effects) was used to select the ecological endpoints for this ERA. The following section of this report contains a description of the ecological endpoints selected for this ERA, and the reason they were selected.

There are two primary types of ecological endpoints: assessment endpoints and measurement endpoints. Assessment endpoints are environmental characteristics, which, if they were found to be significantly affected, would indicate a need for remediation (e.g., decrease in sports/fisheries). Measurement endpoints are quantitative expressions of an observed or measured effect of the contamination of concern. Measurement endpoints may be identical to assessment endpoints (e.g., measurement of abundance of fish), or they may be used as surrogates for assessment endpoints (e.g., toxicity test endpoints). Both types of endpoints were used in the ecological risk evaluation and are discussed in the following sections.

### 7.2.4.1 Assessment Endpoints

Assessment endpoints are the ultimate focus of risk characterization and link the measurement endpoints to the risk management process (USEPA, 1992i). There are five criteria that an assessment endpoint should satisfy (Suter, 1993):

- Societal relevance
- Biological relevance
- Unambiguous operational definition
- Accessibility to prediction and measurement
- Susceptibility to the hazardous agent

Societal relevance is important because risk to ecological receptors of little intrinsic interest to the public (e.g., nematodes, zooplankton) are unlikely to influence decisions unless they can be shown to indicate risks to biota of direct human interest (e.g., fish, wildlife) (Suter, 1993). The biological significance of a property is determined by its importance to a higher level of the biological hierarchy (Suter, 1993). The endpoint should be well defined and operational with a subject (e.g., benthic macroinvertebrates) and a characteristic of the subject (e.g., decrease in numbers of benthic macroinvertebrate) (USEPA, 1989b). The endpoint should be measurable (e.g., numbers of individuals) or predictable from measurements (e.g., toxicity tests). Finally, the endpoint must be susceptible to the contaminant being assessed.

The assessment endpoints in this ERA were decreased viability of populations of aquatic and terrestrial floral and faunal species.

Specifically, as discussed further in the Measurement Endpoint section of this report, the ERA will focus on decreased viability to aquatic organisms, deer, rabbits, and quail.

Aquatic organisms (e.g., fish, benthic macroinvertebrates) are socially relevant because humans enjoy the sport of fishing and they also are a food source for many people. The organisms are biologically relevant because they serve as food sources for other aquatic and terrestrial organisms. The endpoint is defined with a subject (aquatic organisms), and a characteristic of the subject (decreased viability to aquatic organisms). The endpoint may be predicted by contaminant concentrations in media exceeding published toxicity values. Finally, aquatic organisms are susceptible to the COPCs at OU No. 1.

Terrestrial organisms (e.g., rabbits, robin, deer, quail) are socially relevant because humans enjoy the sport of hunting and they also are a food source for many people. The organisms are biologically relevant because they serve as food sources for other terrestrial organisms. The endpoint is defined with a subject (rabbits, robin, deer and quail), and a characteristic of the subject (decreased viability to rabbits, robin, deer, and quail). The TRVs can be used to predict risks to terrestrial organisms. Finally, terrestrial organisms are susceptible to the COPCs at OU No. 1.

#### 7.2.4.2 Measurement Endpoints

A measurement endpoint, or "ecological effects indicator" as it is sometimes referred, is used to evaluate the assessment endpoint. Therefore, measurement endpoints must correspond to, or be predictive of, assessment endpoints. In addition, they must be readily measurable, preferably quickly and inexpensively, using existing techniques. Measurement endpoints must take into consideration the magnitude of the contamination (e.g., it would be inappropriate to use abundance of a deer population to assess the effects on a one-acre site) and the exposure pathway. The measurement endpoint should be an indicator of effects that are temporally distributed. Low natural variability in the endpoint is preferred to aid in attributing the variability in the endpoint to the contaminant. Measurement endpoints should be diagnostic of the pollutants of interest, as well as broadly applicable to allow comparison among sites and regions. Also, measurement endpoints should be standardized (e.g., standard procedures for toxicity tests). Finally, it is desirable to use endpoints that already are being measured (if they exist) to determine baseline conditions.

Endpoints are divided into four primary ecological groups: individual, population, community, and ecosystem endpoints. Individual endpoints (e.g., death, growth, tissue concentrations) are evaluated through toxicity tests, models, and other methods used to assess the effects on individual organisms. Population endpoints (e.g., occurrence, abundance, reproductive performance) are evaluated to determine presence and absence of species through field studies. Community endpoints (e.g., number of species, species diversity) are used to describe the complexity of the community. Finally, ecosystem endpoints (e.g., biomass, productivity, nutrient dynamics) are used to determine the effects between groups of organisms, and between organisms and the environment. Individual and population endpoints were evaluated in this assessment.

The primary goal in deciding upon which ecological endpoints to evaluate was to determine the current effects that the contamination is having on the environment. The following sections discuss the measurement endpoints that were chosen for the ERA.

*Aquatic Endpoints*

Aquatic biological samples (e.g., fish, benthic macroinvertebrates) were not collected as part of the field activities at OU No. 1. Fish and benthic macroinvertebrates potentially may inhabit Cogdels Creek and Beaver Dam Creek (Site 78) due to their habitat and physical characteristics. Therefore, these aquatic organisms are potential ecological receptors at risk. However, aquatic organisms at Site 21 (the drainage ditch) are not expected to be ecologically or biologically significant. The following paragraphs discuss how decreased viability to these species was evaluated in this ERA.

Contaminant concentrations detected in the surface water at OU No. 1 were compared to the NC DEHNR WQS, USEPA WQSV, and other toxicity values obtained from the AWQC documents and AQUIRE to determine if there were any exceedences of the published values. In addition, the log normal upper 95 percent confidence limit or the maximum value detected were compared to the WQS and the acute and chronic WQSVs using the quotient ratio method. The quotient ratio method is simply the COPC concentration divided by the ARAR value. A ratio greater than unity indicates a potential for adverse effects to aquatic life. The log normal upper 95 percent confidence limit were used to represent a conservative estimate of exposure at the site. If the variability in measured concentration values is great and the log normal upper 95 percent confidence limit was greater than the maximum detected value, the maximum detected value was used in the quotient ratio.

Contaminant concentrations detected in the sediments at Site OU No. 1 were compared to the NOAA SSVs to determine if there were any exceedences in the established values. In addition, the upper 95 percent confidence limit or the maximum value detected was compared to the ER-L and ER-M using the quotient ratio method.

*Terrestrial Endpoints*

As discussed earlier in this report, several terrestrial faunal species inhabit MCB Camp Lejeune including deer, birds, and small mammals, and potentially are exposed to the COPCs at OU No. 1. Potential effects from contaminants detected at OU No. 1 on these species were evaluated by comparing the CDIs to TRVs. In addition, comparisons of COPC concentrations in the soil to published plant and earthworm toxicity information was used to evaluate potential effects to some terrestrial species.

### 7.2.5 The Conceptional Model

This section of the report contains a list of hypotheses regarding how the stressors might affect ecological components of the natural environment:

- Aquatic receptors potentially may be adversely affected by exposure to contaminated water and sediment.
- Terrestrial receptors potentially may be adversely affected by exposure to contaminants in the surface water and surface soil.
- Terrestrial receptors potentially may be adversely affected by exposure to contaminants organisms and vegetation they ingest.

## 7.3 Analysis Phase

The next phase after the problem formulation is the analysis which consists of the technical evaluation of data on the potential effects and exposure of the stressor. This phase includes the ecological exposure characterization and the ecological effects characterization.

### 7.3.1 Characterization of Exposure

Characterization of exposure evaluates the interaction of the stressor with the ecological component. The following sections characterize the exposure in accordance with the stressors, ecosystem, exposure analysis, and exposure profile.

#### 7.3.1.1 Stressor Characterization: Distribution or Pattern of Change

The remedial investigations involved collecting samples from four environmental media; surface water, sediment, soil, and groundwater. The analytical results of these investigations are presented in Section 4.0 of this report. In addition, the source identification also is presented in Section 4.0 of the report, while the extent of contamination is discussed in

Section 4.3 of this report. Only one round of sampling was collected for the remedial investigations, therefore the temporal pattern of change cannot be determined.

### 7.3.1.2 Ecosystem Characterization

This section includes a discussion of the regional ecology, study area description, and sensitive environments at and adjacent to OU No. 1. A discussion of the site history is discussed in Section 1.0 of this report.

#### *Ecology*

The following section describes the regional ecology at MCB Camp Lejeune including the regional flora and fauna, and the associated surface water bodies.

#### *Regional Flora and Fauna*

MCB Camp Lejeune, North Carolina, is approximately 108,800 acres, with 84 percent of the area covered by forests (USMC, 1987). The base drains primarily to the New River or its tributaries including Northeast Creek, Southwest Creek, Wallace Creek, French Creek, Bear Head Creek, Freeman Creek, and Duck Creek. The soil types range from sandy loams to fine sand and muck, with the dominant series being sandy loam (USMC, 1987).

Vegetation at MCB Camp Lejeune, North Carolina, includes pure pine stands of loblolly and longleaf pine in the drier upland soils, pure pond pine stands in high organic wet soils, pine-hardwood and pure hardwood stands in streamside zones and in more productive soils, and bottomland hardwoods in the floodplains of the major creeks (USMC, 1987). Wildlife on the base includes white-tailed deer, wild turkey, and black bear along with numerous small game species (e.g., bobwhite quail, morning dove, rabbit) (USMC, 1987).

#### *Water Body Description*

A drainage ditch surrounding Site 21 collects surface runoff from the site. Previous reports state that drainage from the site flows in a northerly direction, towards Bearhead Creek. However, during RI field activities, observations of the drainage ditch revealed that it was dry, with the exception of the deeper northern end. It was thus determined that water occupies the drainage ditch during periods of heavy precipitation (and for some time afterward). Since the drainage ditch is intermittent, it does not have a class designation.

Cogdels Creek is designated as Class SC NSW (NC DEHNR, 1993b). The SC classification is for tidal salt waters protected for aquatic life propagation and survival, fishing, wildlife, and secondary recreation. The NSW (Nutrient Sensitive Waters) classification is for waters subject to growths of microscopic or macroscopic vegetation requiring limitations on nutrient inputs (NC DEHNR, 1992a, 1993b). Cogdels Creek flows into The New River. The New River, downstream of Northeast Creek, is designated as Class SC NSW. Beaver Dam Creek is designated as Class SB NSW (NC DEHNR, 1993b). The SB classification is for primary recreation in addition to other usage specified by the "SC" classification.

### *Site Description and Ecology*

Site 78 is primarily flat and consists of paved areas, including roadways, parking lots, loading dock areas, and open lots, along with many smaller lawn and wooded areas. Site 24 is primarily a wooded area, and is hilly and unpaved with site drainage towards Cogdels Creek. The land associated with Site 21 is relatively flat and consists of grassy, gravel, and concrete areas. Deer, rabbits and birds were the only terrestrial faunal species observed at OU No. 1. Based on the regional ecology, and due to the wooded areas around OU No. 1, there is the potential for other terrestrial fauna to periodically visit the site.

Baker has conducted several ecological surveys at MCB Camp Lejeune. These surveys were conducted in Wallace Creek, Bearhead Creek, Everett Creek, the New River and several unnamed tributaries to the New River. During these surveys, fish and benthic macroinvertebrate species were collected, along with blue crabs, and mussels. Some of the sampling stations were located in the headwaters of the creeks that were similar in size and habitat as Cogdels Creek. Fish and benthic macroinvertebrates were collected from creek reaches that were similar to Cogdels Creek. Therefore, it is assumed that fish and benthic macroinvertebrates are present in Cogdels Creek in the areas where the COPCs were detected.

Based on observations noted during the field investigation, the portion of Beaver Dam Creek within OU No. 1 appears to be too small and shallow to support any significant fish or aquatic life habitat. However, downstream portions of Beaver Dam Creek (to which COPCs potentially may migrate) are similar in size and habitat to other tributaries at Camp Lejeune where fish and benthic macroinvertebrates are present.

Based on the available information compiled from historical data and a site visit, as well as observations made during the sampling of similar types of ecosystems at MCB Camp Lejeune, a biohabitat map was developed that depicts the various aquatic and terrestrial ecosystems on and adjacent to OU 1. Included on the map (see Figure 7-1) are wetlands, waterways, fisheries, woodlands, management adaption areas, wildlife food plots, and land use (commercial/industrial, roadways, landscaped, barren).

### *Sensitive Environments*

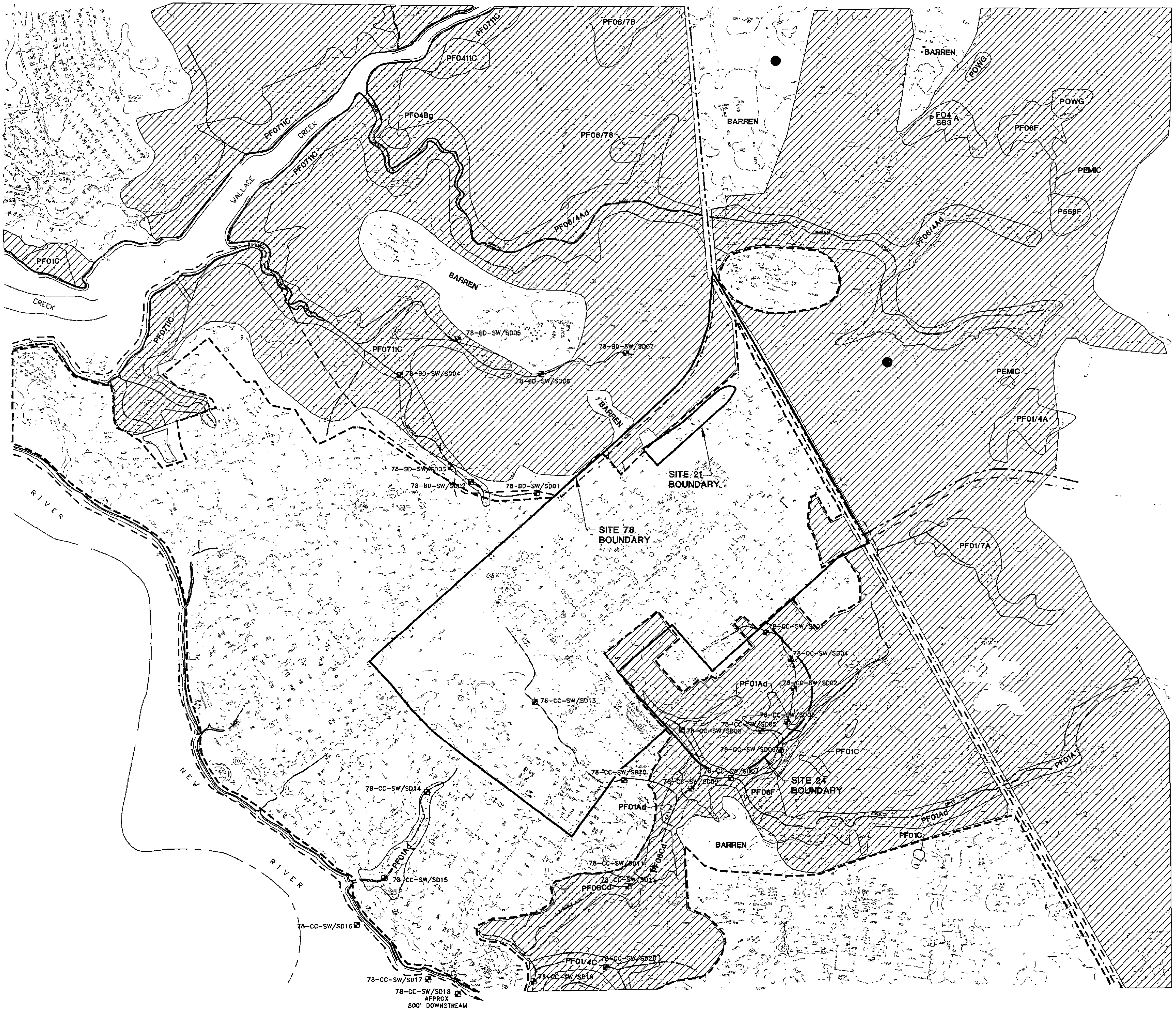
This section describes the sensitive environments that were evaluated at OU No. 1. These sensitive environments include wetlands, threatened and endangered species, and other potentially sensitive environments.

#### *Wetlands*

The NC DEHNR's Division of Environmental Management (DEM) has developed guidance pertaining to activities that may impact wetlands (NC DEHNR, 1992b). In addition, certain activities impacting wetlands also are regulated by the U.S. Corps of Engineers.

The U.S. Fish and Wildlife Service (FWS) prepared a National Wetlands Inventory (NWI) map for the Camp Lejeune, North Carolina quadrangle by stereoscopic analysis of high altitude aerial photographs (USDI, 1982). OU No. 1 is included in this map (see Appendix A for a copy of the NWI map). The wetlands were identified on the photographs based on vegetation, visible hydrology, and geography in accordance with Classification of Wetland and Deep-Water Habitats of the United States (Cowardin, et al, 1979). NWI maps are intended for an initial identification of wetland areas. They cannot be substituted for an actual wetland delineation that may be required by Federal, State and/or local regulatory agencies.

No wetlands have been identified within OU No. 1 from the NWI map (see Appendix S), although several palustrine wetland areas have been identified along the southeastern border of OU No. 1, adjacent to Cogdels Creek. A site specific wetland delineation has not been conducted at OU No. 1.



WETLANDS KEY

| SYSTEM | P – PALUSTRINE | | | | |
|---|---|---|---|---|---|
| CLASS | RB–ROCK BOTTOM | UB–UNCONSOLIDATED BOTTOM | AB–AQUATIC BED | US–UNCONSOLIDATED SHORE | ML–MOSS LICHEN |
| SUBCLASS | 1 BEDROCK<br>2 RUBBLE | 1 COBBLE–GRAVEL<br>2 SAND<br>3 MUD<br>4 ORGANIC | 1 ALGAL<br>2 AQUATIC MOSS<br>3 ROOTED VASCULAR<br>4 FLOATING VASCULAR<br>5 UNKNOWN SUBMERGENT<br>6 UNKNOWN SURFACE | 1 COBBLE–GRAVEL<br>2 SAND<br>3 MUD<br>4 ORGANIC<br>5 VEGETATED | 1 MOSS<br>2 LICHEN |

| SYSTEM | P – PALUSTRINE | | | |
|---|---|---|---|---|
| CLASS | EM–EMERGENT | SS–SCRUB SHRUB | FO–FORESTED | OW–OPEN WATER (UNKNOWN BOTTOM) |
| SUBCLASS | 1 PERSISTENT<br>2 NONPERSISTENT | 1 BROAD–LEAVED DECIDUOUS<br>2 NEEDLE LEAVED DECIDUOUS<br>3 BROAD–LEAVED EVERGREEN<br>4 NEEDLE–LEAVED EVERGREEN<br>5 DEAD<br>6 DECIDUOUS<br>7 EVERGREEN | 1 BROAD–LEAVED DECIDUOUS<br>2 NEEDLE LEAVED DECIDUOUS<br>3 BROAD–LEAVED EVERGREEN<br>4 NEEDLE–LEAVED EVERGREEN<br>5 DEAD<br>6 DECIDUOUS<br>7 EVERGREEN | |

LEGEND

| | |
|---|---|
| ● | WILDLIFE FOOD PLOTS |
| — — — — | DEER MANAGEMENT ADAPTATION AREA |
| — — — | QUAIL MANAGEMENT ADAPTATION AREA |
| —— - - —— | TURKEY MANAGEMENT ADAPTATION AREA |
| ———— | WATERWAYS |
| ▬ ▬ ▬ ▬ | INDUSTRIAL/COMMERCIAL AREA |
| ⬚ | WETLANDS |
| ▨ | FORESTED AREA |
| 78–BD–SW/SD01 ⊠ | SURFACE WATER(SW)/SEDIMENT(SD) SAMPLE STATION |

NOTE
- –THE FORESTED AREA IS COMPRISED PRIMARILY OF LOBLOLLY PINE AND LONGLEAF PINE SLASH PINES AND SHORTLEAF PINES MAY ALSO BE PRESENT HARDWOODS, SUCH AS WATER OAK, GREEN ASH, SWEETGUM, AND EASTERN COTTONWOOD ARE INTERMIXED WITH THE CONIFERS ALONG THE SURFACE WATER BODIES
- –THE RED–COCKADED WOODPECKER AND AMERICAN ALLIGATOR ARE ENDANGERED SPECIES FOUND AT CAMP LEJEUNE HOWEVER THERE ARE NO KNOWN SIGHTINGS OF THESE SPECIES ON SITE O.U #1

800 0 400 800 1600
1 inch = 800 ft.

REVISIONS

| | |
|---|---|
| DATE | APRIL 1994 |
| SCALE | 1" = 800' |
| DRAWN | REL |
| REVIEWED | SCJ |
| S O # | 62470–177 |
| CADD# | 177390ER |

NORTH

REMEDIAL INVESTIGATION CTO–0177
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

BAKER ENVIRONMENTAL,Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmental, Inc.

BIOHABITATION MAP

SCALE 1" = 800'
DATE APRIL 1994

FIGURE NO
7–1

00522W08X

*Threatened and Endangered Species*

Certain species have been granted protection by the FWS under the Federal Endangered Species Act (16 U.S.C. 1531-1543), and/or the North Carolina Wildlife Resources Commission, under the North Carolina Endangered Species Act (G.S. 113-331 to 113-337). The protected species fall into one of the following status classifications: Federal or State endangered, threatened or candidate species, State special concern, State significantly rare, or State watch list. While only the Federal or State threatened or endangered and State special concern species are protected from certain actions, the other classified species have the potential for protection in the future.

Table 7-3 lists the protected faunal species (either endangered, threatened, or special concern) and the only federally endangered or threatened floral species that have been identified in previous studies within the boundaries of MCB Camp Lejeune (USMC, 1991; LeBlond, 1991; Fussell, 1991; and Walters, 1991). The following paragraphs discuss the protected species observed at MCB Camp Lejeune during previous studies.

A Peregrine falcon was spotted approximately three miles east of OU No. 1 (Fussell, 1991). These birds potentially may inhabit or feed in areas surrounding OU No. 1 because of their large foraging range. Black skimmers and piping plovers were observed near the New River inlet (Fussell, 1991). These birds primarily inhabit shore line areas and, therefore, are not expected to be found at OU No. 1. Bachmans sparrows and red-cockaded woodpeckers were observed at numerous locations throughout southern MCB Camp Lejeune. None of these species were observed at OU No. 1 during intensive investigations previously conducted for MCB Camp Lejeune, therefore, there is a low potential for them to exist at OU No. 1 (Fussell, 1991; Walters, 1991).

Sea turtles and sea turtle nests have been observed downstream of OU No. 1 in the New River on Onslow Beach. Sea turtles do not swim very far up the New River because of the low salinity, therefore, they are not expected to inhabit areas of OU No. 1 (USMC, 1991). The American alligator is known to inhabit the New River Estuary and has been observed in Cogdels Creek, which is a tributary to the New River (USMC, 1993). It has also been observed in Wallace Creek, which includes Beaver Dam Creek among its tributaries. Therefore, there is the potential that the American Alligator may inhabit the lower reaches in Cogdels Creek and Beaver Dam Creek adjacent to OU No. 1.

# TABLE 7-3

# OPERABLE UNIT NO. 1
# PROTECTED SPECIES WITHIN MCB CAMP LEJEUNE
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE, NORTH CAROLINA

| Species | Protected Classification |
|---|---|
| American alligator (Alligator mississippienis) (2) | T(f), T(s) |
| Bachmans sparrow (Aimophilia aestivalis)(1) | SC |
| Black skimmer (Rhynochops niger)(1) | SC |
| Green (Atlantic) turtle (Chelonia m. mydas) (2) | T(f), T(s) |
| Loggerhead turtle (Caretta caretta) (2) | T(f), T(s) |
| Peregrine falcon (*)(1) | (*) |
| Piping plover (Charadrius melodus)(1) | T(f), T(s) |
| Red-cockaded woodpecker (Picoides borealis)(3) | E(f), E(s) |
| Rough-leaf loosestrife (Lysimachia asperulifolia)(4) | E(f), E(s) |

Legend:
SC = State Special Concern
E(f) = Federal Endangered
E(s) = State Endangered
T(f) = Federal Threatened
T(s) = State Threatened

* The observer did not differentiate between the American eastern peregrine falcon [E(f), E(s)] or the Arctic peregrine falcon [T(f), T(s)].

Source:
(1) Fussell, 1991
(2) USMC, 1991
(3) Walters, 1991
(4) LeBlond, 1991

A protected floral species and special-interest community survey previously was conducted at Camp Lejeune (LeBlond, 1991). From this list, the Rough-leaf loosestrife was the only Federally threatened or endangered plant species found on the Marine Corps Base. Several State endangered or threatened and Federal and State candidate species were found on the MCB. None of these protected floral species were identified at OU No. 1 during the previous investigation (LeBlond, 1991).

*Other Sensitive Environments*

In addition to wetlands and protected species, the presence of other sensitive environments, including those listed in 40 CFR Part 300, were evaluated. These sensitive environments are evaluated when assessing potential hazardous waste sites using the Hazard Ranking System. These sensitive environments and their presence or absence at OU No. 1 are discussed below.

- Marine Sanctuary - OU No. 1 is not located within a Marine Sanctuary (NCMFC, 1992).

- National Park - OU No. 1 is not located within a National Park (NPS, 1991).

- Designated Federal Wilderness Area - OU No. 1 is not located within a Designated Federal Wilderness Area (WS, 1989).

- Areas Identified under the Coastal Zone Management Act - The North Carolina Coastal Area Management Act (CAMA) regulates various types of Areas of Environmental Concern including estuarine waters, coastal wetlands, public trust areas, and estuarine shoreline through the establishment of unified policies, criteria, standards, methods, and processes (CAMA, 1974). Cogdels Creek and Beaver Dam Creek are not located within any areas identified under CAMA.

- Sensitive Areas Identified under the National Estuary Program (NEP) or Near Coastal Waters Program (NCWP) - OU No. 1 is not located within a Sensitive Area identified under the NEP or NCWP (USEPA, 1993b).

- Critical Areas Identified under the Clean Lakes Program - OU No. 1 is not located within a Critical Area identified under the Clean Lakes Program (NPS, 1991).

- National Monument - OU No. 1 is not located near a National Monument (NPS, 1991).

- National Seashore Recreational Area - OU No. 1 is not located within a National Seashore Recreational Area (NPS, 1991).

- National Lakeshore Recreational Area - OU No. 1 is not located within a National Lakeshore Recreational Area (NPS, 1991).

- National Preserve - OU No. 1 is not located within a National Preserve (NPS, 1991).

- National or State Wildlife Refuge - OU No. 1 is not located within a National or State Wildlife Refuge (NCWRC, 1992).

- Unit of the Coastal Barrier Resource Program - OU No. 1 is not located within a unit of the Coastal Barrier Resource Program (USDI, 1993).

- Administratively Proposed Federal Wilderness Area - OU No. 1 is not located within an Administratively Proposed Federal Wilderness Area (WS, 1989, 1993).

- Spawning Areas Critical for the maintenance of fish/shellfish species within river, lake, or coastal tidal waters - Due to size restrictions, no critical spawning areas have been identified within Cogdels Creek or Beaver Dam Creek (USMC, 1993). No specific spawning areas critical for the maintenance of fish/shellfish species in Cogdels Creek or Beaver Dam Creek have been designated as such by state agencies (NC DEHNR, 1993a).

- Migratory pathways and feeding areas critical for maintenance of anadromous fish species within river reaches or areas in lakes or coastal tidal waters in which fish spend extended periods of time - Surface waters associated with OU No. 1 are not migratory pathways or feeding areas critical for the maintenance of an anadromous fish species because there is not a significant population of anadromous fish in Cogdels Creek or Beaver Dam Creek . (USMC, 1993).

- Terrestrial areas utilized for breeding by large or dense aggregations of animals - As discussed in the Regional Ecology section of this report, several large and dense aggregations of terrestrial species inhabit MCB Camp Lejeune. Therefore, there is the potential for breeding of these animals in other areas, some of which may be adjacent to OU No. 1. However, the majority of OU No. 1 is highly developed, greatly reducing the potential for breeding of animals within the site (see Biohabitat Map, Figure 7-1).

- National river reach designated as Recreational - Cogdels Creek or Beaver Dam Creek are not designated as National Recreational Rivers (NPS, 1990, 1993).
- Federal designated Scenic or Wild River - Cogdels Creek or Beaver Dam Creek are not Federally designated Scenic or Wild Rivers (NPS, 1990, 1993).
- State land designated for wildlife or game management - OU No. 1 is not located within a State game land (NCWRC, 1992).
- State designated Scenic or Wild River - Cogdels Creek or Beaver Dam Creek are not State designated Scenic or Wild Rivers (NCMFC, 1992).
- State designated Natural Area - OU No. 1 is not located within a State designated Natural Area or Area of Significant Value (LeBlond, 1991).
- State designated areas for protection or maintenance of aquatic life - No areas within the boundaries of OU No. 1 are designated as primary nursery areas or are unique or special waters of exceptional state or national recreational or ecological significance which require special protection to maintain existing uses (NC DEHNR, 1993b).
- Areas of Significant Value - OU No. 1 is not located within a State Area of Significant Value (LeBlond, 1991).
- State Registered Natural Resource Area - OU No. 1 is not located within a State Registered Natural Resource Area (LeBlond, 1991).

#### 7.3.1.3 Exposure Analysis/Profile

The next step in the characterization of exposure is to combine the spatial and temporal distributions of both the ecological component and the stressor to evaluate exposure. This section of the ERA addresses and quantifies each exposure pathway via surface water, sediment, air, soil, and groundwater.

To determine if ecological exposure via these pathways may occur in the absence of remedial actions, an analysis was conducted including the identification and characterization of the exposure pathways. The following four elements were examined to determine if a complete exposure pathway was present:

- A source and mechanism of chemical release
- An environmental transport medium
- A feasible receptor exposure route
- A receptor exposure point

*Potential Exposure Scenarios*

This section discusses the potential exposure scenarios at OU No. 1 including surface water, sediments, soil, groundwater and air. The location of samples was based on historical information available for the site and a site visit to evaluate potential ecosystems and ecological receptors (see Figure 7-1, Biohabitat Map).

*Surface Water Exposure Pathway*

Potential release sources to be considered in evaluating the surface water pathway are contaminated surface soils and groundwater. The release mechanisms to be considered are groundwater seepage and surface runoff. The potential routes to be considered for ecological exposure to the contaminated surface waters are ingestion and dermal contact. Potential exposure points for ecological receptors include species living in, or coming in contact with, the surface water on site or off site and downgradient relative to tidal influence.

Contaminants of concern were detected in the surface water demonstrating a release from a source to the surface water transport medium. Potential receptors that may be exposed to COPCs in surface waters in/or around surface water include: fish, benthic macroinvertebrates, deer, birds, and other aquatic and terrestrial life.

Aquatic organisms (i.e. fish, benthic macroinvertebrates) are exposed to contaminants in the surface water by ingesting water while feeding and by direct contact. In addition, aquatic organisms may ingest other aquatic flora and fauna that have bioconcentrated chemicals from the surface water. Overall, aquatic organisms have a high exposure to contaminants in the surface water. Potential decreased viability of aquatic receptors from contaminants in the surface water were evaluated in this ERA by direct comparisons of contaminant concentrations in the surface water to published water quality standards and criteria.

Terrestrial faunal receptors potentially are exposed to contaminants in the surface water through ingestion and dermal contact. The magnitude of the exposure depends on their feeding habits and the amount of time they reside in the contaminated waters. In addition, terrestrial species may ingest organisms (e.g., fish, insects, plants) that have bioconcentrated contaminates from the surface water.

Potential decreased viability of terrestrial receptors from contaminants in the surface water was evaluated in this ERA by comparing CDI to TRVs. Total exposure of the terrestrial receptors to the COPCs in the surface waters was determined by estimating the CDI dose and comparing this dose to TRVs representing acceptable daily doses in mg/kg/day.

*Sediment Exposure Pathway*

The potential release sources to be considered in evaluating the sediment pathway are contaminated surface soils and groundwater. The release mechanisms to be considered are groundwater seepage and surface runoff. The potential routes to be considered for ecological exposure to the contaminated sediments are ingestion and dermal contact. Potential exposure points for ecological receptors include species living in, or coming in contact with, the sediments.

Contaminants of concern were detected in the sediment demonstrating a release from a source to the sediment transport medium. Potential receptors that may be exposed to contaminated sediments include benthic macroinvertebrates, bottom feeding fish, aquatic vegetation and other aquatic life.

Aquatic organisms (i.e. fish, benthic macroinvertebrates) are exposed to contaminants in the sediments by ingesting sediments while feeding and by direct contact. In addition, aquatic organisms may ingest other aquatic flora and fauna that have bioconcentrated chemicals from the sediments. Overall, aquatic organisms have a high exposure to contaminants in the sediment. Potential decreased viability of aquatic receptors from contaminants in the sediment were evaluated in this ERA by direct comparisons of contaminant concentrations in the sediments to NOAA SSVs.

Terrestrial faunal receptors potentially are exposed to contaminants in the sediments through ingestion and dermal contact. The magnitude of the exposure depends on their feeding habits and the amount of time they reside in the contaminated sediments. In addition, terrestrial species may ingest organisms (e.g., fish, insects, plants) that have bioconcentrated contaminates from the sediments. Potential decreased viability of terrestrial receptors from contaminants in the sediments was qualitatively evaluated in this ERA.

*Soil Exposure Pathway*

Potential release sources to be considered in evaluating the soil pathway are surface or buried wastes and contaminated soil. The release mechanisms to be considered are fugitive dust, leaching, tracking, and surface runoff. The transport medium is the soil. The potential routes to be considered for ecological exposure to the contaminated soils are ingestion and dermal contact. Potential exposure points for ecological receptors include species living in, or coming in contact with, the soils.

Contaminants of concern were detected in the surface soil demonstrating a release from a source to the surface soil transport medium. Potential receptors that may be exposed to contaminants in surface soil at/or around surface soil in the areas of detected COPCs including: rabbits, birds, plants, and other terrestrial life.

Terrestrial receptors potentially are exposed to contaminants in the soils through ingestion, dermal contact, and/or direct uptake (for flora). The magnitude of the exposure depends on their feeding habits and the amount of time they reside in the contaminated soils. In addition, terrestrial species may ingest organisms (e.g., insects, plants) that have bioconcentrated contaminates from the soils. Potential decreased viability of terrestrial receptors from contaminants in the surface soils was evaluated in this ERA by comparison of CDIs to TRVs, and direct comparisons of soil concentrations to literature toxicity value for plants and invertebrates.

Potential decreased viability of terrestrial receptors from contaminants in the surface soils was evaluated in this ERA by comparing CDI to TRVs. Total exposure of the terrestrial receptors to the COPCs in the surface soils was determined by estimating the CDI dose and comparing this dose to TRVs representing acceptable daily doses in mg/kg/day.

*Groundwater Exposure Pathway*

The potential release source to be considered in evaluating the groundwater pathway is contaminated soils. The release mechanism to be considered is leaching. The routes to be considered for ecological exposure to the contaminated groundwater are ingestion and dermal contact. Groundwater discharge to area surface waters may represent a pathway for contaminant migration. Since organisms are not directly exposed groundwater at OU No. 1, the groundwater to surface water exposure will be evaluated in the surface water section of the ERA.

*Air Exposure Pathway*

There are two potential release mechanisms to be considered in evaluating the atmospheric pathway: release of contaminated particulates and volatilization from surface soil, groundwater and surface water. The potential exposure points for receptors are areas on or adjacent to the site.

No data has been collected to document exposure to receptors via the air pathway. However, based on the low concentrations of VOCs detected in the soils, sediments, and surface water, and the negligible vapor pressure of pesticides and metals, the air concentration of the COPCs is not expected to cause a decrease in viability of the terrestrial receptors. Therefore, this pathway was not evaluated as part of the ERA.

### 7.3.2 Ecological Effects Characterization

The potential ecological effects to aquatic receptors were evaluated by direct comparisons of contaminant concentrations in surface water and sediment to ARARs. Potential ecological effects to terrestrial receptors were evaluated by comparison to literature values and by comparing the CDIs to TRVs. The following sections further discuss the ARAR comparisons and the CDI to TRV comparisons to evaluate the potential ecological effects to aquatic and terrestrial receptors from the COPCs.

#### 7.3.2.1 Water Quality

Table 7-4 contains the saltwater North Carolina Water Quality Standards (NCWQS) and the USEPA Water Quality Screening Values (WQSV) for the COPCs detected in Cogdels Creek

# TABLE 7-4

# OPERABLE UNIT NO. 1
# SURFACE WATER DATA SUMMARY
# SITE 78 - COGDELS CREEK AND THE NEW RIVER
# FREQUENCY AND RANGE OF DETECTION COMPARED TO SALTWATER NORTH CAROLINA WQSs AND USEPA WQSVS
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE

| | Surface Water ARARs | | | Contaminant Frequency/Range | | Comparison to ARARs | | |
|---|---|---|---|---|---|---|---|---|
| | | Region IV Screening Values (USEPA WQSVs) | | | | | No. of Positive Detects Above Screening Values | |
| Analyte | North Carolina (NCWQS)(1) | Acute | Chronic | No. of Positive Detects/ No. of Samples | Range of Positive Detections | No. of Positive Detects Above NCWQS | Acute | Chronic |
| **Inorganics (µg/L)** | | | | | | | | |
| Aluminum | NE | NE | NE | 20/20 | 34B-17900 | NA | NA | NA |
| Arsenic | 50 | 69 | 36 | 3/20 | 2.2B-1.9B | 0/3 | 0/3 | 0/3 |
| Barium | NE | NE | NE | 20/20 | 13B-68B | NA | NA | NA |
| Beryllium | NE | NE | NE | 3/20 | 1J | NA | NA | NA |
| Chromium (III)(1) | 20(2) | 1030 | 103 | 3/20 | 12J-30J(2) | 1/3 | 0/3 | 0/3 |
| Chromium (IV) | 20(2) | 1100 | 50 | 3/20 | 12J-30J(2) | 1/3 | 0/3 | 0/3 |
| Copper(1) | 3 | 2.9 | 2.9 | 20/20 | 2J-42J | 18/20 | 18/20 | 18/20 |
| Iron | NE | NE | NE | 20/20 | 415J-14200 | NA | NA | NA |
| Lead(1) | 25 | 140 | 5.6 | 10/20 | 2J-42 | 4/10 | 0/10 | 5/10 |
| Manganese | NE | NE | NE | 20/20 | 15J-162 | NA | NA | NA |
| Vanadium | NE | NE | NE | 9/20 | 4J-33B | NA | NA | NA |
| Zinc(1) | 86 | 95 | 86 | 14/20 | 11B-152J | 2/14 | 2/14 | 2/14 |
| **Organics (µg/L)** | | | | | | | | |
| Trichloroethene | NE | NE | NE | 4/20 | 3J-47 | NA | NA | NA |

NE = Not Established

(1) Criteria are hardness dependent.

(2) Values are for total chromium.

and the New River. Table 7-5 contains the saltwater NCWQS and the USEPA WQSV for the COPCs detected in Beaver Dam Creek.

The water quality values for the following metals in freshwater and saltwater are water hardness dependent: cadmium, chromium III, copper, lead, nickel, silver, and zinc. In general, the higher the water hardness (in mg/l of $CaCO_3$) the higher the water quality value. A hardness concentration of 50 mg/l $CaCO_3$ was used to calculate these values since actual hardness data was not available.

The following COPCs detected in the surface water samples do not have WQS or WQSVs for them: aluminum, barium, beryllium, iron, manganese, and vanadium. The potential impact to aquatic species from these chemicals in the surface water was evaluated using the results of acute and chronic tests obtained from the AQUIRE database (AQUIRE, 1993). The maximum detected concentration of these chemicals in the surface water were below the adverse effects levels obtained from the database. Therefore, no decrease in viability of ecological receptors from these chemicals is expected.

#### 7.3.2.2 Sediment Quality

Table 7-6 contains the sediment NOAA SSVs for hazardous waste sites for the COPCs detected in Cogdels Creek and the New River. Table 7-7 contains the sediment NOAA SSVs for hazardous waste sites for the COPCs detected in Beaver Dam Creek. Sediment samples were collected from zero to six inches, and six to twelve inches at most of the sediment stations. Some sediment stations were sampled at a depth of zero to six inches only.

The following COPCs detected in the sediments do not have NOAA SSVs for them: aluminum, barium, beryllium, cobalt, iron, manganese, selenium, vanadium, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-CD)pyrene, and benzo(g,h,i)perylene. There is limited, if any, data assessing the effects on aquatic organism exposed to these chemicals in sediment samples. Therefore, the effects of these chemicals on aquatic organisms were not determined.

#### 7.3.2.3 Surface Soil Quality

There are no standards, criteria, or other screening values for assessing potential impacts to terrestrial ecological receptors from contaminants in soils. In addition, the amount of literature data evaluating adverse ecological effects on terrestrial species exposed to

## TABLE 7-5

## OPERABLE UNIT NO. 1
## SURFACE WATER DATA SUMMARY
## SITE 78 - BEAVER DAM CREEK
## FREQUENCY AND RANGE OF DETECTION COMPARED TO SALTWATER NORTH CAROLINA WQSs AND USEPA WQSVs
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE

| Analyte | Surface Water ARARs | | | Contaminant Frequency/Range | | Comparison to ARARs | | |
|---|---|---|---|---|---|---|---|---|
| | North Carolina (NCWQS)(1) | Region IV Screening Values (USEPA WQSVs) | | No. of Positive Detects/ No. of Samples | Range of Positive Detections | No. of Positive Detects Above NCWQS | No. of Positive Detects Above Screening Values | |
| | | Acute | Chronic | | | | Acute | Chronic |
| **Inorganics (µg/l)** | | | | | | | | |
| Aluminum | NE | NE | NE | 7/7 | 103J-5610 | NA | NA | NA |
| Arsenic | 50 | 69 | 36 | 2/7 | 4.3B-11.8J | 0/2 | 0/2 | 0/2 |
| Barium | NE | NE | NE | 7/7 | 34J-75B | NA | NA | NA |
| Copper(1) | 3 | 2.9 | 2.9 | 7/7 | 3J-17J | 6/7 | 7/7 | 7/7 |
| Iron | NE | NE | NE | 7/7 | 500-11800J | NA | NA | NA |
| Lead | 25 | 140 | 5.6 | 2/7 | 7.4J-22.2 | 0/2 | 0/2 | 2/2 |
| Manganese | NE | NE | NE | 7/7 | 24-262J | NA | NA | NA |
| Vanadium | NE | NE | NE | 3/7 | 4B-17B | NA | NA | NA |
| Zinc(1) | 86 | 95 | 86 | 7/7 | 25J-96 | 1/7 | 1/7 | 1/7 |

NE = Not Established

(1) Criteria are hardness dependent.

# TABLE 7-6

# OPERABLE UNIT NO. 1
# SEDIMENT DATA SUMMARY
# COGDELS CREEK AND THE NEW RIVER
# FREQUENCY AND RANGE OF DETECTION COMPARED TO NOAA SEDIMENT SCREENING VALUES
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE

| Analyte | NOAA Sediment Screening Values (NOAA SSVs) | | Contaminant Frequency/Range | | Comparison to Screening Values | |
|---|---|---|---|---|---|---|
| | ER-L | ER-M | No. of Positive Detects/ No. of Samples | Range of Positive Detections | No. of Positive Detects Above ER-L | No. of Positive Detects Above ER-M |
| **Inorganics (mg/kg)** | | | | | | |
| Aluminum | NE | NE | 40/40 | 238-22600 | NA | NA |
| Arsenic | 33 | 85 | 21/40 | 0.57J-6.5J | 0/21 | 0/21 |
| Barium | NE | NE | 40/40 | 1J-109 | NA | NA |
| Beryllium | NE | NE | 6/40 | 0.28B-1.58 | NA | NA |
| Cadmium | 5 | 9 | 9/40 | 1.3-11.9 | 3/9 | 3/9 |
| Chromium | 80 | 145 | 29/40 | 2.5-42 | 0/29 | 0/29 |
| Copper | 70 | 390 | 40/40 | 0.77J-116 | 2/40 | 0/40 |
| Iron | NE | NE | 40/40 | 154-16300J | NA | NA |
| Lead | 35 | 110 | 40/40 | 2-359 | 12/40 | 3/40 |
| Manganese | NE | NE | 40/40 | 1.8B-72.3 | NA | NA |
| Selenium | NE | NE | 7/40 | 0.31J-1J | NA | NA |
| Silver | 1 | 2.2 | 6/40 | 0.74B-3.9B | 2/6 | 2/6 |
| Vanadium | NE | NE | 36/40 | 1B-59.4 | NA | NA |
| Zinc | 120 | 270 | 40/40 | 2.4J-363 | 6/40 | 6/40 |

NOAA = National Oceanic and Atmospheric Administration
NE = Not Established
(1) NOAAs are for total chlordane screening values.

# TABLE 7-6 (Continued)

## OPERABLE UNIT NO. 1
## SEDIMENT DATA SUMMARY
## COGDELS CREEK AND THE NEW RIVER
## FREQUENCY AND RANGE OF DETECTION COMPARED TO NOAA SEDIMENT SCREENING VALUES
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE

| Analyte | NOAA Sediment Screening Values (NOAA SSVs) | | Contaminant Frequency/Range | | Comparison to Screening Values | |
|---|---|---|---|---|---|---|
| | ER-L | ER-M | No. of Positive Detects/ No. of Samples | Range of Positive Detections | No. of Positive Detects Above ER-L | No. of Positive Detects Above ER-M |
| **Organics (µg/kg)** | | | | | | |
| Phenanthrene | 225 | 1380 | 10/40 | 60J-4500 | 5/10 | 1/10 |
| Fluoranthene | 600 | 3600 | 14/40 | 79J-6800 | 3/14 | 1/14 |
| Pyrene | 350 | 2200 | 14/40 | 50J-4500 | 7/14 | 1/14 |
| Benzo(a)anthracene | 230 | 1600 | 10/40 | 70J-2500 | 5/10 | 1/10 |
| Chrysene | 400 | 2800 | 13/40 | 51J-2400 | 4/13 | 0/13 |
| Benzo(b)fluoranthene | NE | NE | 12/40 | 59J-2800 | NA | NA |
| Benzo(k)fluoranthene | NE | NE | 10/40 | 72J-1800 | NA | NA |
| Benzo(a)pyrene | 400 | 2500 | 11/40 | 84J-1700 | 3/11 | 0/11 |
| Indeno(1,2,3-cd)pyrene | NE | NE | 11/40 | 66J-630 | NA | NA |
| Benzo(g,h,i)perylene | NE | NE | 8/40 | 88J-500J | NA | NA |
| **Pesticides/PCBs (µg/kg)** | | | | | | |
| 4,4'-DDE | 2 | 15 | 8/40 | 5-33 | 8/8 | 2/8 |
| 4,4'-DDD | 2 | 20 | 20/40 | 4.4J-400 | 20/20 | 9/20 |
| 4,4'-DDT | 1 | 7 | 11/40 | 4.6J-150 | 11/11 | 9/11 |
| alpha-Chlordane(1) | 0.5 | 6 | 5/40 | 2.5J-5.9J | 5/5 | 0/5 |
| gamma-Chlordane(1) | 0.5 | 6 | 3/40 | 3.2J-6.3 | 3/3 | 2/3 |

NOAA = National Oceanic and Atmospheric Administration
NE = Not Established
(1) NOAAs are for total chlordane screening values

# TABLE 7-7

# OPERABLE UNIT NO. 1
SEDIMENT DATA SUMMARY
BEAVER DAM CREEK
FREQUENCY AND RANGE OF DETECTION COMPARED TO NOAA SEDIMENT SCREENING VALUES
REMEDIAL INVESTIGATION CTO-0177
MCB CAMP LEJEUNE

| Analyte | NOAA Sediment Screening Values (NOAA SSVs) | | Contaminant Frequency/Range | | Comparison to Screening Values | |
|---|---|---|---|---|---|---|
| | ER-L | ER-M | No. of Positive Detects/ No. of Samples | Range of Positive Detections | No. of Positive Detects Above ER-L | No. of Positive Detects Above ER-M |
| **Inorganics (mg/kg)** | | | | | | |
| Aluminum | NE | NE | 14/14 | 742J-37100 | NA | NA |
| Arsenic | 33 | 85 | 12/14 | 0.53J-12.1J | 0/12 | 0/12 |
| Barium | NE | NE | 14/14 | 3.9J-49.1B | NA | NA |
| Beryllium | NE | NE | 10/14 | 0.24J-1.1J | NA | NA |
| Chromium | 80 | 145 | 12/14 | 3.4J-41.2 | 0/12 | 0/12 |
| Cobalt | NE | NE | 4/14 | 3B-7.6B | NA | NA |
| Copper | 70 | 390 | 14/14 | 1.3B-24.7J | 0/14 | 0/14 |
| Iron | NE | NE | 14/14 | 871J-10600 | NA | NA |
| Lead | 35 | 110 | 14/14 | 4.4J-50.7J | 4/14 | 0/14 |
| Manganese | NE | NE | 14/14 | 2.2J-30.9 | NA | NA |
| Selenium | NE | NE | 8/14 | 0.3J-2.6J | NA | NA |
| Vanadium | NE | NE | 14/14 | 2.1J-50.5 | NA | NA |
| Zinc | 120 | 270 | 14/14 | 7.9-37.4J | 0/14 | 0/14 |

NOAA = National Oceanic and Atmospheric Administration
NE = Not Established
(1) NOAA Screening Values are for total chlordane.
(2) NOAA Screening Values are for total PCBs.

## TABLE 7-7 (Continued)

## OPERABLE UNIT NO. 1
## SEDIMENT DATA SUMMARY
## BEAVER DAM CREEK
## FREQUENCY AND RANGE OF DETECTION COMPARED TO NOAA SEDIMENT SCREENING VALUES
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE

| Analyte | NOAA Sediment Screening Values (NOAA SSVs) | | Contaminant Frequency/Range | | Comparison to Screening Values | |
|---|---|---|---|---|---|---|
| | ER-L | ER-M | No. of Positive Detects/ No. of Samples | Range of Positive Detections | No. of Positive Detects Above ER-L | No. of Positive Detects Above ER-M |
| **Organics (µg/kg)** | | | | | | |
| Phenanthrene | 225 | 1380 | 3/14 | 160J-1900 | 2/3 | 1/3 |
| Fluoranthene | 600 | 3600 | 6/14 | 74J-2100 | 1/6 | 0/6 |
| Pyrene | 350 | 2200 | 4/14 | 70J-1500 | 2/4 | 0/4 |
| Chrysene | 400 | 2800 | 3/14 | 74J-920 | 1/3 | 0/3 |
| **Pesticides/PCBs (µg/kg)** | | | | | | |
| 4,4'-DDE | 2 | 15 | 6/14 | 4.8J-93 | 6/6 | 3/6 |
| 4,4'-DDD | 2 | 20 | 2/14 | 33J-39J | 2/2 | 2/2 |
| 4,4'-DDT | 1 | 7 | 3/14 | 8J-47J | 2/2 | 2/2 |
| alpha-Chlordane(1) | 0.5 | 6 | 4/14 | 2.5-7.3J | 4/4 | 1/4 |
| gamma-Chlordane(1) | 0.5 | 6 | 6/14 | 2.4-5.6J | 6/6 | 0/6 |
| PCB-1260(2) | 50 | 400 | 1/14 | 70 | 1/1 | 0/1 |

NOAA = National Oceanic and Atmospheric Administration
NE = Not Established
(1) NOAA Screening Values are for total chlordane.
(2) NOAA Screening Values are for total PCBs.

contaminants in surface soils is limited. However, toxicological effects on plants and/or invertebrates inhabiting soils contaminated by the following chemicals were obtained from various studies in the literature: arsenic, barium, beryllium, chromium, copper, lead, manganese, mercury, silver, vanadium, and zinc. This data was used to evaluate decreased viability of terrestrial flora and invertebrates from COPCs in the soil.

No toxicological effects of plants and/or invertebrates inhabiting soils contaminated by the following chemicals were obtained from various studies in the literature: aluminum, cobalt, iron, nickel, selenium, and thallium. Therefore, these contaminants were not evaluated in the ERA.

No information was found which evaluate the toxicological affects on plants and/or invertebrates inhabiting soils contaminated with TCL organics, therefore, the evaluation was limited to TAL inorganics.

#### 7.3.2.4 Terrestrial Chronic Daily Intake

As discussed above, there are no standards, criteria, or other screening values for assessing potential impacts to terrestrial ecological receptors from contaminants in soils. However, there are some models exist that estimate the exposure to terrestrial receptors. The following describes the procedures used to evaluate the potential soil exposure to terrestrial fauna at OU No. 1 by both direct and indirect exposure to COPCs via water (surface water), soil, and food-chain transfer.

Contaminants of concern at OU No. 1 are identified in Section 7.2.1.1 for each media. Based on the regional ecology and potential habitat at the site, the indicator species used in this analysis are the whitetailed deer, cottontail rabbit, and the bobwhite quail. The exposure points for these receptors are the surface soils, surface water, and vegetation. The routes for terrestrial exposure to the COPCs in the soil and water are incidental soil ingestion, drinking water ingestion, and vegetation ingestion.

Total exposure of the terrestrial receptors to the COPCs in the soil and surface waters was determined by estimating the Chronic Daily Intake (CDI) dose and comparing this dose to TRVs representing acceptable daily doses in mg/kg/day. For this analysis, TRVs were developed from No-Observed-Adverse-Effect-Levels (NOAELs) or Lowest-Observed-Adverse-

Effect-Levels (LOAELs) obtained from the Integrated Risk Information System (IRIS, 1993) or other toxicological data in the literature (Table 7-8).

## 7.4 Risk Characterization

The risk characterization is the final phase of a risk assessment. It is at this phase that the likelihood of adverse effects occurring as a result of exposure to a stressor are evaluated. This section evaluates the potential adverse effects on the ecological integrity at Sites 24 and 78 from contaminants identified at the site. The surface water sampled at Site 21 was not evaluated because it does not impact the ecological integrity of the site.

Tables 7-4 and 7-5 contain a comparison of the COPCs identified in the surface water to the ARARs to determine if they exceeded the published values. The ratio of the maximum detected value, and WQS and WQSVs were calculated for each COPC (see Table 7-9). The 95 percent upper confidence interval was used to calculate the ratio, however, in some cases the upper 95 percent confidence limit was higher than the maximum concentration detected in the media. For these cases, the maximum concentration was used to calculate the ratio. A ratio greater than unity indicates a potential for decreased viability of aquatic life.

Tables 7-6 and 7-7 contain a comparison of the COPCs identified in the sediment to the ARARs to determine if they exceeded the published values. For reasons stated above, the sediment samples at Site 21 were not evaluated.. The quotient ratio of the log normal 95 percent confidence interval or maximum detected value and the ER-L and ER-M were calculated for each COPC (see Table 7-10). A ratio greater than unity indicates a possibility for adverse effects to aquatic life, and USEPA recommends conducting toxicity tests as a follow-up.

Total exposure of the terrestrial receptors at Sites 24 and 78 to the COPCs in the soil and surface waters was determined by estimating the CDI dose and comparing this dose to TRVs representing acceptable daily doses in mg/kg/day. The estimated CDI dose of the receptors (bobwhite quail, cottontail rabbit, and whitetailed deer) to soils, surface water, and vegetation was determined using the following equation:

$$E = \frac{(Cw)(Iw) + [(Cs)(Bv)(Iv) + (Cs)(Is)]\,[H]}{BW}$$

# TABLE 7-8

## OPERABLE UNIT NO. 1
## TERRESTRIAL REFERENCE VALUES
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant of Concern | Soil to Plant Transfer Coefficient (Bv) | Toxicity Reference Value (TRV) mg/kg/day |
|---|---|---|
| Fluoranthene | 0.037(1,3) | 125(10) |
| Pyrene | 0.059(1,3) | 75(10) |
| 4,4'-DDE | 0.003(1, 3) | 0.05(4) |
| 4,4'-DDD | 0.101(1, 3) | 0.05(4) |
| 4,4'-DDT | 0.102(1, 3) | 0.05(4) |
| Dieldrin | 0.367(1, 3) | 0.005(4) |
| Chlordane, total | 0.467(1, 3) | 0.055(4) |
| PCBs, total | (0.004 - 0.007)(1,3) | 2.5(12) |
| Arsenic | 0.040(2) | 16(5) |
| Barium | 0.150(2) | 30(4) |
| Beryllium | 0.010(2) | 0.54(6) |
| Cadmium | 0.550(2) | 4.7(7) |
| Chromium | 0.008(2) | 2.7(8) |
| Copper | 0.400(2) | 300(4) |
| Lead | 0.045(2) | 27.4(4) |
| Manganese | 0.250(2) | 0.14(5) |
| Mercury | 0.900(2) | 7.4(9) |
| Nickel | 0.060(2) | 5(4) |
| Thallium | 0.004(2) | 0.23(10) |
| Selenium | 0.025(2) | 0.853(10) |
| Vanadium | 0.006(2) | 5(10) |
| Zinc | 1.500(2) | 38(11) |

NA - No information to determine TRV

(1) Travis, 1988
(2) Baes, 1984
(3) USEPA, 1986
(4) IRIS, 1993
(5) USDH, 1992a
(6) IRIS, 1991
(7) USDH, 1992b
(8) USDH, 1991a
(9) ATSDR, 1988
(10) HEAST, 1993
(11) ASTDR, 1989
(12) USDH, 1991b

# TABLE 7-9

# OPERABLE UNIT NO. 1
# SURFACE WATER QUOTIENT INDEX FOR COGDELS CREEK, THE NEW RIVER, AND BEAVER DAM CREEK
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE, NORTH CAROLINA

| Parameter | Surface Water Concentration (µg/l) | North Carolina Quotient Index WQS | USEPA Region IV Quotient Index WQSV | |
|---|---|---|---|---|
| | | | Acute | Chronic |
| **Cogdels Creek and the New River** | | | | |
| Arsenic | 2.2 | 0.04 | 0.03 | 0.06 |
| Chromium | 8.3 | 0.42 | 0.01 | 0.08 |
| Copper | 16.4 | 5.47 | 5.65 | 5.65 |
| Lead | 18.5 | 0.74 | 0.13 | 3.3 |
| Zinc | 65 | 0.76 | 0.68 | 0.76 |
| **Beaver Dam Creek** | | | | |
| Arsenic | 11.8J | 0.236 | 0.17 | 0.33 |
| Copper | 17J | 5.67 | 5.86 | 5.86 |
| Lead | 22.3 | 0.89 | 0.16 | 3.98 |
| Zinc | 95.4 | 1.1 | 1 | 1.11 |

Notes: (1) WQS = Water Quality Standards
(2) WQSV = Water Quality Screening Values

Surface water concentrations are the log normal 95% confidence limit unless it was higher than the maximum detected value, then the maximum was used.

## TABLE 7-10

## OPERABLE UNIT NO. 1
## SEDIMENT QUOTIENT INDEX FOR COGDELS CREEK, THE NEW RIVER, AND BEAVER DAM CREEK
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Parameter | Sediment Concentration (mg/kg) | NOAA SSV Quotient Index | |
|---|---|---|---|
| | | ER-L | ER-M |
| **Cogdels Creek and the New River** | | | |
| Arsenic | 2.4 | 0.072 | 0.03 |
| Cadmium | 2 | 0.4 | 0.22 |
| Chromium | 10.1 | 0.13 | 0.07 |
| Copper | 22.9 | 0.33 | 0.06 |
| Lead | 74.2 | 2.12 | 0.67 |
| Silver | 0.8 | 0.80 | 0.36 |
| Zinc | 101.8 | 0.85 | 0.38 |
| Phenanthrene | 477 | 2.12 | 0.35 |
| Fluoranthene | 601 | 1.00 | 0.17 |
| Pyrene | 586 | 1.67 | 0.27 |
| Benzo(a)anthracene | 436.1 | 1.90 | 0.27 |
| Chrysene | 463.2 | 1.16 | 0.17 |
| Benzo(a)pyrene | 407.3 | 1.02 | 0.16 |
| 4,4'-DDE | 8.6 | 4.30 | 0.57 |
| 4,4'-DDD | 51.5 | 25.75 | 2.58 |
| 4,4'-DDT | 13.4 | 13.4 | 1.91 |
| Alpha-chlordane | 3.4 | 6.8 | 0.57 |
| Gamma-chlordane | 3.3 | 6.6 | 0.55 |

Notes: (1) NOAA SSVs = National Oceanic and Atmospheric Administration Sediments
(2) ER-L = Effects Range - Low
(3) ER-M = Effects Range - Medium

Sediment concentrations are the maximum detected values since the log normal confidence limit was equal to or higher than the maximum value.

## TABLE 7-10 (Continued)

## OPERABLE UNIT NO. 1
## SEDIMENT QUOTIENT INDEX FOR COGDELS CREEK, THE NEW RIVER, AND BEAVER DAM CREEK
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Parameter | Sediment Concentration (mg/kg) | NOAA SSV Quotient Index | |
|---|---|---|---|
| | | ER-L | ER-M |
| **Beaver Dam Creek** | | | |
| Arsenic | 7.2 | 0.22 | 0.08 |
| Chromium | 25.5 | 0.32 | 0.18 |
| Copper | 9.8 | 0.14 | 0.03 |
| Lead | 41.6 | 1.19 | 0.38 |
| Zinc | 26.8 | 0.22 | 0.10 |
| Phenanthrene | 447.2 | 1.99 | 0.32 |
| Fluoranthene | 519.4 | 0.87 | 0.14 |
| Pyrene | 439.1 | 1.25 | 0.20 |
| Chrysene | 337 | 0.84 | 0.12 |
| 4,4'-DDE | 38.5 | 19.25 | 2.57 |
| 4,4'-DDD | 13.7 | 6.85 | 0.69 |
| 4,4'-DDT | 14.8 | 14.8 | 2.11 |
| Alpha-chlordane | 3 | 6.00 | 0.50 |
| Gamma-chlordane | 3.1 | 6.20 | 0.52 |
| PCB-1260 | 30.1 | 0.60 | 0.08 |

Notes: (1) NOAA SSVs = National Oceanic and Atmospheric Administration Sediments
(2) ER-L = Effects Range - Low
(3) ER-M = Effects Range - Medium

Sediment concentrations are the maximum detected values since the log normal confidence limit was equal to or higher than the maximum value.

Where:

E = Total Exposure, mg/kg/d
Cw = Constituent concentration in the surface water, mg/l
Iw = Rate of drinking water ingestion, L/d
Cs = Constituent concentration in soil, mg/kg
Bv = Soil to plant transfer coefficient, unitless
Iv = Rate of vegetation ingestion, kg/d
Is = Incidental soil ingestion, kg/d
H = Contaminated area/Home area range area ratio, unitless
BW = Body weight, kg

The estimated CDI dose of the robin was was determined using the following equation.

$$E = \frac{(Cw)(Iw) + [(Cs)(Bv)(Iv) + (Cs)(Is)]\,(Cwor)(Iwor)][H]}{BW}$$

Where:

E = Total Exposure, mg/kg/d
Cw = Constituent concentration in the surface water, mg/l
Iw = Rate of drinking water ingestion, L/d
Cs = Constituent concentration in soil, mg/kg
Bv = Soil to plant transfer coefficient, unitless
Iv = Rate of vegetation ingestion, kg/d
Is = Incidental soil ingestion, kg/d
Iwor = Rate of worm ingestion, kg/d
Cwor = Constituent concentration in the worm, mg/kg
H = Contaminated area/Home area range area ratio, unitless
BW = Body weight, kg

To determine the concentration of contaminant in the worms a "diet-to-invertebrate transfer coefficient for metals was used, a transfer coefficient of 0.06 was used for all metals (Talmadge, 1993). The log-normal upper 95 percent confidence limit for each constituent in the surface soil was multiplied by the transfer coefficient to determine the concentration in the worm, it was assumed that the worm's diet was 100 percent soil. For the organics a modeled bioconcentration factor for worms was used. The modeled bioconcentration factor values are independent of the octanol-water coefficient but depend on the lipid content of the animal and the fraction organic content of the soil. A BCF of 0.25 was used for all organics (Menzie, 1992). The BCF was multiplied by the log-normal upper 95 percent confidence limit for each constituent in the surface soil to determine the concentration in the worm.

Bioconcentration of the COPCs was calculated using the soil to plant transfer coefficient (Bv) for organics (Travis, 1988) and metals (Baes, 1984). The concentrations of the COPCs in the soil (Cs) were the upper 95 percent confidence limit or the maximum concentration detected of each COPC at each site. The upper 95 percent confidence limit or the maximum concentration detected for each constituent was used as the concentration of each COPC in the surface. The exposure parameters used in the CDI calculations are presented in Table 7-11 and are summarized for each receptor below.

For the whitetailed deer, the feeding rate is 1.6 kg/d (Dee, 1991). The incidental soil ingestion rate is 0.019 kg/d (Scarano, 1993). The rate of drinking water ingestion is 1.1 L/d (Dee, 1991). The rate of vegetation ingestion is 1.6 kg/d. The body weight is 45.4 kg (Dee, 1991), and the home range is 454 acres (Dee, 1991).

For the cottontail rabbit, the feeding rate is 0.1 kg/d (Newell, 1987). The incidental soil ingestion rate is 0.002 kg/d (Newell, 1987). The rate of drinking water ingestion is 0.185 L/d (Federal Register, 1993). The rate of vegetation ingestion is 0.1 kg/d. The body weight is 2 kg (Newell, 1987), and the home range is 10 acres (USDI, 1984).

For the bobwhite quail, the feeding rate is 0.01 kg/d (Newell, 1987). The incidental soil ingestion rate is 0.001 kg/d (Newell, 1987). The rate of drinking water ingestion is 0.013 L/d (Federal Register, 1993). The rate of vegetation ingestion is 0.01 kg/d. The body weight is 0.1 kg (Newell, 1987), and the home range is 12.1 acres (USDI, 1985).

For the robin, the feeding rate is 0.009 kg/d (Levey, 1989). The incidental soil ingestion rate is 0.0008 kg/d(Beyer, 1991). The rate of drinking water ingestion is 0.01 l/d (Calder, 1983). The rate of vegetation ingestion is 0.004 kg/d, and the rate of worm ingestion is 0.004 kg/d. The body weight of the robin is 0.078 kg (Levey, 1989), and the home range is 1.037 acres (Pitts, 1984).

A hazard index or Quotient Index (QI) approach was used to characterize the risk to terrestrial receptors. This approach characterized the potential effects by comparing the CDIs for each COPCs to the TRVs and is calculated as follows:

$$QI = \frac{E}{TRV}$$

# TABLE 7-11

# OPERABLE UNIT NO. 1
# TERRESTRIAL CHRONIC DAILY INTAKE MODEL EXPOSURE PARAMETERS(1)
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE, NORTH CAROLINA

| | Units | White-Tailed Deer | Cotton-Tail Rabbit | Bobwhite Quail | Robin |
|---|---|---|---|---|---|
| Food Source Ingestion | | Vegetation 100% | Vegetation 100% | Vegetation 100% | Vegetation 50% |
| Feeding Rate | kg/d | 1.6(2) | 0.1(3) | 0.01(3) | 0.0009(7) |
| Incident Soil Ingestion | kg/d | 0.019(1) | 0.002(3) | 0.001(3) | 0.0008(8) |
| Rate of Drinking Water Ingestion | L/d | 1.1(2) | 0.185(4) | 0.013(4) | 0.010(9) |
| Rate of Vegetation Ingestion | kg/d | 1.6(2) | 0.1 | 0.01 | 0.004 |
| Body Weight | kg | 45.4(2) | 2(3) | 0.1(3) | 0.078(7) |
| Rate of Worm Ingestion | kg/d | NA | NA | NA | 0.004 |
| Home Range Size | acres | 454(2) | 10(6) | 12.1(5) | 1.037(10) |

NA - Not Applicable
(1) Scarano, 1993
(2) Dee, 1991
(3) Newell, 1987
(4) Federal Register, 1993
(5) USDI, 1985
(6) USDI, 1984
(7) Levey, 1989
(8) Beyer, 1991
(9) Calder, 1983
(10) Pitts, 1984

Where:

QI = Quotient Index
E = Total Exposure, mg/kg/day
TRV = Terrestrial Reference Value, mg/kg/day

Tables 7-12 and 7-13 contain the Quotient Index for the COPCs in each of the areas. A quotient index of less than "1" is considered to be indicative of potential risk. Such values do not necessarily indicate that an effect will occur but only that a lower threshold has been exceeded. The evaluation of the significance of the Quotient Index has been judged as follows: (Menzie, 1993)

- Quotient Index exceeds "1" but less than "10": some small potential for environmental effects;
- Quotient Index exceeds "10": significant potential that greater exposures could result in effects based on experimental evidence;
- Quotient Index exceeds "100": effects may be expected since this represents an exposure level at which effects have been observed in other species.

The risks characterized above provide insight into general effects upon animals in the local population. However, depending on the endpoint selected, they may not indicate if population-level effects will occur.

There are some differences of opinion found in the literature as to the effectiveness of using models to predict concentrations of contaminants found in terrestrial species. According to one source, the food chain models currently used incorporate simplistic assumption that may not represent conditions at the site, bioavailability of contaminants, or site-specific behavior of the receptors. Simple food chain models can provided an effective means of initial characterization of risk, however, residue analyses, toxicity tests, and the use of biomarkers provide a better approach for assessing exposure (Menzie, 1993).

The following sections discuss the results of the ARAR comparisons as they relate to each of the media at the site. Also included in these sections is the terrestrial CDI compared to the TRVs, the COPCs in the soils compared to published soil toxicity data, and an evaluation of

## TABLE 7-12

## OPERABLE UNIT NO. 1
## QUOTIENT INDEX RATIO - SITE 24
## REMEDIAL INVESTIGATION CTO-0177
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant of Concern | Quail Quotient Index | Rabbit Quotient Index | Robin Quotient Index | Whitetailed Deer Quotient Index |
|---|---|---|---|---|
| Fluoranthene | 0.000 | 0.000 | 0.000 | 0.000 |
| Pyrene | 0.000 | 0.000 | 0.000 | 0.000 |
| Dieldrin | 0.038 | 0.017 | 0.037 | 0.003 |
| 4,4'-DDE | 0.008 | 0.001 | 0.018 | 0.000 |
| 4,4'-DDD | 0.015 | 0.005 | 0.022 | 0.001 |
| 4,4'-DDT | 0.024 | 0.007 | 0.035 | 0.001 |
| alpha-Chlordane | 0.007 | 0.003 | 0.006 | 0.000 |
| gamma-Chlordane | 0.005 | 0.002 | 0.005 | 0.000 |
| PCB-1254 | 0.000 | 0.000 | 0.000 | 0.000 |
| PCB-1260 | 0.000 | 0.000 | 0.000 | 0.000 |
| Arsenic | 0.003 | 0.001 | 0.004 | 0.000 |
| Barium | 0.047 | 0.016 | 0.041 | 0.002 |
| Beryllium | 0.010 | 0.001 | 0.013 | 0.000 |
| Chromium | 0.037 | 0.005 | 0.048 | 0.001 |
| Copper | 0.002 | 0.001 | 0.002 | 0.000 |
| Lead | 0.015 | 0.003 | 0.017 | 0.000 |
| Manganese | 8.140 | 3.162 | 6.395 | 0.481 |
| Mercury | 0.001 | 0.001 | 0.001 | 0.000 |
| Nickel | 0.024 | 0.006 | 0.026 | 0.001 |
| Selenium | 0.015 | 0.003 | 0.018 | 0.000 |
| Thallium | 0.011 | 0.001 | 0.014 | 0.000 |
| Vanadium | 0.100 | 0.012 | 0.130 | 0.001 |
| Zinc | 0.100 | 0.048 | 0.061 | 0.007 |

# TABLE 7-13

# OPERABLE UNIT NO. 1
# QUOTIENT INDEX RATIO - SITE 78
# REMEDIAL INVESTIGATION CTO-0177
# MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant of Concern | Rabbit Quotient Index | Robin Quotient Index |
|---|---|---|
| Fluoranthene | 0.000 | 0.000 |
| Pyrene | 0.000 | 0.000 |
| Dieldrin | 1.147 | 2.645 |
| 4,4'-DDE | 0.031 | 0.645 |
| 4,4'-DDD | 0.015 | 0.076 |
| 4,4'-DDT | 0.602 | 2.950 |
| alpha-Chlordane | 0.020 | 0.040 |
| gamma-Chlordane | 0.011 | 0.024 |
| PCB-1260 | 0.000 | 0.001 |
| Arsenic | 0.000 | 0.001 |
| Barium | 0.060 | 0.153 |
| Beryllium | 0.001 | 0.005 |
| Cadmium | 0.012 | 0.019 |
| Chromium | 0.011 | 0.110 |
| Copper | 0.001 | 0.002 |
| Lead | 0.062 | 0.305 |
| Manganese | 3.013 | 6.051 |
| Selenium | 0.001 | 0.007 |
| Vanadium | 0.003 | 0.025 |
| Zinc | 2.500 | 3.196 |

the potential impacts to threatened and endangered species, wetlands, and other sensitive environments.

### 7.4.1 Cogdels Creek and The New River

The following sections discuss the results of the risk characterization in Cogdels Creek and the New River. These sections contain a comparison of the contaminants detected in the surface water and sediments to their ARARs.

#### 7.4.1.1 Water Quality

Twenty surface water samples collected in Cogdels Creek were analyzed for TCL organics, TCL pesticides, TCL PCBs, and TAL inorganics. Chromium exceeded the WQS in one sample. Copper exceeded the WQS, and the acute and chronic WQSVs in eighteen samples. Lead exceeded the WQS in four samples and the chronic WQSV in five samples. Zinc exceeded the WQS, and the acute and chronic WQSVs in two samples. No other TAL inorganics exceeded any of the surface water ARARs in Cogdels Creek.

No TCL organics, TCL pesticides, or TCL PCBs detected in Cogdels Creek exceeded established ARARs for surface water samples in any of the samples.

The only COPC which had a Quotient Index (QI) greater than unity when compared to the WQSs, and the acute and chronic WQSVs was copper. Lead had a QI greater than unity when compared with the chronic WQSV.

#### 7.4.1.2 Sediment Quality

Forty sediment samples collected from twenty stations in Cogdels Creek were analyzed for TCL organics, TCL pesticides, TCL PCBs, and TAL inorganics. Cadmium exceeded the ER-M and the ER-L in three samples. Copper exceeded the ER-L in two samples. Lead exceeded the ER-L in twelve samples and the ER-M in three samples. Silver Exceeded the ER-L and the ER-M in three samples. Zinc exceeded the ER-L and the ER-M in six samples. No other TAL inorganic detected in the sediments exceeded the SSVs.

Among the organics, phenanthrene exceeded the ER-L in five samples and the ER-M in one sample. Fluoranthene exceeded the ER-L in three samples and the ER-M in one sample.

Pyrene exceeded the ER-L in seven samples and the ER-M in one sample. Benzo(a)anthracene exceeded the ER-L in five samples and the ER-M in one sample. Chrysene exceeded the ER-L in four samples, while Benzo(a)pyrene exceeded the ER-L in three samples. All of the ER-M exceedences among TCL organics were from sediment sample location 78-CC-SD18-612 at the extreme southern end of OU NO. 1. Among the pesticides/PCBs, 4,4'-DDE exceeded the ER-L in eight samples and the ER-M in two samples. While 4,4'-DDD exceeded the ER-L in twenty samples and the ER-M in nine samples, 4,4'-DDT exceeded the ER-L in eleven samples and the ER-M in nine samples. Alpha-chlordane exceeded the ER-L in five samples, while gamma-chlordane exceeded the ER-L in six samples and the ER-M in two samples. No other TCL pesticides or organics detected in Cogdels Creek sediments exceeded the ER-L or ER-M values in any of the samples.

The following COPCs in Cogdels Creek sediments had QIs greater than unity when compared to the ER-L: lead, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(a)pyrene, 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, alpha-chlordane, and gamma-chlordane. The following COPCs had ratios greater than unity when compared to the ER-M: 4,4'-DDE, 4,4'-DDD, and 4,4'-DDT.

### 7.4.2 Beaver Dam Creek

The following sections discuss the results of the risk characterization in Beaver Dam Creek. These sections contain a comparison of the contaminants detected in the surface water and sediments to their ARARs.

#### 7.4.2.1 Water Quality

Seven surface samples collected in Beaver Dam Creek were analyzed for TCL organics, TCL pesticides, TCL PCBs, and TAL inorganics. None of the TCL organics, TCL pesticides or TCL PCBs exceeded the SSVs. However, copper exceeded the WQS in six samples, and the acute and toxic WQSVs in seven samples. Zinc exceeded the WQS, and the acute and chronic WQSVs in one sample. No other TAL inorganics detected in Beaver Dam Creek exceeded any of the surface water ARARs.

The only COPCs to have QIs greater than unity when compared to the WQSs, and the acute and chronic WQSVs were copper and zinc. Lead had a QI greater than unity when compared to the chronic WQSV. No other COPCs had QIs greater than unity when compared to the WQS or WQSVs.

#### 7.4.2.2 Sediment Quality

Fourteen sediment samples collected from seven stations were analyzed for TCL semivolatile organics, TCL pesticides, TCL PCBs, and TAL inorganics. Thirteen sediment samples were analyzed for TCL volatile organics. The only TAL inorganic detected in sediments which exceeded any of the ER-L or ER-M values was lead, which exceeded the ER-L in four samples. Phenanthrene exceeded the ER-L in two samples and the ER-M in one sample. Fluoranthene and chrysene each exceeded the ER-L in one sample, while pyrene exceeded the ER-L in two samples. Among the pesticides, 4,4'-DDE exceeded the ER-L in six samples and the ER-M in three samples, while 4,4'-DDD and 4,4'-DDT both exceeded the ER-L and the ER-M in two samples. Alpha-chlordane exceeded the ER-L in four samples and the ER-M in one sample. Gamma-chlordane exceeded the ER-L in six samples, while PCB-1260 exceeded the ER-L in one sample.

The following COPCs in Beaver Dam Creek sediments had QIs greater than unity when compared with the ER-Ls: lead, phenanthrene, pyrene, 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, alpha-chlordane, and gamma-chlordane. The following COPCs had QIs greater than unity when compared with the ER-Ms: 4,4'-DDE, 4,4'-DDT, and alpha-chlordane.

### 7.4.3 Surface soils

The following sections discuss the results of the risk characterization of surface soils at OU No. 1. These sections contain a comparison of the contaminants detected in the surface soils to the concentrations of the contaminants in soil that caused adverse effects to plants and terrestrial invertebrates. This data was obtained from various sources in the literature.

#### 7.4.3.1 Site 21

Arsenic concentrations ranged from 0.76B to 3.9J mg/kg in the surface soils at Site 21 which are below the 25 mg/kg that depressed crop yields (USDI, 1988). Beryllium concentrations of 0.21B to 0.22B mg/kg were found in the surface soils which are below the 0.500 mg/kg limit for neutral to alkaline fine-textured soils (Adriano, 1986). The chromium concentrations found in the surface soils (5.8J to 19.9J mg/kg) are greater than the 10 kg/mg in surface soils that caused mortality in the earthworm species Pheretima pesthuma, (Hopkin, 1989).

Copper concentrations ranged from 3.1B to 16.3J mg/kg which are below the 50 mg/kg level that interfered with the reproduction activity of the earthworm species Allolobuphora caliginosa (Hopkin, 1989). The phytotoxicity of lead was reported to be lower than that of copper (which would be greater than 50 mg/kg). Lead concentrations ranged from 10.9J to 252 J mg/kg which are greater than the phytotoxicity value for copper (Adriano, 1986). Manganese concentrations (13.8 to 70J mg/kg) and vanadium concentrations (4.2B to 17.4 mg/kg) are lower than the mean U.S. soil concentration of 560 mg/kg and 58 mg/kg, respectively (Adriano, 1986). Zinc concentrations ranged from 14.5 to 67.7J mg/kg which are less than the 450 to 1400 mg/kg that caused plant toxicity (Adriano, 1986).

#### 7.4.3.2 Site 24

Arsenic concentrations ranged from 0.43B to 35.2B mg/kg in the surface soils at Site 21 which are greater than the 25 mg/kg that depressed crop yields (USDI, 1988). Barium concentrations ranged from 4.4B to 502 mg/kg which are below the 2,000 mg/kg that induced plant toxicity (Adriano, 1986). Beryllium concentrations of 0.2B to 4 mg/kg were found in the surface soils which are greater than the 0.500 mg/kg limit for neutral to alkaline fine-textured soils (Adriano, 1986). Chromium concentrations of 2 to 23 mg/kg were found in the surface soils which are greater than the 10 mg/kg in surface soils that caused mortality in the earthworm species Pheretima pesthuma, (Hopkin, 1989). Copper concentrations ranged from 0.45B to 314 mg/kg which are greater than the 50 mg/kg level that interfered with the reproduction activity of the earthworm species Allolobuphora caliginosa (Hopkin, 1989).

Lead concentrations ranged from 1.5 to 393 mg/kg which are greater than the phytotoxicity value for copper (greater than 50 mg/kg)(Adriano, 1986). Manganese concentrations ranged from 3B to 93.4J mg/kg which are lower than the mean U.S. soil concentration of 560 mg/kg (Adriano, 1986). Mercury concentrations ranged from 0.15 to 1.2 mg/kg which are greater than the 79 mg/kg that caused toxicity to earthworms (USDI, 1987). Vanadium concentrations ranged from 1.3J to 634 mg/kg which are greater than the U.S. soil concentrations of 560 mg/kg (Adriano, 1986). Zinc concentrations ranged from 2.4J to 93.8J mg/kg which are less than the 450 to 1400 mg/kg that caused plant toxicity (Adriano, 1986).

#### 7.4.3.3 Site 78

Arsenic concentrations ranged from 0.69B to 2.8 mg/kg in the surface soils which are below the 25 mg/kg that depressed crop yields (USDI, 1988). Barium concentrations ranged from 8.2B to 520 mg/kg which are below the 2,000 mg/kg that induced plant toxicity (Adriano, 1986). Beryllium concentrations ranging from 0.21B to 25B mg/kg were found in the surface soils which are greater than the 0.500 mg/kg limit for neutral to alkaline fine-textured soils (Adriano, 1986). Chromium concentrations of 2.2 to 74.6 mg/kg were found in the surface soils which are greater than the 10 kg/mg in surface soils that caused mortality in the earthworm species Pheretima pesthuma, (Hopkin, 1989). Copper concentrations ranged from 2.4B to 29.6 mg/kg which are below the 50 mg/kg level that interfered with the reproduction activity of the earthworm species Allolobuphora caliginosa (Hopkin, 1989).

Lead concentrations ranged from 12.8J to 962J mg/kg which are considerably greater than the phytotoxicity values for copper (greater than 50 mg/kg) (Adriano, 1986). Manganese concentrations ranged from 4.3 to 45.1 mg/kg which are lower than the mean U.S. soil concentration of 560 mg/kg (Adriano, 1986). Vanadium concentrations ranged from 3.1B to 16.1 mg/kg which are below the mean U.S. soil concentrations of 560 mg/kg (Adriano, 1986). Zinc concentrations ranged from 13.1 to 4370J mg/kg which are greater than the 450 to 1400 mg/kg that caused plant toxicity (Adriano, 1986).

### 7.4.4 Terrestrial Chronic Daily Intake Model

The CDI model was used to assess decreased viability in terrestrial species from exposure to contaminants in surface water and surface soils. The surface soil data was grouped into two areas, Site 24 and Site 78 for the statistics. Therefore, a QI was calculated for each area (Note: the surface water samples were included in the calculations for each area).

At Site 24, the quotient indexes of the CDI to the TRVs were less than unity for all COPCs except manganese. The quotient index for each indicator species for this chemical is less than ten indicating only a small potential that the animals are being adversely effected.

At Site 78, the quotient indexes of the CDI to the TRVs were less than unity for all the COPCs except for dieldrin, 4,4'-DDT, manganese and zinc. However, for each of these chemicals, the quotient index is less than ten indicating only a small potential for adverse environmental effects.

### 7.4.5 Threatened and/or Endangered Species

Several threatened and/or endangered species inhabit MCB Camp Lejeune. Although the American Alligator has been reported in Cogdels Creek, it, is not, nor is any other threatened and/or endangered species, known to regularly frequent or breed at OU No. 1 (USMC, 1993). Therefore, potential adverse impacts to these protected species from contaminants at OU No. 1 appear to be low.

### 7.4.6 Flora/Wetlands

No wetlands were identified at OU No. 1 from the NWI maps, although some wetland areas border the southeastern boundary of the site. A site specific wetland study has not been conducted.

### 7.4.7 Other Sensitive Environments

Cogdels Creek and Beaver Dam Creek are designated as nutrient-sensitive tidal saltwaters by the North Carolina Department of Environment, Health, and Natural Resources (NC DEHNR, 1993). No specific nursery areas or spawning areas critical for the maintenance of fish/shellfish species in Cogdels Creek or Beaver Dam Creek have been designated by state agencies. The potential impacts to the fish in these waters have already been discussed in this report. No areas within the boundaries of OU No. 1 are designated as primary nursery areas or are unique or special waters of exceptional state or national recreational or ecological significance which require special protection to maintain existing uses.

The potential impact to terrestrial organisms that are present at OU No. 1 is discussed in earlier sections of this report. The terrestrial organisms that may be breeding in contaminated areas at OU No. 1 may be more susceptible to chemical stresses due to the higher sensitivity of the reproductive life stages of organisms to these types of stresses.

## 7.5 Ecological Significance

This section essentially summarizes the overall risks to the ecology at the site. It addresses impacts to the ecological integrity at the Operable Unit from the COPCs detected in the media, and which of these COPCs are impacting the site ecology to the greatest degree. This information, used in conjunction with the results of the Human Health RA, supports the selection of remedial action(s) for the Operable Unit that are protective of public health and the environment.

### 7.5.1 Aquatic Endpoints

The measurement endpoint used to assess the aquatic environment is decreased viability of aquatic organisms. Overall, pesticides appear to be the most significant site related COPCs that have the potential for decreasing the viability of aquatic organisms at OU No. 1. Pesticides are not only potentially toxic to aquatic life through a direct exposure pathway, but as indicated by their high BCF value, they have a high potential to bioconcentrate pesticides in organisms. Therefore, other fauna that feed upon these organisms will be exposed to pesticides via this indirect exposure pathway. Following is a summary of other findings within OU No. 1.

Based on the potential habitat, and other physical characteristics, the most significant populations of aquatic organisms at the site, including fish, tadpoles, bentho macro-invertebrates, and some terrestrial vertebrates, potentially are in Cogdels Creek and Beaver Dam Creek. Chromium, copper, lead, and zinc were the only COPCs detected in the surface water in Cogdels Creek at concentrations that exceeded any of the ARARs. These same four constituents, along with silver, several PAHs and pesticides were detected in sediments at concentrations that potentially may decrease the viability of aquatic life.

However, there is some aquatic life inhabiting Cogdels Creek and Beaver Dam Creek including fish, tadpoles, and benthic macroinvertebrates. In addition, some terrestrial invertebrates probably inhabit undeveloped areas in the vicinity.

Copper and zinc were the only COPCs detected in surface water at Beaver Dam Creek that exceeded any of the ARARs. Lead, several PAHs and several pesticides were detected in sediment samples from Beaver Dam Creek. The surface water in the drainage ditch at Site 21 was either shallow or nonexistent, and intermittent in flow.

### 7.5.2 Terrestrial Endpoints

The measurement endpoints used to assess the terrestrial environment is decreased viability of terrestrial organisms. Overall, pesticides appear to be the most significant site-related

COPCs that have the potential for decreasing the viability of terrestrial organisms at OU No. 1. Other site-specific comments follow.

Based on the soil toxicity data for plants and terrestrial invertebrates (earthworms), lead and chromium were detected in concentrations that potentially may decrease the viability of terrestrial invertebrates and floral species at Site 21.

Lead and chromium, along with beryllium, copper, mercury, and vanadium were detected in concentrations that potentially may decrease the viability of terrestrial invertebrates and floral species at Site 24.

At Site 78, lead and chromium were once again detected in concentrations that potentially may decrease the viability of terrestrial invertebrates and floral species, along with beryllium and zinc.

Other terrestrial organisms (e.g., rabbits, birds, deer) may be exposed to contaminants in the surface soils and surface water by ingestion. Based on the comparison of the CDI to the TRVs.

### 7.5.3 Threatened and Endangered Species

Potential adverse impacts to these threatened or endangered species from contaminants at OU No. 1 appear to be low. There are no areas where protected, threatened, or endangered species have been observed on OU No. 1.

### 7.5.4 Wetlands

No wetlands were identified at OU No. 1 from the NWI maps, although some wetland areas border the southeastern boundary of the site. A site specific wetland study has not been conducted.

### 7.5.5 Other Sensitive Environments

There are no known spawning and nursery areas for resident fish species within Cogdels Creek or Beaver Dam Creek. Therefore, there is no potential for decreased viability of fish spawning or nursing in Cogdels Creek or Beaver Dam Creek.

### 7.5.6 Uncertainty Analysis

The procedures used in this evaluation to assess risks to ecological receptors, as in all such assessments, are subject to uncertainties. The following discusses the uncertainty in the ERA.

There is uncertainty in the ecological endpoint comparison. The values used in the ecological endpoint comparison (either the WQS of the SSV) are set to be protective of a majority of the potential receptors. There will be some species, however, that will not be protected by the values because of their increased sensitivity to the chemicals. Also, the toxicity of chemical mixtures is not well understood. All the toxicity information used in the ecological risk assessment for evaluating risk to the ecological receptors is for individual chemicals. Chemical mixtures can affect the organisms very differently than the individual chemicals. In addition, there were several contaminants that did not have WQS or SSVs. Therefore, potential effects to ecological receptors from these chemicals cannot be determined.

The NOAA SSVs were developed using data obtained from freshwater, estuarine and marine environments. Therefore, their applicability for use to evaluate potential effects to aquatic organisms from contaminants in estuarine habitats must be evaluated on a chemical specific basis because of differences in both the toxicity of individual contaminants to freshwater and saltwater organisms, and the bioavailability of contaminants in the two aquatic systems. In addition, the toxicity of several of the metals (cadmium, chromium, copper, lead, nickel, and zinc) to aquatic organisms increases or decreases based on water hardness. Because water hardness was not available, a default value of 50 mg/l of $CaCO_3$ was used.

Several contaminants in the surface water and sediment exceeded applicable ARAR values. Some of the surface water and sediment samples were collected from areas that were not considered ecologically significant (drainage ditch in Site 21, shallow, low flow areas in Beaver Dam Creek). Therefore, although the ARARs may have been exceeded in these samples, the potential for them to impact aquatic life may not be significant.

Finally, there is also uncertainty in the chronic daily intake models used to evaluate decreased viability to terrestrial receptors. Many of the input parameters are based on default values (i.e., ingestion rate) that may or may not adequately represent the actual values of the parameters. In addition, there is uncertainty in the amount that the indicator species will represent other species potentially exposed to COPCs at the site. Finally, terrestrial species will also be exposed to contaminants by ingesting fauna that have accumulated contaminants.

This additional exposure route was not evaluated in this ERA because the high uncertainty associated with this exposure route.

# 8.0 CONCLUSIONS AND RECOMMENDATIONS

This section presents a summary of the conclusions of the RI, the human health baseline risk assessment (BRA), and the ecological risk assessment (ERA). Recommendations for further action are also provided in the section.

## 8.1 Conclusions

Conclusions with respect to the analytical results from the environmental media sampled, and the human health and ecological risks associated with OU No. 1 are presented below:

### 8.1.1 Environmental Media Conclusions

#### 8.1.1.1 Site 21 - Transformer Storage Lot 140 Conclusions

With respect to Site 21, it appears that the former activities conducted at the site (i.e., pesticide mixing/disposal and PCB oil disposal) have impacted limited areas of soil and sediments within the site. Groundwater and on-site surface water does not appear to be significantly impacted by the former activities at this site. Overall, it appears that the contaminants detected within Site 21 have not migrated off site.

Overall, pesticides and PCBs were the dominant contaminants present in soils at Site 21. The most significant pesticide levels were found in surface soils collected in the vicinity of the Former Pesticide Mixing/Disposal Area. These elevated concentrations (ranging from 4.6 µg/kg to 34,000 J µg/kg) are believed to be related to the previous handling practices which were reported by base personnel. PCBs (PCB-1260) were present in significant concentrations primarily in surface soils in the vicinity of the Former PCB Transformer Disposal Area. The presence of the PCBs (maximum detected concentration of 4,600 µg/kg) is presumed to be related to the previous disposal practices at the site.

VOCs and SVOCs were not extensively found in Site 21 soils. In general, the VOCs and SVOCs appear to be limited to the surface soils. The detected VOCs and their maximum concentrations included toluene (37 J µg/kg), ethylbenzene (570 µg/kg), and total xylenes (3,400 µg/kg). Furthermore, several of the more prevalent detected SVOCs and their maximum concentrations included naphthalene (3,200 J µg/kg), fluorene (1,300 µg/kg), pyrene (520 µg/kg), benzo(b & k)fluoranthene (560 µg/kg), and chrysene (450 µg/kg). Because these constituents are petroleum based, they may be associated with the pesticide mixing/disposal since petroleum products are used for a base-medium.

With respect to groundwater, metals were the most prevalent contaminants at Site 21. Concentrations of arsenic, manganese, cadmium, beryllium, chromium, lead, and/or nickel were found above MCLs and/or NCWQSs in seven of the eight wells sampled. The highest concentrations were detected in wells located near the southwestern portion of the site. VOCs in the groundwater were primarily limited to well 21GW02, which is located near the northeastern portion of the site. Concentrations of TCE (41 µg/l), benzene (77 J µg/l), toluene (210 J µg/l), ethylbenzene (540 µg/l), and total xylenes (1,300 µg/l) were detected in this well. All five of these compounds were detected at concentrations which exceeded the MCLs and NCWQSs. Note that this groundwater contamination is most likely related to Site 78, specifically the 900 Series buildings. Additionally, a low level of dichloromethane (2.0 µg/l) was detected in well 21GW03. Note that pesticides and PCBs, which were found extensively in site soils, were not detected in the groundwater at Site 21.

Surface water samples collected from the drainage ditches which surround Site 21 indicated that limited contamination was present at the site. The only organic contaminant detected in Site 21 surface water was 4,4'-DDD. This compound was detected in one sample at a concentration of 0.24 µg/l. Inorganics were detected in the surface water samples but not at concentrations exceeding freshwater standards.

Pesticides and PCBs were the dominant contaminants present in sediments at Site 21. Pesticides were detected a total of 66 times, all of which exceeded established SSVs. Generally, the most significant pesticide levels were found in sediment samples collected from 21-DD-SD04 and 21-DD-SD06. Both of these locations are downgradient of the suspected pesticide mixing area, along the southwestern portion of the site. PCBs were detected near the Former PCB Transformer Disposal Area. The PCB concentration exceeded the SSVs.

#### 8.1.1.2 Site 24 - Industrial Fly Ash Dump Conclusions

With respect to Site 24, it appears that former disposal activities conducted at the site have impacted limited areas of soil and groundwater within the site. Analytical results indicated that pesticides and metals were the predominant contaminants detected in the soils at Site 24. Pesticide concentrations (highest concentration at 350 µg/kg) were not significantly elevated (as compared to other areas within MCB Camp Lejeune); however, they were present throughout the site, mostly in the surface soils. The presence of the pesticides appeared to be the result of spraying activities rather than direct disposal due to their relatively low concentrations and widespread detections. In addition, there is no record of pesticide disposal or pesticide mixing activities at the site.

Detections of metals in surface and subsurface soils were one order of magnitude or higher above average base-specific background levels. The presence of metals is most likely attributed to the disposal of fly ash material and various metal debris. These materials were reportedly disposed of within the vicinity of Site 24. The metals detected above base-specific background levels (surface and/or subsurface soils) included: aluminum, calcium, barium, copper, chromium, iron, lead, manganese, nickel, and selenium. In general, samples collected from the Buried Metal Areas exhibited the highest overall concentration of these metals. A few of these elevated metals were detected to depths of 12 feet.

Test pit samples, which were collected in the vicinity of the suspected Buried Metal and Fly Ash Disposal Areas, tested below Federal regulatory levels for TCLP organics and inorganics. Additionally, the soils classify as nonhazardous under RCRA. TCE, 4,4'-DDD, 4,4'-DDT, and metals were the contaminants detected in the test pit samples. The detected levels of the organic compounds were: TCE (2J mg/kg and 7J mg/kg), 4,4'-DDD (12 mg/kg), and 4,4'-DDT (8.4 mg/kg). Twenty-one of 24 TAL metals were detected in the test pit samples.

The analytical findings indicated that TAL metals were the predominant contaminants impacting Site 24 groundwater. The most elevated concentrations above the standards occurred near the suspected Buried Metals Area and the Fly Ash Disposal Area. The source of the elevated metals at the site is most likely related to the previous disposal practices. Base records indicated that the area was used for the disposal of metal debris and fly ash materials. The most common elevated metals in groundwater at Site 24, chromium, lead, and manganese, were also elevated in site soils. Subsequently, the source of the metals in the groundwater may be attributed to the contaminated soils in the area.

Low levels of the pesticide, heptachlor epoxide, were detected in three wells at a concentration slightly above the NCWQS. The source of the heptachlor epoxide appeared to be related to pesticide spraying activities since the overall concentration levels were relatively low in both the groundwater and soil. Additionally, there is no history of pesticide disposal or mixing operations at the site.

### 8.1.1.3 Site 78 - HPIA Conclusions

With respect to Site 78, the environmental data collected within the site confirmed the results from the interim remedial action (IRA) RI (i.e., shallow groundwater contamination). In addition, it appears that the former operational/disposal practices conducted within the industrial area have primarily impacted shallow groundwater. The deeper portions of the operable unit groundwater (i.e., Castle Hayne aquifer) is also contaminated due to vertical migration, but to a far lesser degree compared to shallow groundwater. In addition, former disposal practices also impacted soils, in limited areas. The site groundwater contamination appears to be migrating off site (i.e., vertically). No specific source areas were identified during the RI with the exception of a few suspected USTs and building where solvents are known to have been used.

With respect to soil, SVOCs, pesticides, and metals were the predominant contaminants detected at Site 78. The concentrations of the detected pesticides were generally below 500 µg/kg, with the exception of a few samples exhibiting levels above 1,000 µg/kg at Buildings 1103 and 1502. In general, the higher pesticide concentrations were detected in surface soils samples. The data suggests that the pesticide-impacted soils at Site 78 may be the result of routine spraying activities since disposal of pesticides (e.g., buried drums, pesticide mixing) have not been documented at these building locations, and the fact that the overall concentrations are relatively low and comparable to other surface soils within OU No. 1.

SVOCs were present in soils in the vicinity of Buildings 903, 1103, 1502, 1601, and 1608. In general, the higher SVOC concentrations and the more frequent detections occurred in surface soils. A few detections of SVOCs, however, were also noted in subsurface soils near Building 1601. The most frequently detected SVOCs were PAHs, which included phenanthrene, anthracene, fluoranthene, pyrene, benzo(b&k)fluoranthene, benzo(a)pyrene, and benzo(g,h,i)perylene. These compounds are found in petroleum fuels such as fuel oil No. 2, diesel, and kerosene which are used for heating purposes, emergency generators, or refueling base vehicles. Storage of these fuels in aboveground tanks or USTs are common practices at a number of buildings throughout Site 78. It is possible that the source of the SVOCs is related to surface (i.e., spills) or subsurface releases (i.e., leaking tanks) of fuels.

Barium, lead, and zinc were the three most common metals detected at an order of one magnitude or higher above base-specific background levels. These metals were found predominantly in surface soils collected around Buildings 1103, 1502, and 1608. The specific sources of these metals are unknown since there is no history of disposal at these buildings that would relate to these three contaminants. Note that just the industrial nature of the area with respect to vehicular traffic would potentially contribute to the metals problem.

Analytical data indicated that VOCs and PCBs are not significantly impacting soils at the five building areas investigated within Site 78. Low levels of toluene (9.0 µg/kg) and total xylenes (10 µg/kg) were detected at Building 1103 (surface); somewhat higher levels of ethylbenzene (55 J µg/kg) and total xylenes (450 µg/kg) were detected in subsurface soils (6 to 7 feet) at Building 1601. The source of the ethylbenzene and xylenes at Building 1601 may be related to releases of fuel from the suspected UST at the building. It is important to note that TCE and 1,2-DCE were detected in the subsurface soil samples collected from the replacement well 78GW09-1. TCE concentrations were 140 µg/kg at the 3 to 5 foot interval and 35 µg/kg at the 11 to 13 foot interval. Detected concentrations of 1,2-DCE (total) were 26 µg/kg (3 to 5 feet) and 22 µg/kg (11 to 13 feet). PCBs were only detected in a surface sample collected at Building 1300 (PCB-1260 at 100 J µg/kg).

The analytical findings confirmed that shallow groundwater at Site 78 was impacted by organics and metals. The primary organic contaminants were VOCs, namely BTEX, PCE, TCE, vinyl chloride, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, and 1,2-dichloropropane. The highest concentrations of these compounds were detected in wells 78GW22-1, 78GW23, and 78GW24-1 which are located near the northeastern portion of Site 78 in the vicinity of the 900 Series buildings, and in wells 78GW09-1 and 78GW01 which are located near Building 1601 (southwestern portion of the site). A number of these buildings, reportedly stored/handled petroleum fuels and/or solvents. The TAL metals which were detected at elevated concentrations above the standards included: arsenic, barium, beryllium, cadmium, chromium, lead, manganese, mercury, and nickel. In general, there was no particular area which exhibited excessive metals contamination since the entire site appeared to be impacted.

The VOCs detected at Site 78 represent two different categories of VOCs including: halogenated compounds (e.g., PCE, TCE, vinyl chloride, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, and 1,2-dichloropropane) and nonhalogenated compounds (e.g., BTEX). The halogenated compounds are typically associated with items such as solvents, degreasing agents, and paint strippers. Nonhalogenated compounds on the other hand, especially the lighter compounds such as BTEX, are typically associated with petroleum fuels (e.g., gasoline). A variety of these substances are stored or handled extensively throughout Site 78 at maintenance facilities, gas stations, fuel farms, and waste storage areas. Subsequently, the presence of VOCs in groundwater through accidental spills or leaking pipelines or tanks at Site 78 is plausible.

The intermediate wells sampled at Site 78 exhibited low levels of VOCs and a few metals which exceeded the standards. Benzene, TCE, 1,2-DCE, vinyl chloride, and dichloromethane were the most prevalent VOCs detected. The overall highest VOC concentrations were found in well 78GW30-2, which is located in the northeastern portion of the site, and wells 78GW04-2 and 78GW09-2, which are located in the southern portion of the site. Additionally, several SVOCs including naphthalene, acenaphthene, and carbazole were detected in well 78GW24-2 (located in the northern portion of Site 78). With respect to TAL metals, well 78GW32-2 exhibited the overall highest concentrations. Beryllium, cadmium, lead, manganese, and nickel concentrations in this well exceeded the Federal MCLs and/or the NCWQSs.

The analytical data indicated that organic compounds, namely VOCs, were the predominant contaminants in the deep wells. The most prevalent VOCs (i.e., both halogenated and nonhalogenated compounds) included benzene, cis-1,2-DCE, trans-1,2-DCE, and TCE. Wells 78GW04-3, 78GW24-3, and 78GW32-3 exhibited the overall highest concentrations of VOCs. Further, well 78GW09-3 exhibited elevated alpha chlordane (pesticide) levels above the NCWQS.

Overall contamination levels in shallow groundwater appear to have decreased over time. Several wells which exhibited elevated VOCs in 1987 and/or 1991 either had nondetectable or significantly lower concentrations in 1993. These wells included 78GW01, 78GW02, 78GW03, 78GW09-1, 78GW10, 78GW11, 78GW17-1, and 78GW19. Several possible explanations may account for the decrease in contaminant levels, including:

- The contaminants may have migrated vertically from the shallow aquifer into the underlying aquifer, or horizontally to other portions of the site.

- The contaminant concentrations may have dissipated over time through natural processes.

Since the validity of the previous data in unknown, it is difficult to conclude which one of these possible explanations above is the most valid.

Three of the wells including 78GW22-1, 78GW23, and 78GW24-1 either had increased contaminant levels or had detections of compounds not previously detected. These three wells are situated near the northeastern portion of Site 78 where multiply sources of contamination are known to exist (e.g., Hadnot Point Fuel Farm, numerous maintenance shops). These sources are presumed to be continually impacting the groundwater in the area.

Several of the deep wells have exhibited increased levels of VOCs over time. Wells 78GW04-3, 78GW09-3, 78GW24-3, and 78GW32-3, which all indicated nondetectable levels of VOCs in 1991, had positive detections of benzene, TCE, 1,2-DCE, cis-1,2-DCE, and/or trans-1,2-DCE in 1993. Only one of the deep wells, 78GW31-3, revealed lower overall concentrations in 1993 compared to 1991. The suggests that the contaminants may be migrating into the deeper water-bearing zone at Site 78. Additional rounds of sampling, however, may be required to support this conclusion.

Metals are also prevalent in groundwater at Site 78, especially shallow groundwater. The most frequently detected metals above the MCLs or NCWQSs included beryllium, chromium, lead, and manganese. Manganese, as discussed earlier, is commonly found at elevated concentrations in soil and groundwater throughout MCB Camp Lejeune. The elevated lead concentrations may be related to releases of leaded fuels which may have been stored at the Base at one time. The specific source for beryllium and chromium is unknown but they are most likely related to industrial processes or buried metal debris.

Overall, it appears that the source of groundwater contamination within Site 78 originated from the shallow aquifer. The groundwater contaminants appear to be migrating vertically. No off-site migrating has occurred to date.

#### 8.1.1.4 OU No. 1 Surface Water and Sediment Conclusions

The only contaminants found in Cogdels Creek and New River surface water samples which exceeded WQS and/or WQSV were TAL inorganics, particularly copper, which was detected in all 20 samples (18 of which exceeded WQS and WQSV standards), and lead, which exceeded WQS and/or WQSV standards in five samples. A majority of maximum detection concentrations were found at sample locations 78-CC-SW19 (including lead and eight other

TAL inorganics) and 78-CC-SW-17, both of which are situated near the Hadnot Point Sewage Treatment Plant, along the southern end of Site 78.

The most prevalent contaminants found in Cogdels Creek and New River sediments were PAH compounds, pesticides (particularly 4,4'-DDD), and several TAL inorganics (lead and zinc were most often in exceedance of screening values). The sample locations that produced a majority of maximum concentrations were 78-CC-SD08-06, 78-CC-SD08-612, and 78-CC-SD18-612.

PAH compounds can be found in petroleum fuels such as No. 2 oil, diesel, and kerosene, which are used for heating purposes, emergency generators, or refueling base vehicles. As mentioned earlier, storage of these fuels in aboveground or USTs is a common practice throughout Site 78. It is likely, therefore that the source of SVOCs, and possibly lead, is related to surface or subsurface releases of fuels.

Pesticides were detected throughout Site 78, but in concentrations that were relatively low. This suggests that the presence of pesticides throughout Cogdels Creek and New River sediments are the result of spraying activities rather than disposal practices or spill incidents, since pesticide detections are not exceptionally high or concentrated in any specific area.

A number of TAL inorganics were detected at every sediment sample location. Lead and zinc were most often in exceedance of the screening values. Sample location 78-CC-SD08-06 was the site of 6 of the 14 TAL inorganics maximum concentrations.

The only contaminants that were present in Beaver Creek surface water were TAL inorganics. The only TAL inorganics that exceeded WQS or WQSV standards were copper (in all seven samples), lead (in two samples), and zinc (in one sample). Sample location 78-BD-SW07, which exhibited a majority of maximum detections, is situated near an access road along a very narrow stretch of Beaver Dam Creek. Activities along this access road may be the origin of elevated metal concentrations at this sample location.

The most prevalent contaminants found in Beaver Creek sediments were PAHs, pesticides, and TAL inorganics (lead was the only TAL inorganic to exceed the screening values). As discussed earlier, storage of petroleum fuels (which contain PAH compounds) in aboveground or underground storage tanks is a common practice throughout Site 78. It is likely, therefore that the source of PAHs, and possibly lead, is related to surface or subsurface releases of fuels.

Additionally, a second source of the PAHs may be from stormwater runoff from roads. Pesticides were detected throughout Beaver Dam Creek sediments, but in concentrations that were relatively low. As is the case with Cogdels Creek and New River sediments, this data suggests that the presence of pesticides in Beaver Dam Creek may be the result of spraying activities rather than disposal practices or spill incidents, since pesticides detections are not exceptionally high or concentrated in any specific area.

### 8.1.2 Human Health Risk Conclusions

The human health BRA highlighted the media of interest from the human health standpoint at OU No. 1 by identifying areas with elevated ICR and HI values. Overall, the RA indicated that areas of groundwater throughout OU No. 1 may pose potential risks. The following paragraphs summarize the results of the human health assessment performed for OU No. 1.

The estimated site risks for Site 21 fell within the USEPA's acceptable risk range (i.e., ICR < 1E-04 and HI ≤ 1.0). Therefore, the contaminants detected at Site 21 do not appear to present an unacceptable risk to human health and the derivation of remediation levels for protection of human health will not be necessary.

Future potential residential exposure (i.e., children and adults) to surface water and sediments (Beaver Dam Creek and Cogdels Creek) did not produce ICRs in excess of the target risk range or HIs exceeding unity. Therefore, derivation of remediation levels for protection of human health for either of these water bodies will not be necessary.

With respect to Site 24, the majority of the total site risk (greater than 95 percent) was associated with the ingestion and dermal contact of Operable Unit groundwater by future residents. With the exception of the total site risk associated with groundwater exposure to future adult and child residents, all total site risks fall within the USEPA's acceptable risk range. The ICR and HI for future potential adult residents were 2E-03 and 13, respectively. The ICR and HI for future potential child residents were 7E-04 and 29, respectively. The risk was driven by vinyl chloride, arsenic, vanadium, and chromium. Therefore, OU No. 1 groundwater must be considered a medium of interest for which remediation levels for protection of human health will be needed.

It is important to note that although lead could not be quantitatively evaluated in the Human Health RA, lead was mainly detected in the shallow groundwater and not the deeper portions of the aquifer. Therefore, exposure is unlikely since the shallow groundwater is not conducive to usage.

### 8.1.3 Ecological Risk Conclusions

The aquatic and terrestrial environments were assessed in the ERA. Based on the potential habitat, and other physical characteristics, the most significant populations of aquatic organisms at OU No. 1 were in Cogdels Creek and Beaver Dam Creek since the surface water in the drainage ditch at Site 21 was either shallow or nonexistent, and intermittent in flow.

Chromium, copper, lead, and zinc were the only COPCs detected in the surface water in Cogdels Creek at concentrations that exceeded any of the water quality standard. These same four constituents, along with silver, several PAHs and pesticides were detected in sediments at concentrations that potentially may decrease the viability of aquatic life. The PAH and pesticide concentrations may be related to past disposal practices. However, the pesticide concentration in Cogdels Creek may also be due to the widespread pesticide spraying that has occurred at MCB Camp Lejeune.

Copper and zinc were the only COPCs detected in surface water at Beaver Dam Creek that exceeded any of the water quality standards. Lead, several PAHs and several pesticides were detected in sediment samples from Beaver Dam Creek.

Finally, there is some aquatic life inhabiting Cogdels Creek and Beaver Dam Creek including fish, tadpoles, and bentho macroinvertebrates. In addition, some terrestrial invertebrates probably inhabit the undeveloped areas within OU No.1. Pesticides are not only potentially toxic to aquatic life through a direct exposure pathway, but as indicated by their high bioconcentration factor value, they have a high potential to bioconcentrate pesticides in organisms. Therefore, other fauna that feed upon these organisms will be exposed to pesticides via this indirect exposure pathway.

Overall, pesticides appear to be the most significant site related COPCs that have the potential for decreasing the viability of aquatic organisms at OU No. 1.

With respect to the terrestrial environment, the following conclusions were made. Overall, pesticides appear to be the most significant site-related COPCs that have the potential for decreasing the viability of terrestrial organisms at OU No. 1. In addition, based on the soil toxicity data for plants and terrestrial invertebrates (earthworms), lead and chromium were detected in concentrations that potentially may decrease the viability of terrestrial invertebrates and floral species at Site 21. Lead and chromium, along with beryllium, copper, mercury, and vanadium were detected in concentrations that potentially may decrease the viability of terrestrial invertebrates and floral species at Site 24. At Site 78, lead and chromium were once again detected in concentrations that potentially may decrease the viability of terrestrial invertebrates and floral species, along with beryllium and zinc. Other terrestrial organisms (e.g., rabbits, birds, deer) may be exposed to contaminants in the surface soils and surface water by ingestion.

Potential adverse impacts from contaminants at OU No. 1 to potential threatened or endangered species appear to be low. No wetlands were identified at OU No. 1 from available wetland maps, although some wetland areas border the southeastern boundary of the site. A site specific wetland study has not been conducted.

There are no known spawning and nursery areas for resident fish species within Cogdels Creek or Beaver Dam Creek. Therefore, there is no potential for decreased viability of fish spawning or nursing in Cogdels Creek or Beaver Dam Creek.

## 8.2 Recommendations

Based on the results of the RI environmental investigations and risk assessments conducted for OU No. 1, the following recommendations for further action have been made.

- Based on the results of the risk assessments, and on a comparison of contaminant levels to applicable water quality standards, remedial action of the surficial aquifer and possibly the deeper portions of the aquifer under OU No. 1 is recommended in order to restore the aquifer and/or reduce further migration of the contaminants. This remedial action should coincide with the interim action currently under design for the shallow aquifer at Site 78. The action may recommend monitoring of the deeper aquifer.

- Pesticide and PCB-contaminated soil at Site 21 should be addressed in the feasibility study due to potential ecological impacts.

- Metal-contaminated soil at Site 24 should be evaluated in the feasibility study due to potential ecological impacts. In addition, the soil in this area may be contributing to groundwater contamination at Site 24.

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