Bechtel

401 West A Street
Suite 1000
San Diego, CA 92101-7905

CLEAN II Program
Bechtel Job No. 22214
Contract No. N68711-92-D-4670
File Code: 0202

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MCAS EL TORO
SSIC # 5090.3

IN REPLY REFERENCE: CTO-0059/000223

September 6, 1995

Department of the Navy
Southwest Division
Naval Facilities Engineering Command
1220 Pacific Highway
San Diego, CA 92131-5187

Attention: Jason Ashman, RPM
Code 1831.JA

Subject: Final Risk Assessment Work Plan
Phase II Remedial Investigation/Feasibility Study,
MCAS El Toro California, CTO-059

Dear Mr. Ashman:

Enclosed are three (3) copies of the Final Risk Assessment Work Plan, Phase II RI/FS, MCAS El Toro, California, prepared under CTO-059 for Contract No. N68711-92-D-4670.

We have submitted the appropriate number of copies of this plan to individuals on the attached transmittal. The Final Risk Assessment Work Plan is being delivered at the same time as the Response to Comments document but each will be delivered under separate transmittals.

If you have any questions, please contact Timothy Latas at (619) 687-8848, or me at (619) 687-8802.

Very truly yours,

David K. Cowser
Project Manager

DC/sp

Attachment: Final Risk Assessment Work Plan for CTO-059

BECHTEL NATIONAL INC.

CLEAN II TRANSMITTAL/DELIVERABLE RECEIPT

Contract No. N-68711-92-D-4670 **Document Control No.** CTO-0059/000223

File Code: 0202

TO: Jason Ashman, RPM (3 copies)
Code 1831.JA
Naval Facilities Engineering Command
Southwest Division
1220 Pacific Highway
San Diego, CA. 92132-5187

DATE: September 6, 1995
CTO #: 0059

FROM: J. W. Kluesener, Operations Manager

D. K. Cowser, Project Manager

DESCRIPTION: Final Risk Assessment Work Plan,
Phase II Remedial Investigation/Feasibility Study
MCAS El Toro, California, CTO-0059

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San Diego, California 92132-5187

Contract No. N68711-92-D-4670

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

CLEAN II

FINAL
RISK ASSESSMENT WORK PLAN
MARINE CORPS AIR STATION
EL TORO, CALIFORNIA

CTO-0059

Prepared by:

BECHTEL NATIONAL, INC.
401 West A St., Suite 1000
San Diego, California 92101

August 1995

Signature: _____ Date: 8/29/95
Timothy W. Latas, CTO Leader

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Appendix

A SUMMARY TABLES

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ACRONYMS/ABBREVIATIONS

Air SWAT	Air Quality Solid Waste Assessment Test
AQUIRE	Aquatic Information Retrieval
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	ambient water quality criteria
BAF	bioaccumulation factor
bgs	below ground surface
BMF	biomagnification factors
BNI	Bechtel National, Inc.
Cal/EPA	California Environmental Protection Agency
CARB	California Air Resources Board
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIS	Chemical Information System
CLEAN	Comprehensive Long-Term Environmental Action Navy
cm/hr	centimeters per hour
cm^2	square centimeters
cm^2/day	square centimeters per day
CNDD	California Natural Diversity Database
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CPF	cancer potency factor
CSF	cancer slope factor
CTO	Contract Task Order
Desalter	Irvine Desalter Project
DoD	Department of Defense
DON	Department of the Navy
DRMO	Defense Reutilization and Marketing Office
EBS	Environmental Baseline Study
EE/CA	Engineering Evaluation/Cost Analysis
°F	degrees Fahrenheit
FFA	Federal Facilities Agreement
FS	Feasibility Study
FSP	Field Sampling Plan
g/m^3	grams per cubic meter
gpm	gallons per minute
GPR	ground-penetrating radar

ACRONYMS/ABBREVIATIONS (continued)

HEAST	Health Effects Assessment Summary Tables
hr/day	hours per day
HSDB	Hazardous Substances Data Bank
IAFS	Interim-Action Feasibility Study
IAS	Initial Assessment Study
IR	Installation Restoration
IRIS	Integrated Risk Information System
Irvine Subbasin	Irvine Groundwater Subbasin
kg	kilogram
kg/g	kilograms per gram
kg/mg	kilograms per milligram
L/day	liters per day
L/cm^3	liters per cubic centimeter
LOAEL	lowest-observed-adverse-effect level
MCAS	Marine Corps Air Station
m^3/hr	cubic meters per hour
MeCl	methyl chloride
µg/dL	micrograms per deciliter
mg/cm^2	milligrams per square centimeter
mg/dL	milligrams per deciliter
mg/kg	milligrams per kilogram
mg/kg/day	milligrams per kilogram per day
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
mg^3/kg	cubic milligrams per kilogram
MICROTOX	bacterial luminescence bioassay
NACIP	Navy Assessment and Control of Installation Pollutants
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NFAC	No Further Action Certification
NFESC	Naval Facilities Engineering Service Center
NOAEL	no-observed-adverse-effect level
NPL	National Priority List
OCWD	Orange County Water District
OU	operable unit

ACRONYMS/ABBREVIATIONS (continued)

PAH	polynuclear aromatic hydrocarbons
PCB	polychlorinated biphenyl
PCE	tetrachloroethene (perchloroethene)
PM_{10}	respirable particulate material up to 10 microns in diameter
PRG	preliminary remediation goal
PRPs	potentially responsible parties
PSI	Perimeter Study Investigation
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RfC	reference concentration
RfD	reference dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RTECS	Registry of Chemical Substances
RWQCB	Regional Water Quality Control Board
SCAQMD	South Coast Air Quality Management District
SI	Site Investigation
SIPOA	Site Inspection Plan of Action
SQL	sample quantitation limit
SVOC	semivolatile organic compound
SWAT	Solid Waste Assessment Test
SWDIV	Southwest Division Naval Facilities Engineering Command
SWMU/AOC	solid waste management units/areas of concern
TCA	trichloroethane
TCE	trichloroethylene
TICs	tentatively identified compound
UCL	upper confidence limit
URF	unit risk factor
U.S. EPA	United States Environmental Protection Agency
VOC	volatile organic compound
WHR	(California) Wildlife-Habitat Relationships

ACRONYMS/ABBREVIATIONS (continued)

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Section 1
INTRODUCTION

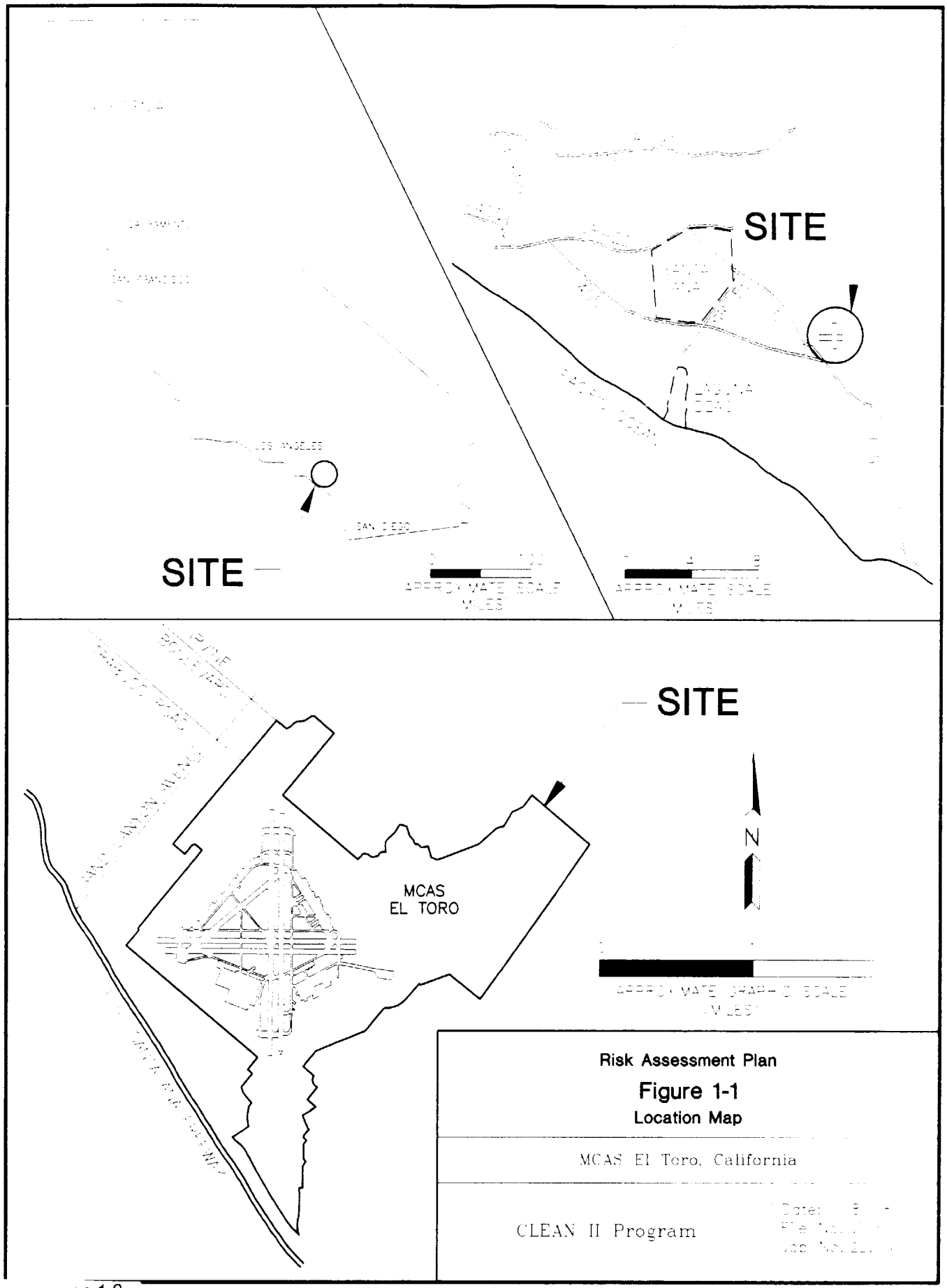
A Phase II Remedial Investigation and Feasibility Study (RI/FS) will be conducted at the Marine Corps Air Station (MCAS) El Toro located in Orange County, California (Figure 1-1). This Risk Assessment Work Plan has been prepared for the Phase II RI/FS at MCAS El Toro by Bechtel National, Inc. (BNI), on behalf of the Department of the Navy (DON), Southwest Division Naval Facilities Engineering Command (SWDIV) in accordance with Contract Task Order (CTO)-0059, issued under the Comprehensive Long-Term Environmental Action Navy (CLEAN) II Program, contract No. N68711-92-D-4670.

This Risk Assessment Work Plan has been prepared to assure that sample collection and analyses performed during the Phase II RI/FS for MCAS El Toro will adequately assess risks to human health and the environment. The scope of the Phase II RI/FS work is to collect information to support the required decision-making process to determine risks associated with Installation Restoration (IR) Program sites and appropriate response actions when IR Program sites pose unacceptable risks to human health and the environment.

There are 25 IR Program sites at MCAS El Toro. Two of the IR Program sites (Site 18, Regional Volatile Organic Compound [VOC] Groundwater Contamination and Site 23, Sewer Lines) are not addressed in this Risk Assessment Work Plan. Site 18 was evaluated in a separate RI/FS effort (Jacobs Engineering 1994a,b). Site 23 was recommended for no further action based on the results of a Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) (Jacobs Engineering 1993a). Table 1-1 presents a summary of the 23 Sites, and Figure 1-2 illustrates the locations of these sites on MCAS El Toro.

The Risk Assessment Work Plan is organized as follows:

- Section 2 provides brief description of the IR Program sites;
- Section 3 discusses the general environmental setting of the station;
- Section 4 outlines the approach to assess the human health risks; and
- Section 5 outlines the approach to assess the ecological risks.



Risk Assessment Plan

Figure 1-1

Location Map

MCAS El Toro, California

CLEAN II Program

Table 1-1
Installation Restoration Program Sites

Site No.	Site Name	Site Description
1	Explosive Ordnance Disposal Range	This site is normally used for the disposal of small munitions (i.e., flares and small ordnance). Whether undetonated explosives or drums are still present is unknown. Drums containing approximately 2,000 gallons of sulfur trioxide chlorosulfonic acid were disposed in trenches and ruptured with small explosive charges. It is estimated that approximately 75 percent of the compound may have remained after the explosions.
2	Magazine Road Landfill	This site was used as a landfill from 1959 until 1991. Reports estimate that approximately 800,000 to 1,000,000 cubic yards of wastes were disposed in the landfill. Wastes consisted of construction debris, municipal waste, batteries, waste oils, hydraulic fluids, paint residues, transformers, and solvents. Methane has been detected within the landfill at levels as high as 45-percent volume according to landfill gas samples.
3	Original Landfill	The Original Landfill was used from 1943 to approximately 1965. Estimates of waste burned and buried in the landfill range from 163,500 to 243,000 cubic yards of metals, incinerator ash, solvents, paint residues, hydraulic fluids, engine coolants, construction debris, oily wastes, municipal solid wastes, and various inert solid waste. Chloroform, TCE, and PCE were detected in landfill gas samples.
4	Ferrocene Spill Area	Approximately 5 gallons of ferrocene and a hydrocarbon carrier solution were spilled in this area.
5	Perimeter Road Landfill	The landfill was in use from 1955 to the late 1960s. Approximately 50,000 to 60,000 cubic yards of wastes were disposed in the landfill, including burnable trash, municipal solid waste, unspecified fuels, oils, solvents, cleaning fluids, scrap metal, paint residues, and other waste materials.
6	Drop Tank Drainage Area No. 1	From 1969 to 1983, aircraft drop tanks were transported to this area, drained of jet fuel, and washed out on the concrete pad. The jet fuel and wash/rinse water drained off the concrete pad onto the adjacent area. It is estimated that 1,400 gallons of jet fuel have drained onto the vegetated area.
7	Drop Tank Drainage Area No. 2	Aircraft drop tanks were drained of jet fuel and washed out on the concrete pad from 1969 to 1983. The jet fuel and wash/rinse water drained off the concrete pad onto the adjacent area. Waste lubrication oil from nearby maintenance buildings was also disposed in this area. In addition, portions of this area served as an unpaved parking area. Lubrication oils were applied for dust control. In 1982, 2,000 gallons of jet fuel were accidentally spilled in this area. The fuel and wash water flowed onto soil around the concrete pad.

(table continues)

Table 1-1 (continued)

Site No.	Site Name	Site Description
8	DRMO Storage Area	This area has been used since the mid-1970s. The yard is used to store various scrap and salvage materials (i.e., mechanical and electrical components) and containerized liquids of unknown composition. In 1984, PCBs were spilled on soils in the immediate area. Soils were excavated up to one foot below grade.
9	Crash Crew Pit No. 1	This area was used from 1965 to 1971. Materials used and ignited during training included jet fuel, aviation gasoline, and other liquid waste. Approximately 123,700 gallons of liquid waste were estimated to have been used during training.
10	Petroleum Disposal Area	Approximately 52,000 gallons of waste crankcase oil, antifreeze, hydraulic and transmission fluids, motor oils, and solvents were applied to the ground for dust control.
11	Transformer Storage Area	Fifty to 75 electrical transformers were stored in this area from 1965 to 1983. Five transformers leaked, and one spilled an estimated 60 gallons of PCB transformer oil onto the concrete pad. The PCB oil probably ran off the concrete pad into the adjacent ditch and surrounding soils.
12	Sludge Drying Beds	From 1943 to 1972, MCAS El Toro operated a secondary wastewater treatment plant. The sludge generated from the wastewater treatment plant was dewatered in this area and subsequently was abandoned in the drying beds and plowed under. Chemicals of potential concern include silver, arsenic, cadmium, copper, lead, mercury, nickel, selenium, and zinc.
13	Oil Change Area	It is estimated that about 7,000 gallons of waste crankcase oil were drained directly onto the ground at this site during vehicle maintenance.
14	Battery Acid Disposal Area	From 1977 to 1983, an estimated 210 gallons of battery acid were drained onto the soil from vehicles.
15	Suspended Fuel Tanks	Between 1979 to 1984, an estimated 500 gallons of diesel fuel leaked from nozzles and hoses of two 500-gallon elevated diesel tanks.
16	Crash Crew Pit No. 2	This area was used from 1972 to 1985. Materials used and ignited during training included jet fuel, leaded aviation gasoline, hydraulic fluid, and crankcase oil. Approximately 275,700 gallons of fluids were estimated to have been used during training. Of this amount, approximately 10 percent (24,700 gallons) may have infiltrated the soil. Small quantities of napalm, white phosphorus, and magnesium phosphate were also burned at the site.

(table continues)

Table 1-1 (continued)

Site No.	Site Name	Site Description
17	Communication Station Landfill	The landfill is reported to have been used from 1981 to 1983; however, there is some evidence that the area may have been used as a landfill as early as 1970 and as late as 1986. Wastes disposed in this landfill include domestic waste and rubble, cooking greases, oils and fuels from sumps, empty drums, and other unknown materials. As much as 36,000 gallons of liquid wastes may have been dumped at this site.
19	Aircraft Expeditionary Refueling Site	Six aboveground bladder tanks, each containing 20,000 gallons of jet fuel, were used from 1964 to 1987. In 1986, one tank ruptured, spilling 15,000 gallons of jet fuel. A 300- by 60-foot area was excavated to a depth of 2 feet; the soil is stockpiled at the site.
20	Hobby Shop	The area is used by military personnel to service privately owned vehicles. The ground surface around an underground waste oil tank is stained black from oil. A ditch is also stained black by wastewater from the 700-gallon oil/water separators. Until 1976, kerosene was routinely used to wash down the pavement in the area.
21	Materials Management Group	The area was used to store drums of contaminated materials. The hazard potential of these contaminated materials was not documented. In 1964, approximately 1,000 drums were stored in the area. By 1986, only 100 to 125 drums were stored in this area. No reported leakages or spills have occurred.
22	Tactical Air Fuel Dispensing System	This site has a history of undocumented spills and leakages of jet fuel and other fuels.
24	Potential Volatile Organic Compounds Source Area	This new site has been established for an expanded groundwater source investigation in the proximity of IR Sites 7, 8, 9, 10, and 22. The Phase I RI indicated that one or more sources may exist for the VOCs in the groundwater in the vicinity of these sites.
25	Major Drainages	Site 25 includes the soil, subsurface soil, and surface water in Agua Chinon Wash, Bee Canyon Wash, Borrego Canyon Wash, and Marshburn Channel. These media and washes were formerly part of the Site 18 Regional Groundwater Investigation.

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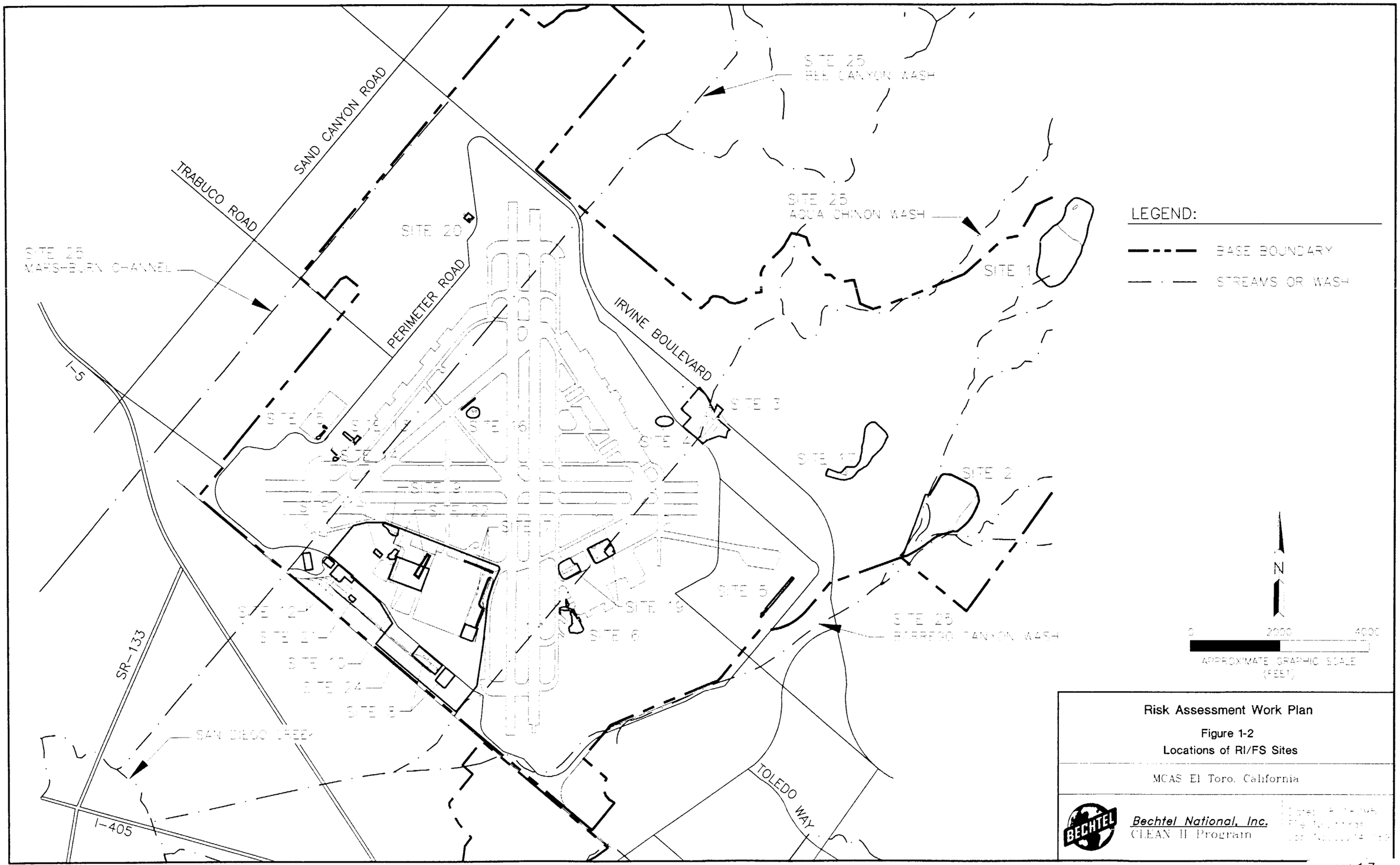
SAND CANYON ROAD
TRABUCO ROAD
PERIMETER ROAD
IRVINE BOULEVARD
TOLEDO WAY
I-5
SR-133
I-405
SITE 25
BEE CANYON WASH
SITE 25
AQUA CHINON WASH
SITE 25
MARS-BURN CHANNEL
SITE 25
BARFOO CANYON WASH
SITE 20
SITE 1
SITE 2
SITE 3
SITE 4
SITE 5
SITE 6
SITE 7
SITE 8
SITE 9
SITE 10
SITE 12
SITE 13
SITE 14
SITE 16
SITE 19
SITE 22
SITE 24
LEGEND:
BASE BOUNDARY
STREAMS OR WASH
N
0
2000
4000
APPROXIMATE GRAPHIC SCALE
(FEET)
Risk Assessment Work Plan
Figure 1-2
Locations of RI/FS Sites
MCAS El Toro, California
BECHTEL
Bechtel National, Inc.
CLEAN II Program

Section 2
SUMMARY OF SITE CHARACTERISTICS AND HISTORY

MCAS El Toro is located in Orange County, California, approximately 8 miles southeast of the city of Santa Ana and 12 miles inland from the city of Laguna (Figure 1-1). The air station comprises over 4,700 acres, including runways, aircraft maintenance and training facilities, housing, shopping, and other support facilities. The following information was summarized from the Phase I Remedial Investigation (RI) Draft Technical Memorandum and the Phase II RI/FS Draft Work Plan (Jacobs Engineering 1993b,c).

2.1 SITE HISTORY

MCAS El Toro was commissioned in 1943 as a Marine Corps fleet operation training facility for pilots. MCAS El Toro was selected in 1950 to become a master jet air station and permanent center for Marine aviation on the West Coast. Its role was to support the operation and combat readiness of the Pacific Fleet Marine Forces. Today, MCAS El Toro provides support and materials for aviation activities of the U.S. Marine Corps.

For over 50 years, aviation activities at MCAS El Toro have generated waste oils, paint residues, hydraulic fluids, used batteries, and other wastes. Because regulations governing waste disposal did not exist in the past, some wastes generated at MCAS El Toro were disposed on the base. Such disposal practices are now recognized as potentially harmful to human health and the environment.

In 1985, the Navy began work on an Initial Assessment Study (IAS) to locate potentially contaminated sites on the station. This work was conducted for the Naval Facilities Engineering Command under the Navy Assessment and Control of Installation Pollutants (NACIP) Program, which was the Navy version of the Department of Defense (DoD) IR Program at that time. The IAS report identified 17 sites as potential sources of contamination (Brown and Caldwell 1986).

In June 1985, while the IAS was underway, the Orange County Water District (OCWD) discovered trichloroethylene (TCE) in an agricultural well belonging to The Irvine Company approximately 3,000 feet west of MCAS El Toro. OCWD subsequently conducted an investigation to determine the source and extent of the TCE contamination in this well (TIC-45). After installing a network of monitoring wells and soil vapor probes and reviewing the results of independent investigations, OCWD concluded that MCAS El Toro was the source of the contamination. These OCWD investigations are ongoing (Herndon and Reilly 1989; Herndon 1990).

In 1987, the Marine Corps contracted for a review of the IAS to produce a Site Inspection Plan of Action (SIPOA) (JMM 1988). The SIPOA included a recommendation of 19 sites for study and amended the site sampling plans proposed in the IAS report. One site (Site 18) was intended to address the off-base contaminant plume of VOCs in groundwater.

In 1988, the Marine Corps conducted a Perimeter Study Investigation (PSI) of VOC contamination along the southwestern boundary of the station (JMM 1989). As a consequence, an interim groundwater pump-and-treat system was installed near the

station boundary. This system began operation in June 1989. It pumps approximately 30 gallons per minute (gpm) of groundwater from three extraction wells and treats VOC-contaminated water at an on-site granular-activated carbon unit. The effluent is used to irrigate the station golf course.

In May 1988, the Marine Corps submitted Air Quality Solid Waste Assessment Test (Air SWAT) proposals for the four station landfills to the South Coast Air Quality Management District (SCAQMD). These four landfills were listed as IR Program sites in 1986. Following SCAQMD approval, the fieldwork was conducted, which consisted of meteorological and geophysical surveys, and sampling of landfill gas, ambient air, and surface gas (Strata 1991). The geophysical surveys using ground-penetrating radar (GPR) were partially successful at defining the landfill perimeters. TCE, tetrachloroethene (PCE), chloroform, and benzene were detected in landfill gas samples in concentrations above the minimum detection limits determined by the California Air Resources Board (CARB). Methylene chloride (MeCl) was also detected in the landfill gases, but the presence of MeCl may have been due to inadequate decontamination procedures (Strata 1991; p. 3-9, 4-7, and 8-6). The ambient air samples collected at the station landfills contained concentrations of MeCl, trichloroethane (TCA), and PCE near the CARB detection limits. These concentrations, based on upwind and downwind measurements, were not necessarily attributable to emissions from the landfills.

In June 1988, the United States Environmental Protection Agency (U.S. EPA) recommended listing MCAS El Toro on the National Priorities List (NPL) of the Superfund Program because of the presence of VOC contamination at the base boundary and the detection of VOCs in the agricultural wells to the west. MCAS El Toro was listed on the NPL in February 1990. A Federal Facilities Agreement (FFA) between the U.S. EPA, California Regional Water Quality Control Board (RWQCB), Santa Ana Region, California Environmental Protection Agency (Cal/EPA), and DON was signed in October 1990 (FFA 1990).

In December 1989, the Navy began preparing the Phase I RI Work Plan and associated documents for MCAS El Toro. The Navy concluded that 22 sites would be investigated (Jacobs Engineering 1993b). These sites were grouped into three operable units (OUs). OU-1 comprised the regional VOC groundwater investigation (Site 18), which was conducted both on- and off-Station. OU-2 included the sites considered to be potential source areas for the regional groundwater VOC contamination: the four landfill sites (Sites 2, 3, 5, and 17) and the Petroleum Disposal Area (Site 10). The remaining 16 sites were grouped together as OU-3. These sites were considered to be potential sources for a variety of contaminants.

In March 1993, MCAS El Toro was placed on the Base Closure and Realignment Act III list of military facilities considered for closure. Under the terms of the FFA, base closure would not affect the requirement for the Navy to conduct the RI/FS and to comply with the other requirements of the FFA (FFA 1990, Section 37, Base Closure).

In July 1993, a Draft Technical Memorandum was submitted that documented the results of the Phase I RI (Jacobs Engineering 1993b). The Phase I RI detected a variety of

contaminants in the groundwater, soil, surface water, and sediment at MCAS El Toro. Contaminants in the soil and sediment consisted primarily of low concentrations of semivolatile organic compounds (SVOCs), petroleum hydrocarbons, pesticides, herbicides, and polychlorinated biphenyls (PCBs) (Jacobs Engineering 1993b). The document also concluded that the source of contamination for regional groundwater is in the southwest quadrant of the station, but no specific sources were identified. The sampling events yielded sufficient information to conduct a preliminary risk assessment of contaminants at the sites for both groundwater and soil contamination. The results of the Phase I RI provided the primary data for the Phase II RI/FS.

Concurrent with the Phase I RI, the Navy conducted an RFA at MCAS El Toro. The final RFA report was submitted in July 1993 (Jacobs Engineering 1993a). The purpose of the RFA was to evaluate whether an additional 140 sites at MCAS El Toro would require further investigation under the Phase II RI/FS program. Several solid waste management units/areas of concern (SWMUs/AOCs) were located in or near IR Program sites and were recommended for sampling under the IR Program. In particular, SWMU/AOC 194, the Former Incinerator Site, where PCE concentrations exceeded the U.S. EPA Region IX preliminary remediation goals (PRGs) (U.S. EPA 1995), and SWMU/AOC 300, a spill area, were included in the Phase II RI/FS by expanding the boundaries at Site 3 (Original Landfill). SWMU/AOC 90 is the former sewage treatment plant at the station. Although it was not recommended for further action in the RFA report, the Phase II RI/FS Program incorporated it into Site 12 (Sludge Drying Beds).

Based on the Phase I RI, two sites were added to the IR Program as part of OU-2 (Sites 24 and 25). A soil gas survey was performed at these sites in June 1994 during which soil gas samples were collected from depths between 5 and 30 feet (Jacobs Engineering 1994a). Fourteen of the 18 VOC soil gas plumes identified in this survey were recommended for further investigation as soil gas concentrations increased with depth. One main soil gas source area and 12 other possible shallow VOC source areas were identified.

The Navy has conducted an RI and Interim-Action Feasibility Study (IAFS) for the regional groundwater contamination designated as OU-1 (Jacobs Engineering 1994b,c). This response action to the VOC contamination in the regional groundwater was addressed by the DON because of the planned development of the Irvine Desalter Project (Desalter) by the OCWD. Based on the detailed analysis presented in the IAFS, several alternatives were considered. The key criteria in alternative selection were based on:

- containing the higher-concentration VOCs on the Station;
- reducing VOC concentrations in the principal and shallow aquifers downgradient of the source areas;
- containing TCE at the downgradient edge of the existing plume; and
- safeguarding the Desalter project water supply by providing on-Station pretreatment of groundwater to reduce VOCs prior to treatment at the Desalter treatment facility.

The interim-action alternative had not been selected as of February 1995.

2.2 DESCRIPTION OF OPERABLE UNITS

After the studies were completed in the late 1980s and early 1990s, 25 sites were identified as posing a potential threat to human health and the environment. The 25 sites were categorized into three OUs. An OU is defined by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) as a discrete action that comprises an incremental step towards comprehensively addressing site problems. Dividing a site into OUs with these focuses facilitates more effective investigations and appropriate remedial actions.

Of the 25 sites at MCAS El Toro, 17 sites were identified in the IAS (Brown and Caldwell 1986). All of the RI/FS sites identified at MCAS El Toro have been placed into one of three OUs for the Phase II RI/FS. The regional groundwater investigation that was originally Site 18 has been reclassified as OU-1. OU-1 will not be discussed in the ecological risk assessment because it deals with chemicals in groundwater and because the groundwater was found at depths of 40 or over 200 feet bgs, which negates the potential concern for ecological receptors. The sites that are considered potential source areas for the regional groundwater investigation have been designated as OU-2. These are the Landfill Sites 2, 3, 5, and 17, the VOC Source Area Site 24, and the Major Drainages Site 25. The remaining sites (1, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 19, 20, 21, 22, and 23) have been designated as OU-3. Site 23 has been slated for no further action and will not be discussed further in this Risk Assessment Work Plan. Both the OU-2 and -3 sites are subdivided into units based on location, physiographic characteristics, and historic waste disposal activities associated with various areas at each site (Jacobs Engineering 1993b). For the Phase II RI/FS, units at some sites have been expanded to include new areas, or new units have been created in response to regulatory requests (BNI 1995a).

In addition, the Navy conducted an RFA and identified 377 SWMUs/AOCs at MCAS El Toro. One hundred and forty sites were sampled to determine whether a release had occurred. Nineteen SWMUs/AOCs were not sampled because they were near or within the boundaries of an RI/FS site. Based on sampling results, 25 SWMUs/AOCs were recommended for further action in the final report. Of these 25 SWMU/AOC sites, 2 sites were incorporated into RI/FS sites. Creation of a fourth OU in the RI/FS was one of the objectives of the RFA for newly identified SWMUs/AOCs. However, newly identified SWMU/AOCs were incorporated into existing sites.

2.3 SOURCES OF CHEMICAL RELEASES

The sources of chemicals are varied and unique to each of the 23 IR Program sites to be considered during the Phase II RI/FS work. Some of the sources are waste oils, solvents, jet and diesel fuel, aviation gasoline, antifreeze, paint residues, used batteries, municipal and construction wastes, sludge, and other wastes. Past disposal and chemical releases at each site are briefly described in Table 1-1. More detailed descriptions are provided in the Phase I RI Draft Technical Memorandum (Jacobs Engineering 1993b).

Section 3
ENVIRONMENTAL SETTING

This section describes the environmental setting of MCAS El Toro, including climate, aboveground and belowground hydrology and geology, demography, and land use. The following information was summarized from the Phase I RI Draft Technical Memorandum and the Phase II RI/FS Draft Work Plan (Jacobs Engineering 1993b,c).

3.1 CLIMATE

MCAS El Toro has Mediterranean climate, characterized by cool, moist winters and warm, dry summers. Annual precipitation averages 12.2 inches per year with early morning fogs in late spring and early summer. Most of the precipitation falls between November and April. The mean low temperature in winter is 37 degrees Fahrenheit (°F). Summer temperatures rarely exceed 100°F. The prevailing wind is out of the west from March through October and out of the east from November through February. Strong, dry, desert winds from the east (Santa Ana winds) are common during late fall and early winter.

3.2 HYDROLOGY

MCAS El Toro lies within the Irvine Groundwater Subbasin (Irvine Subbasin), which is adjacent to the Main Orange County Groundwater Basin. Aquifers in the Irvine Subbasin are thin, discontinuous, limited in areal extent, have low permeabilities, and are separated by thicker sequences of clay and silt then the main basin. Because of the sandy lenticular nature of the aquitards, groundwater probably flows between aquifer zones; thus, groundwater can be considered to flow in one large system (Herndon and Reilly 1989).

3.2.1 Groundwater

Three aquifer systems have been identified near MCAS El Toro: a shallow and perched aquifer, a middle and principal aquifer, and a lower hydrogeologic system. Beneath MCAS El Toro, the shallow aquifer is semiconfined and becomes confined with depth. Sediments in this aquifer consist of Holocene and late Pleistocene alluvium and terrace deposits. The principal aquifer zone occurs between 100 and 750 feet below the surface and is the main water-production zone for the Irvine area. This zone is composed of Pleistocene terrace and alluvial deposits beneath MCAS El Toro. The lower system is composed of pre-Quaternary, semiconsolidated, and low-permeability sedimentary rocks, which are considered nonwater-bearing near MCAS El Toro.

Recharge to the regional groundwater system takes place primarily along washes that exit the Santa Ana Mountains. Recharge of the groundwater system on the station takes place as infiltration of surface water along washes, swales, and as subsurface inflow along permeable zones. Groundwater discharges through irrigation wells or moves westward to the Main Orange County Basin.

3.2.2 Surface Water

Surface drainage generally flows southwest, following the slope of the land perpendicular to the Santa Ana Mountains. Several washes originate in the hills northeast of MCAS El Toro and flow through or near MCAS El Toro. Off-Station runoff from areas upgradient of MCAS El Toro and on-site runoff flow into four main drainage channels. Three of these channels are continuous with natural washes (i.e., Borrego Canyon, Agua Chinon, and Bee Canyon) originating in the Santa Ana Mountains. The Marshburn Channel is the fourth channel.

The Borrego Canyon Wash is lined with concrete as it flows along the southeast boundary of MCAS El Toro. The Borrego Canyon Wash crosses the southern corner of MCAS El Toro and joins Agua Chinon Wash one-quarter mile from the MCAS El Toro boundary. The Agua Chinon and Bee Canyon Washes cross the central portion of the station and receive runoff from the facility storm sewers. Both washes are culverted through most of their path on MCAS El Toro except for several hundred feet at the southwest edge. Surface water may infiltrate through the bottom of the unlined channel and potentially along cracks in the lined culvert. The Marshburn Channel is a lined drainage channel that runs along the northwestern MCAS El Toro boundary. This channel receives runoff from the western part of the facility. All three washes and the Marshburn Channel eventually flow into the San Diego Creek. The creek flows into Upper Newport Bay, which is an ecological preserve used by many migratory bird species.

3.3 GEOLOGY

MCAS El Toro is located on the edge of the Tustin Plain, which derives from alluvial fan deposits from the Santa Ana Mountains. The plain is bounded on the north and east by the Santa Ana Mountains and on the south by the San Joaquin Hills. MCAS El Toro gently slopes down to the west-southwest and extends eastward into the Santa Ana Mountains. Elevation gains across MCAS El Toro range from 215 feet to 800 feet above sea level at the foothills of the Santa Ana Mountains.

3.3.1 Stratigraphy

The geology at MCAS El Toro is composed of Tertiary formations overlain by Quaternary surficial units. The Cenozoic units predominate in the central and western portion of the Station and are approximately 5,000 feet deep. The other half of the area consists of Cretaceous sedimentary rocks and slightly metamorphosed Jurassic sedimentary and volcanic rocks (Fife 1974).

Late Cenozoic units consist of alluvial fan deposits derived from the Santa Ana Mountains, and are characterized by isolated coarse-grained stream-channel deposits and fine-grained overbank deposits ranging in thickness up to 300 feet (Herndon and Reilly 1989). These deposits overlie Pleistocene Age sediments composed of interlayered fine-grained lagoonal and near-shore marine deposits. Pleistocene deposits form

heterogeneous mixtures of silts and clays with interbedded sands and fine gravel ranging in thickness up to 500 feet (Singer 1973).

The Pleistocene deposits overlie older semiconsolidated marine sandstones, siltstones, and conglomerates of the late Miocene to late Pliocene age. These deposits comprise the Niguel, Fernando, and Capistrano Formations. The lower Pliocene Fernando Formation is the base of the water-bearing units (Herndon and Reilly 1989) and interfingers with marine clayey and sandy siltstones of the Capistrano and Niguel formations (JMM 1988). These formations range in thickness up to 1,500 feet. Beneath these formations lie a thick sequence of interbedded Paleocene, Eocene, and Miocene marine and nonmarine sedimentary rocks and volcanic rocks of the Puente, Monterey, Topanga, Vaqueros, Sespe, Santiago, and Silverado Formations. Several thousand feet of Cretaceous sandstone, siltstone, and conglomerates of the Williams, Ladd, and Trabuco Formations underlie the previously described Tertiary formations (Fife 1974; Yerkes et al. 1965). The Cretaceous formations overlie Jurassic basement of crystalline metamorphic and igneous rocks.

3.3.2 Structural Geology

Less than 10 miles from MCAS El Toro, there are three northwest-trending faults: Shady Canyon, Pelican Hill, and Newport-Inglewood. Only the Newport-Inglewood fault is considered active. The Christianitos Fault is located three miles east of MCAS El Toro and is a north- to south-trending fault. The San Andreas Fault is located 30 miles north of MCAS El Toro.

3.4 SOIL

Four soil mapping units have been recognized at MCAS El Toro. The Myford sandy loam predominates in the southern corner of the area with 2- to 9-percent slopes. The Sorrento loam occurs from the western corner eastward across MCAS El Toro with 2- to 9-percent slopes. The San Emigdio fine sandy loam with 0- to 2-percent slopes occupies the northern corner of MCAS El Toro. The Metz loamy sand is found in the northeast section of the area.

3.5 HABITATS

Annual grassland covers approximately 70 percent of the area without pavement or buildings and consists largely of disturbed/managed habitats with exotic annual grassland plant species (Jacobs Engineering 1993b). Many of these areas are highly disturbed and contain little usable habitat for wildlife. Plant species are usually made up of invader species such as bromegrass, wild oat, filaree, mustard, clover, groundsel, pineapple weed, and other weedy species. Planted trees include eucalyptus and other nonnative ornamentals. Wildlife which may be present in this habitat type include western toad, Pacific treefrog, red-tailed hawk, mourning dove, cliff swallow, northern mockingbird, western meadowlark, California ground squirrel, southwestern pocket gopher, desert

cottontail, coyote, skunk, raccoon, and opossum. Sites 3 through 16, and 19 through 22 are located in annual grassland or disturbed habitats.

Coastal sage scrub is found mainly on the dry hillsides and other stable terrain. Plants typical of this habitat include shrubs, such as California sagebrush, buckwheat, and black sage; and understory species such as bunchgrasses, deer weed, beavertail cactus, and lupin. Typical wildlife species found in this habitat include side-blotched lizard, western fence lizard, skunk, California gnatcatcher, turkey vulture, red-tailed hawk, California quail, greater roadrunner, western screech owl, great horned owl, common raven, rufous-sided towhee, Anna's hummingbird, house finche, deer mouse, cactus mouse, Pacific kangaroo rat, California pocket mouse, and coyote. Sites 1, 2, and 17 contain coastal sage scrub habitats.

There is sparse riparian woodland habitat found mainly along upper portions of Borrego Canyon, Bee Canyon, and Agua Chinon Washes. This habitat is predominantly willow, elderberry, western sycamore, and live oak. Monkey flower, hemlock, sedges, and poison oak may compose the understory. Common wildlife species present in this type of habitat include the bullfrog, American kestrel, great horned owl, ash-throated flycatcher, bushtit, northern flicker, American and lesser goldfinch, orange-crowned warbler, song sparrow, brush rabbit, raccoon, skunk, and coyote. Site 2 contains the only significant amount of this type of habitat.

The few aquatic habitats at MCAS El Toro are limited to sections of the washes that flow intermittently or ephemeral pools in the washes and other locations. Aquatic habitats of concern include the Marshburn Channel, Bee Canyon, Agua Chinon, and Borrego Canyon Washes, which drain MCAS El Toro sites to San Diego Creek. Wetlands in the vicinity of MCAS El Toro include upstream portions of Borrego Canyon Wash close to Site 2 classified as R4SBW (riverine streambeds intermittently flooded). This wetland type also occurs along Agua Chinon Wash as it emerges from the culvert beneath MCAS El Toro to its junction with Borrego Canyon Wash. Most of Borrego Canyon Wash along the southwest portion of the Station and downstream portions of Agua Chinon and Bee Canyon Washes are classified as R4SBYx, which represents habitat that is typically saturated or semipermanent seasonally.

3.6 DEMOGRAPHY AND LAND USE

The following sections identify land use and demography in the area of MCAS El Toro.

3.6.1 Current Land Use and Demography

MCAS El Toro is bordered on the south and west by the city of Irvine and on the north and east by unincorporated lands. MCAS El Toro covers approximately 4,700 acres of which 1,000 acres are leased out for agriculture because airfield safety clearances render it unsuitable for any other uses. Crops grown on the leased land include strawberries, winter celery, tomatoes, and avocados.

Land use on MCAS El Toro is laid out in four quadrants as defined by the runways. The northwest quadrant contains administrative services, housing, station headquarters, and community support services. The northeast quadrant contains some family housing, Marine Aircraft Group activities, and ordnance storage. The southeast quadrant contains the golf course, additional administrative and maintenance services, and ordnance storage. The southwest quadrant houses maintenance, supply and storage facilities, and limited administrative services.

Off-Station land use around MCAS El Toro is largely agricultural in the northeast and northwest. Land to the south, southeast, and southwest is commercial, light industrial, and residential.

MCAS El Toro provides support for Navy and Marine Corps aviation and employs both civilians and military personnel. In 1990, the population present on MCAS El Toro was 1,926 civilians and 7,188 military personnel. The estimated population in the city of Irvine in 1990 was 105,311. Population growth occurred primarily in the central district within 2 to 3 miles of MCAS El Toro.

3.6.2 Future Land Use and Demography

The future land use of MCAS El Toro has not yet been determined. The Station may be redeveloped for residential, commercial, light industrial, recreational, and/or institutional land uses or be redeveloped into a commercial airport.

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Section 4
HUMAN HEALTH RISK ASSESSMENT

This section presents the methods and procedures that will be used to assess risks to human health. Included in this section are objectives, regulatory requirements, and procedures to be implemented in the risk assessment process.

4.1 OBJECTIVE OF THE HUMAN HEALTH RISK ASSESSMENT

There are two types of human health risk assessments that will be performed: baseline risk assessments and streamlined risk assessments. Baseline risk assessments are comprehensive evaluations performed on RI/FS sites. The objective of a baseline risk assessment is to estimate the risks if no response action is undertaken at the site and, thereby, provide decision makers information useful in identifying the most appropriate remedial action alternative. The risk estimates from a baseline assessment also serve as a benchmark to which reductions in risk achieved by remedial actions may be compared. Streamlined risk assessments are esentially performed on removal action sites to support the removal action. Such risk assessments provide support for the Engineering Evaluation and Cost Analysis (EE/CA) for the removal action.

During the Phase I RI, a preliminary health risk assessment was performed on chemicals identified at 22 sites that compose OUs-2 and -3. The results of the RI and risk assessment are described in the Draft Technical Memorandum for the Phase I RI of MCAS El Toro (Jacobs Engineering 1993b). The purpose of the preliminary health risk assessment was to calculate risk-based concentrations (RBC) for selected target risk levels. In the process of calculating the RBCs, a conceptual exposure model was developed and used to establish human exposure scenarios and intake routes for soil, sediment, and surface water. U.S. EPA equations for calculating dose and risk were combined and rearranged to calculate chemical concentrations corresponding to target risk levels of 10^{-6}, 10^{-5}, and 10^{-4} for carcinogens and 1.0 for noncarcinogens. RBCs were developed for 113 chemicals for soil on the basis of residential use and for sediment and surface water on the basis of recreational use. The results of the preliminary health risk assessment were reviewed by the U.S. EPA (Region IX) and Cal/EPA. The RBCs and preliminary risk estimates were used to assess appropriate actions and were originally proposed for risk screening in the Phase II RI/FS at the various sites following the Phase I RI. Based on a consensus between SWDIV, U.S. EPA, Cal/EPA, and California RWQCB, Santa Ana Region, the Phase II RI/FS will apply U.S. EPA Region IX February 1995 PRGs rather than the Phase I RBCs for risk screening.

4.2 OVERVIEW OF THE BASELINE RISK ASSESSMENT PROCESS

The general elements of the assessment of risk to human health from chemicals released to the environment consist of the following:

- data evaluation,
- toxicity assessment,
- exposure assessment, and

- risk characterization.

The general steps for evaluating each of these elements are described briefly below. More detailed project-specific procedures associated with each of these elements are described in Section 4.3.

4.2.1 Data Evaluation

The data evaluation process entails critically reviewing the results of the chemical analyses performed on samples collected from a site to:

- determine if U.S. EPA requirements for chemical analysis have been met;
- identify chemicals that may have entered the samples after collection;
- characterize background levels of naturally occurring chemicals (i.e., metals); and
- select the chemicals of potential concern (COPCs) to be evaluated in the risk assessment.

4.2.2 Toxicity Assessment

Once the chemicals to be evaluated are selected, the toxicity of each chemical is assessed. For most of the chemicals, the toxicity assessment involves assembling toxicity criteria developed by regulatory agencies for use in risk assessments. These criteria are used to characterize risk numerically and reflect the toxic potencies of the chemicals. The criterion for assessing noncancer risk is the reference dose (RfD) or reference concentration (RfC). The criterion for assessing cancer risk is called a cancer slope factor (CSF), cancer potency factor (CPF), or unit risk factor (URF). When a chemical with no toxicity criterion is encountered, a criterion may be developed using one of several approaches. The approach to be used in this assessment is described in Section 4.3.2. Alternately, the risk posed by the chemical may be qualitatively assessed.

4.2.3 Exposure Assessment

The exposure assessment can be performed in parallel with the toxicity assessment, since neither is dependent on the other for completion. The exposure assessment involves:

- characterizing the individuals or populations at risk;
- selecting reasonable hypothetical exposure scenarios;
- identifying exposure pathways and routes associated with each scenario; and
- calculating the exposure level or dose associated with each exposure route.

Exposure scenarios used in a risk assessment depend on existing and future land use, for both the site and the surrounding areas. Residential use is considered to be the highest-risk scenario. When appropriate, an industrial or occupational scenario is used alone or in combination with the residential scenario.

With each scenario, risk is based on exposure of a hypothetical person to the U.S. EPA reasonable-maximum-exposure conditions. Conservative estimates of chemical concentrations, exposure times, and intake rates are used to estimate risk. This deliberate attempt to overestimate risk is made in the interest of public protection. When the assessment of the site indicates that the risk is acceptable, one can be reasonably assured that it is. When the assessment indicates that risk is not acceptable, the question remains as to whether the risk might be lower if better estimates of exposure conditions were used. In such cases, refined risk assessments may be performed. Such assessments often require collecting additional data, including information on the behavior of the individuals or population at risk.

4.2.4 Risk Characterization

The final step in assessing risk consists of quantifying the risk associated with each chemical and exposure pathway for each exposure scenario, and assessing the accuracy of the risk estimates. Noncancer risk and cancer risk are assessed separately. Noncancer risk is expressed as the ratio of the estimated dose and the RfD (the ratio is called a hazard quotient). Cancer risk is expressed as the probability that an individual will develop cancer as the result of exposure to the carcinogens. Population burden (the number of people in the population at risk estimated to develop cancer) may also be calculated if the hypothetical individual(s) at risk represents a real population and the number of people in the population is known.

The accuracy of the risk estimates can be appraised qualitatively or quantitatively by conducting an uncertainty analysis. The analysis estimates the degree to which each of the major factors affecting risk overestimates or underestimates risk.

4.3 BASELINE RISK ASSESSMENT PROCEDURES

This section describes the specific procedures that will be used to implement each of the four elements of the baseline risk assessment.

4.3.1 Data Evaluation

Chemical analytical data obtained during the Phase II field investigation will be validated to satisfy Naval Facilities Engineering Service Center (NFESC, formerly Naval Energy and Environmental Support Activity) Level D (U.S. EPA Level 4) requirements. If data from the Phase I investigation are used and do not meet Level D requirements, they will be used "as is" (i.e., they will not be revalidated). The COPCs will consist of chemicals not flagged and "J" qualified chemicals. Tentatively identified compounds (TICs) will be included on the list where more than just a class grouping has been identified.

Chemicals on this COPC candidate list will be removed from further consideration if they are:

- common laboratory contaminants (i.e., acetone, 2-butanone, methylene chloride, toluene, and phthalate esters) for which the concentrations in the samples are less than 10 times the concentrations in corresponding blank samples;
- other chemicals found in soil or groundwater and blank samples for which the concentrations in the soil or groundwater sample are less than five times the concentrations in the blanks;
- TICs found only once;
- naturally occurring chemicals (e.g., metals) for which the concentrations are within the range considered normal for the area around the site (i.e., background range); and
- any of the following essential nutritional elements: iron, potassium, sodium, calcium, or magnesium.

Table 4-1 identifies the COPCs identified during the Phase I RI as well as the sites and the media in which they were found. The Phase II RI/FS investigation may identify additional chemicals.

4.3.2 Toxicity Assessment

The toxicity assessment will consist of:

- gathering toxicological information on each chemical and summarizing the information in the risk assessment report, and
- assembling RfDs and CPFs for the COPCs.

The purpose of the toxicological summaries is to provide the nontoxicologist an overview of potential health effects of the COPCs. The summaries will provide acute toxicity estimates; describe the symptoms of acute and chronic toxicity; and identify organ and systemic effects (carcinogenic and noncarcinogenic), if available. Some of the chemicals, such as the polynuclear aromatic hydrocarbons (PAHs), will be treated as classes. The summaries will also describe the basis of the RfDs and CPFs for the COPCs.

RfDs are estimates of doses that will not cause adverse noncarcinogenic chronic health effects and are chemical-specific. CPFs are estimates of the cancer risk associated with unit doses of chemical carcinogens. The U.S. EPA has developed RfDs and CPFs for a large number of chemical substances. The U.S. EPA RfDs and CPFs are first published in the U.S. EPA Health Effects Assessment Summary Tables (HEAST). These tables are issued annually and contain provisional numbers only. RfDs and CPFs that have been approved by the agency after extensive review and evaluation are entered into the Integrated Risk Information System (IRIS) database, which is updated periodically.

Table 4-1
Chemicals of Potential Concern for the MCAS El Toro Phase II Remedial Investigation/Feasibility Study

Chemicals of Potential Concern	IR PROGRAM SITES																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19	20	21	22	24	25
Total Petroleum Hydrocarbons	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Total Recoverable Petroleum Hydrocarbons	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
BTEX																							
Benzene		X		X	X		X						X		X	X						X	
Toluene	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Ethylbenzene		X						X					X			X		X				X	
Xylene(s)		X	X	X		X	X	X		X		X	X		X	X		X	X			X	
HALOGENATED VOLATILE ORGANIC COMPOUNDS																							
Bromodichloromethane																	X						
Carbon tetrachloride		X				X	X		X	X		X	X	X		X			X		X	X	X
Chloroform		X	X				X		X	X		X		X		X	X			X	X	X	
Chloromethane	X		X		X	X	X		X	X			X		X				X	X		X	X
Dibromochloromethane			X														X						
1,1-Dichloroethane									X													X	
1,2-Dichloroethane									X													X	
1,1-Dichloroethene							X		X	X												X	
1,2-Dichloroethene (total)		X								X												X	
Methylene Chloride		X	X	X		X	X	X		X		X			X	X	X	X	X	X	X	X	X
Tetrachloroethene		X			X		X	X	X	X		X						X		X	X	X	
1,1,1-Trichloroethane						X	X		X				X									X	

(table continues)

Table 4-1 (continued)

Chemicals of Potential Concern	IR PROGRAM SITES																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19	20	21	22	24	25
HALOGENATED VOLATILE ORGANIC COMPOUNDS (continued)																							
1,1,2-Trichloroethane		X																				X	
Trichloroethylene		X			X		X		X	X		X		X		X		X	X	X	X	X	
VOLATILE ORGANIC COMPOUNDS																							
Acetone		X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		
2-Butanone (Methyl ethyl ketone)	X	X	X				X	X	X			X	X		X	X	X	X	X		X	X	X
Carbon disulfide								X							X				X				
2-Hexanone		X	X	X		X		X								X			X		X	X	
4-Methyl-2-pentanone		X																X					
Vinyl Chloride																						X	
POLYNUCLEAR AROMATIC HYDROCARBONS																							
Acenaphthene																		X		X			
Acenaphthylene																		X		X			
Anthracene														X				X		X			
Benzo(a)anthracene							X			X		X		X			X	X		X	X		
Benzo(a)pyrene				X			X	X		X		X	X	X			X	X	X	X	X		
Benzo(b)fluoranthene				X			X			X		X	X	X				X		X	X		
Benzo(g,h,i)perylene							X	X		X		X	X	X			X	X	X	X	X		
Benzo(k)fluoranthene				X			X			X		X	X	X				X		X			
Chrysene				X			X	X		X		X	X	X	X		X	X		X	X		

(table continues)

Table 4-1 (continued)

Chemicals of Potential Concern	IR PROGRAM SITES																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19	20	21	22	24	25
POLYNUCLEAR AROMATIC HYDROCARBONS (continued)																							
Fluoranthene				X		X	X	X		X		X	X	X		X	X	X		X	X		
Fluorene																X		X		X			
Indeno(1,2,3-cd)pyrene							X	X		X		X	X	X			X	X		X	X		
Naphthalene				X												X		X			X		X
Phenanthrene							X			X		X	X	X	X	X		X		X	X		X
Pyrene				X		X	X	X		X		X	X	X		X	X	X	X	X	X		
SEMIVOLATILE ORGANIC COMPOUNDS																							
Benzyl butyl phthalate		X		X		X		X	X	X		X	X	X	X					X			X
Bis(2-ethylhexyl) phthalate	X	X	X	X	X			X	X	X			X	X	X	X		X	X	X			X
Carbazole							X							X				X		X			
2-Chlorophenol																		X					
4-Chloro-3-methylphenol																		X					
Dibenzofuran	X															X		X		X			X
1,4-Dichlorobenzene																		X					
Diethyl phthalate							X			X								X					
Dimethyl phthalate								X	X														
2,4-Dimethylphenol																	X						
Di-*n*-butyl phthalate								X															
Di-*n*-octyl phthalate																		X					
Hexachloroethane								X															

(table continues)

Table 4-1 (continued)

Chemicals of Potential Concern	IR PROGRAM SITES																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19	20	21	22	24	25
SEMIVOLATILE ORGANIC COMPOUNDS (continued)																							
Isophorone																					X		
2-Methyl naphthalene				X												X		X	X	X	X		X
4-Methyl phenol																	X						
4-Nitrophenol																		X					
n-Nitrosodipropylamine																		X					
Pentachlorophenol																		X					
Phenol				X		X									X			X					
1,2,4-Trichlorobenzene																		X					
PESTICIDES/POLYCHLORINATED BIPHENYLS																							
Alpha chlordane		X		X				X				X					X			X			X
Alpha BHC																			X				
4,4'-DDD		X	X	X			X					X	X				X		X	X	X		X
4,4'-DDE		X	X	X			X	X				X					X		X	X	X		X
4,4'-DDT		X	X	X	X		X					X	X				X		X	X	X		X
Delta BHC				**X**				**X**					**X**				**X**		**X**				**X**
Dieldrin			X	X			X	X				X					X		X	X			
Endosulfan I				X															X				
Endosulfan II				X							X									X			
Endosulfan sulfate				X			X	X				X	X				X		X	X			X
Endrin				X			X				X								X	X			X

(table continues)

Table 4-1 (continued)

Chemicals of Potential Concern	IR PROGRAM SITES																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19	20	21	22	24	25
PESTICIDES/POLYCHLORINATED BIPHENYLS (continued)																							
Endrin aldehyde				X							X	X											
Endrin ketone				X			X					X	X				X		X	X			X
Gamma chlordane		X	X	X								X					X		X				X
Heptachlor			X																				
Heptachlor epoxide																	X						
Lindane (gamma BHC)			X	X																X			
Methoxychlor						X						X					X			X			
PCB 1248								X			X												
PCB 1254								X			X	X											
PCB 1260								X			X	X											X
HERBICIDES																							
2,4-D												X											
2,4-DB		X										X					X			X			X
Dalapon		X	X									X					X						X
Dichloroprop		X										X					X						X
Dinoseb																	X						
MCPA		X															X						
MCPP		X	X		X							X					X						
2,4,5-trichlorophenoxy acetic acid			X	X																X			
2,4,5-trichlorophenoxy propionic acid (Silvex)			X		X							X											X

(table continues)

Table 4-1 (continued)

Chemicals of Potential Concern	IR PROGRAM SITES																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19	20	21	22	24	25
DIOXIN/DIBENZOFURANS																							
Octachlorodibenzo-p-dioxins	X																						
RADIONUCLIDES																							
Gross alpha	X	X	X		X		X		X														
Gross beta	X	X	X	X	X		X		X														
EXPLOSIVES																							
HMX	X																						
RDX	X																						
2,4,6-Trinitrotoluene	X																						
INORGANICS																							
Total Cyanide/metallo			X																				
Nitrate-Nitrite	X		X	X																			
Phosphorus	X																						
TARGET ANALYTE LIST METALS																							
Aluminum	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Antimony		X		X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Arsenic	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Barium	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Beryllium		X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Cadmium	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Calcium		X			X																		
Chromium, Hexavalent																							

(table continues)

Table 4-1 (continued)

Chemicals of Potential Concern	IR PROGRAM SITES																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19	20	21	22	24	25
TARGET ANALYTE LIST METALS (continued)																							
Chromium		X	X	X	X			X				X	X	X	X		X		X	X			X
Cobalt	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Copper	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Lead	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Manganese	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Mercury	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		
Nickel	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Selenium	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Silver	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Sulfate	X	X	X														X						X
Thallium		X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Vanadium	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Zinc	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X

Cal/EPA has developed two sets of CPFs. One set comprises 78 chemicals with CPFs that have been used to establish promulgated health standards such as maximum contaminant levels for drinking water and air quality standards. The other set, which comprises "expedited" CPFs for about 140 chemicals, was developed primarily to implement the California Safe Drinking Water and Toxics Enforcement Act (Proposition 65). Cal/EPA has not developed RfDs for any chemical. Cal/EPA CPFs for some chemicals differ from those developed by the U.S. EPA.

CPFs assigned to the carcinogenic COPCs will consist of those recommended by the U.S. EPA except for cadmium, hexavalent chromium, chrysene, nickel, benzo(a)pyrene, benzo(k)fluoranthene, and tetrachloroethylene. This procedure is based on Cal/EPA recommendations on the use of U.S. EPA Region IX PRGs in screening risk assessments in which use of PRGs based on Cal/EPA CPFs for the excepted chemicals was recommended.

The RfDs and CPFs developed by the U.S. EPA will be obtained from the IRIS database. Any RfDs or CPFs that are not available in the IRIS database will be taken from the latest issue of HEAST. When neither source contains an RfD or CPF for a chemical, the chemical will be assigned the RfD or CPF of a structurally similar or related chemical after consultation with toxicologists at U.S. EPA Region IX and Cal/EPA.

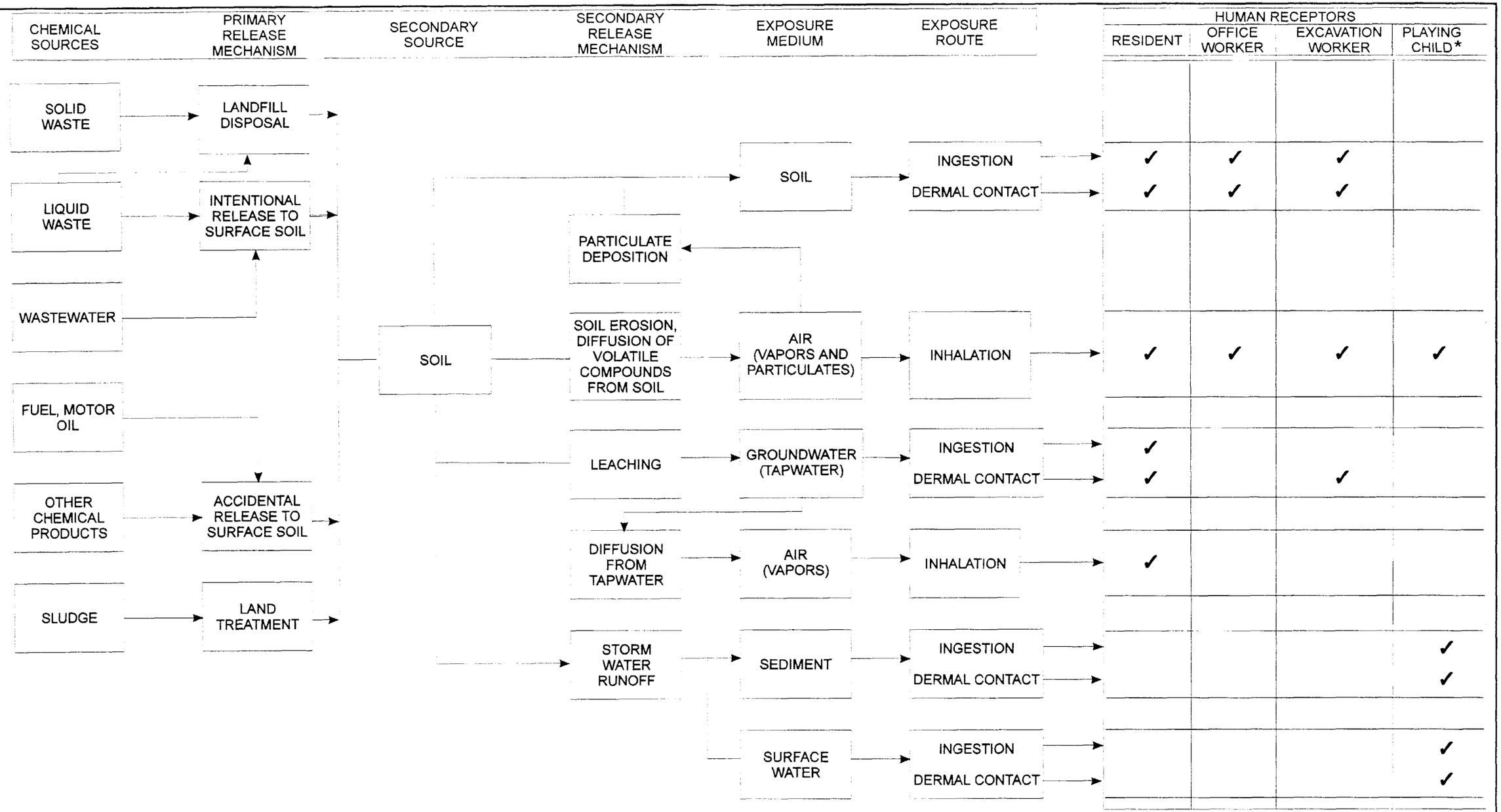
Cal/EPA CPFs used in the assessment will be from the July 1992 CPFs, which were used to develop promulgated standards. If necessary, the April 1992 expedited CPFs will be used. If these sets are updated before the risk assessment is performed, the updated values will be used.

4.3.3 Exposure Assessment

MCAS El Toro is currently being used as a military air base, and its land use can be classified as industrial. Reuse plans have not been formulated for the Station following closure. However, for the human health risk assessment, it will be assumed that MCAS El Toro will be reused for residential, commercial, industrial, recreational, and institutional land uses. Receptors chosen to represent these uses are:

- residential adult and child,
- office worker,
- excavation worker, and
- playing child.

A conceptual exposure model based on the assumption of multipurpose use is shown in Figure 4-1. The model is based on existing knowledge of the sources and disposition of the chemicals at the sites. The exposure pathways and routes shown in the model are not necessarily complete at the present time; however, they may be complete if the Station is redeveloped for multipurpose use.



* SITES 2, 3, AND 25 ONLY

Risk Assessment Work Plan
Figure 4-1
Human Health Exposure Routes and Receptors

MCAS El Toro, California

CLEAN II Program

Date: 8/21/95
File No. CHT059
Job No. 22214-059

The conceptual exposure model presented herein contains the same exposure pathways and exposure routes depicted in the model developed during the Phase I RI. However, it contains two additional receptors—an office worker and an excavation worker. The office worker is a representative receptor for the commercial setting. The excavation worker is a representative receptor for the construction setting (e.g., constructing homes and commercial buildings). This setting is associated with land redevelopment, but does not reflect actual land use.

The Phase II RI/FS identified Sites 2, 3, and 25 as having surface water exposure pathways. The Borrego Canyon Wash is part of Site 2, and the Aqua Chinon Wash is part of Site 3. Site 25 comprises the major drainages (e.g., Aqua Chinon Wash, Borrego Canyon Wash, Bee Canyon Wash, and the Marshburn Channel). Human exposure to water and sediment in these drainages will be evaluated on the basis of recreational use as established during the Phase I RI. The Conceptual Base Model (Figure 4-2) is an illustrated representation of receptors and pathways for MCAS El Toro.

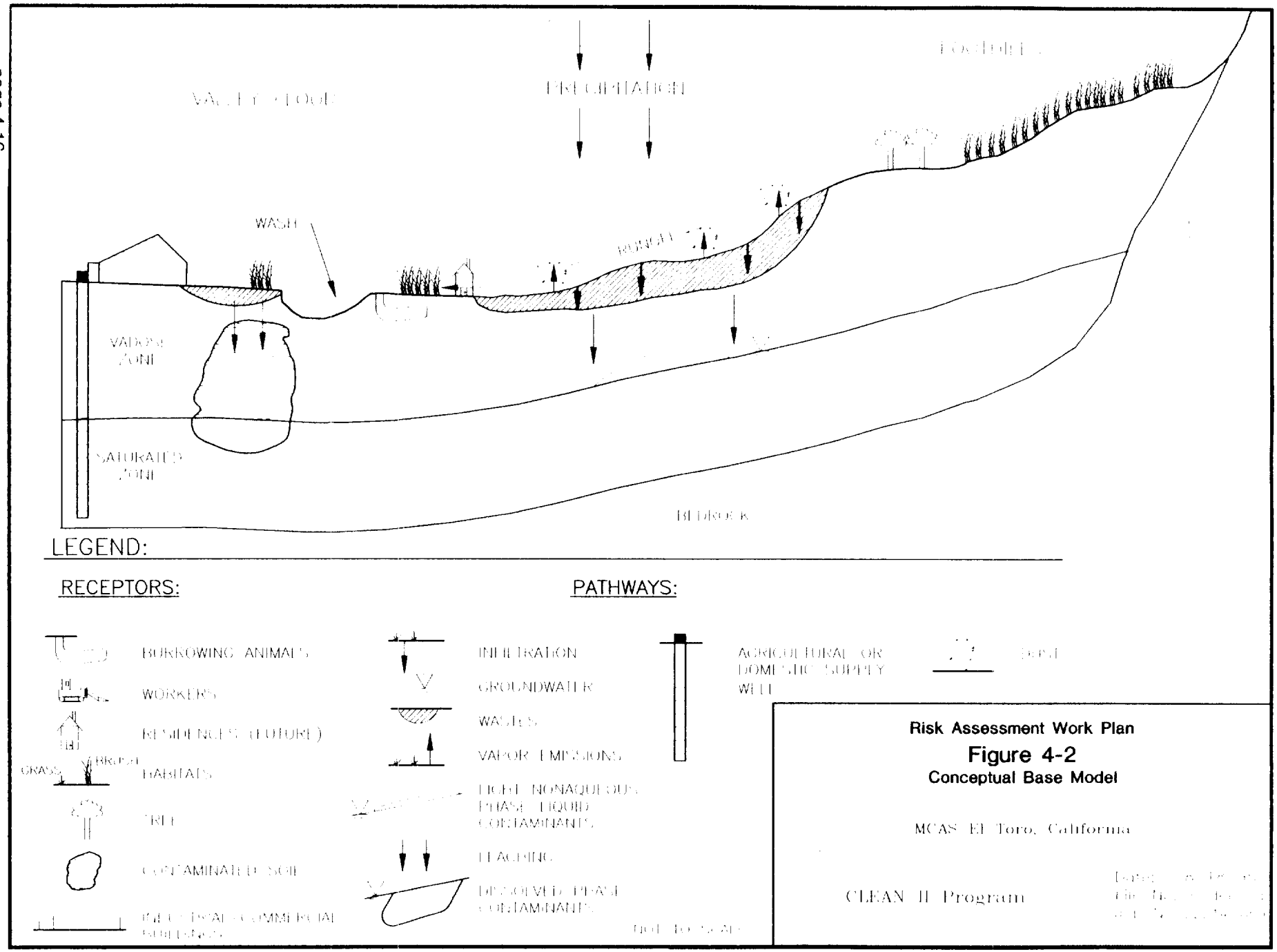
4.3.3.1 EXPOSURE POINT CONCENTRATIONS

An exposure point concentration is the concentration of a chemical in an environmental medium, such as air, water, soil, or food, at the point of contact with a biological receptor. The U.S. EPA risk assessment guidance manual (U.S. EPA 1989a) recommends that for each chemical, the 95-percent upper confidence limit (UCL) of the mean or the highest measured concentration (whichever is lower) be used either as an exposure point concentration or to calculate an exposure point concentration when estimating the reasonable maximum risk. This guideline will be followed. In computing of the 95-percent UCL, COPC concentrations reported as being below sample quantitation limits (SQLs) will be assigned values equal to one-half the SQL.

4.3.3.2 PARTICULATE EMISSION FACTOR FOR SURFACE SOIL

A particulate emission factor of 1.316×10^9 cubic milligrams per kilogram (mg^3/kg) will be used in the calculation of chemical dose resulting from inhalation of fugitive dust. This is a new emission factor that was used by the U.S. EPA Region IX to calculate its February 1995 PRGs. The factor is based on an area of 0.5 acres instead of the 30 acres that was the basis for the older emission factor of 9.63 x 109 m^3/kg (used in the Phase I RI preliminary risk assessment). The new area is probably larger than the size of residential lots common to cities surrounding MCAS El Toro, but may be about the size of a commercial lot in that area. If a site is much smaller than 0.5 acres, a particulate emission factor based on the estimated size of the site will be calculated and used with chemicals at that site. The equations used by U.S. EPA Region IX to calculate particulate emission factors for chemicals on its February 1995 table of PRGs will be used to calculate the new emission factors.

If data on respirable particulate material up to 10 microns in diameter (PM_{10}) are available for the El Toro area, those data will be used instead of the particulate emissions factor to calculate dose. PM_{10} is a measure of total respirable particulates in the



Risk Assessment Work Plan

Figure 4-2

Conceptual Base Model

MCAS El Toro, California

CLEAN II Program

atmosphere. Where measured, PM_{10} includes particulate emissions from industrial operations, wind-blown dust, and smog particles. It is thus an overestimate of the amount of dust that might be generated at a site.

The 95-percent UCL arithmetic mean PM_{10} concentration will then be used to calculate the atmospheric concentrations of chemicals sorbed to soil particles using the equation:

$$C_a = C_s \times CF \times ML$$

where:

C_a = chemical concentration in air (milligrams per cubic meter [mg/m^3])
C_s = 95-percent UCL of mean chemical concentration in soil (milligrams per kilogram [mg/kg])
CF = conversion factor (0.001 kilograms per gram [kg/g])
ML = mass loading factor (grams per cubic meter [g/m^3])

4.3.3.3 CALCULATION OF ATMOSPHERIC CONCENTRATION OF VOLATILE COMPOUNDS

Calculation of the atmospheric concentrations of volatile compounds from soils will be in accordance with the procedures used by the U.S. EPA Region IX in developing its February 1995 PRGs. That procedure also assumes emissions from a 0.5-acre lot. If a site is significantly smaller than 0.5 acres, the estimated site area will be used in the calculation.

4.3.3.4 CALCULATION OF DOSE

Dose is the amount of chemical to which a biological receptor is exposed per unit body weight and time. Dose may be expressed as rate of application (applied dose) or as a rate of absorption (absorbed dose). Equations recommended in the U.S. EPA risk assessment guidance manual calculate applied dose when exposure is by ingestion and inhalation and absorbed dose when exposure is by dermal contact. These equations are given below.

Incidental Ingestion of Soil or Sediment

$$D_s = (CS \times IRs \times CF \times FI \times EF \times ED)/(BW \times AT)$$

where:

D_s = dose resulting from ingestion of soil (milligrams per kilogram per day [mg/kg/day])
CS = chemical concentration in soil (mg/kg)
IR_s = soil intake rate by ingestion (mg/day)
CF = conversion factor (10^{-6} kilograms per milligram [kg/mg])
FI = fraction ingested from site (unitless)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kilogram [kg])
AT = averaging time (days)

Dermal Contact With Soil or Sediment

$$D_{ab} = (CS \times CF \times SA \times AF \times ABS \times EF \times ED)/(BW \times AT)$$

where:

D_{ab} = absorbed dose from dermal contact with soil (mg/kg/day)
CS = chemical concentration in soil (mg/kg)
CF = conversion factor (10^{-6} kg/mg)
SA = skin surface area available for contact (square centimeters per day [cm^2/day])
AF = soil-to-skin adherence factor (milligrams per square centimeter [mg/cm^2])
ABS = absorption factor (unitless)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days)

Inhalation of Dust – PM_{10} Data Not Available

$$D_{inh} = (C_a \times IR_a \times ET \times EF \times ED)/(BW \times PEF \times AT)$$

where:

D_{inh} = dose resulting from inhalation of dust (mg/kg/day)
C_a = chemical concentration in air (mg/m^3)
IR_a = air intake rate by inhalation (cubic meters per hour [m^3/hr])
ET = exposure time (hours per day [hr/day])
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
PEF = particulate emission factor (1.316×10^9 mg/kg)
AT = averaging time (days)

Inhalation of Dust – PM_{10} Data Available

$$D_{inh} = (C_a \times IR_a \times ET \times EF \times ED)/(BW \times AT)$$

where:

D_{inh} = dose resulting from inhalation of dust (mg/kg/day)
C_a = chemical concentration in air (mg/m^3)
IR_a = air intake rate by inhalation (m^3/hr)
ET = exposure time (hr/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days)

Inhalation of Vapor from Soil

$$D_{inh} = (C_s \times IR_a \times ET \times EF \times ED)/(BW \times AT \times VF)$$

where:

D_{inh} = dose resulting from inhalation of vapor (mg/kg/day)
C_s = chemical concentration in soil (mg/kg)
IR_a = air intake rate by inhalation (m^3/hr)
ET = exposure time (hr/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days)
VF = soil-to-air volatilization factor (m^3/kg)

Ingestion of Water

$$D_w = (C_w \text{ x } IR_w \text{ x } EF \text{ x } ED)/(BW \text{ x } AT)$$

where:

D_w = dose resulting from ingestion of water (mg/kg/day)
C_w = chemical concentration in water (milligrams per liter [mg/L])
IR_w = water intake rate by ingestion (liters per day [L/day])
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days)

Dermal Contact with Water

$$D_{ab} = (C_w \text{ x } CF \text{ x } SA \text{ x } PC \text{ x } ET \text{ x } EF \text{ x } ED)/(BW \text{ x } AT)$$

where:

D_{ab} = absorbed dose from dermal contact with groundwater (mg/kg/day)
C_w = chemical concentration in water (mg/L)
CF = conversion factor (0.001 liters per cubic centimeter [L/cm^3])
SA = skin surface area available for contact (square centimeters [cm^2])
PC = dermal permeability constant (centimeters per hour [cm/hr])
ET = exposure time (hr/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days)

Table 4-2 identifies the values that will be assigned to the equation parameters. Table 4-3 identifies the dermal absorption factors that will be used for various chemicals and chemical classes.

Table 4-2
Values Assigned to Dose Equation Parameters

Equation Parameter	Unit	Resident Child[a]	Resident Adult	Office Worker	Excavation Worker	Playing Child[b]
Averaging time (cancer)	days	25,550	25,550	25,550	25,550	25,550
Averaging time (noncancer)	days	ED[c] x 365	ED x 365	ED x 365	ED x 365	ED x 365
Body weight	kg	70	70	70	70	46
Dermal adsorption factor	unitless	See Table 4-3				
Exposed skin area (soil/sediment)[d]	cm^2	2,000	5,000	5,000	5,000	3,000
Exposed skin area (water)[e]	cm^2	7,000	19,000	NA	3000	5,000
Exposure duration (cancer)	years	NA	30	25	1	7
Exposure duration (noncancer)	years	6	24	25	1	7
Exposure frequency (air)[f]	days/year	350	350	250	250	350
Exposure frequency (water, bath)	days/year	350	350	NA	NA	NA
Exposure frequency (soil)[f]	days/year	350	100	250	250	350
Exposure time (water, bath)	hours/day	0.25	0.25	NA	NA	2
Exposure time (air)	hours/day	24	24	8	8	2
Intake rate, air	m^3/hour	0.42	0.83	0.83	2.5	2.5
Intake rate, soil/sediment	mg/day	200	100	50	480	100
Intake rate, water	L/day	1	2	NA	NA	0
Permeability constant	cm/hr	Chemical specific, from U.S. EPA 1992a				
Soil/sediment adherence factor	mg/cm^2	1	1	1	1	1

Notes:
[a] child age = 0 to 6 years
[b] child age = 9 to 16 years
[c] ED – exposure duration
[d] exposed skin = 25 percent of mean total body surface area; values rounded to the nearest 1,000 cm^2; Interim Guidance for Dermal Exposure Assessment (U.S. EPA 1992a)
[e] exposed skin (percent of mean total body surface area): resident child/adult = 100 percent (bath); values rounded to the nearest 1,000 cm^2
[f] exposure frequency: standard default for resident and worker; exposure regimen for playing child and golfer developed specifically for this assessment

Table 4-3
Dermal Absorption Factors

Chemical Class	Absorption Factor (unitless)
Chlorinated pesticides	0.05
Polynuclear aromatic hydrocarbons	0.15
Organophosphate pesticides	0.25
Pentachlorophenol	0.25
Polychlorinated dibenzo-p-dioxins	0.03
Polychlorinated dibenzofurans	0.03
Other organic compounds	0.10
Cadmium	0.001
Arsenic	0.03
Chromium, hexavalent	0.00
Other metals and complex cyanides	0.01
Free cyanide	0.10

Source: Preliminary Endangerment Assessment Guidance Manual, Cal/EPA 1994

4.3.4 Risk Characterization

The risk characterization process uses the RfDs and CPFs assembled during the toxicity assessment and the doses calculated in the exposure assessment to estimate noncancer and cancer risk. Noncancer risk (hazard quotient) and cancer risk are quantified separately.

Quantified health risks will be presented as the:

- cancer risk and noncancer hazard quotient for each chemical for each exposure pathway;
- sum of the cancer risks associated with each exposure pathway;
- sum of the hazard quotients (hazard index) for each exposure pathway;
- total cancer risk to the exposed individual for each exposure scenario calculated by summing the cancer risks associated with exposure pathways; and
- total noncancer hazard to the exposed individual for each exposure scenario calculated by summing the relevant hazard indices for potentially simultaneous exposure pathways.

4.3.4.1 QUANTIFICATION OF CANCER RISK

Cancer is believed to be the end result of a multistage process in which a large number of biological and environmental factors interact, simultaneously or in sequence, to disrupt normal cell growth and division. The first stage, called initiation, involves the creation of errors in genetic coding. Because the effects of initiation are thought to occur at the

molecular level, current regulatory policy assumes that there is no finite dose below which the initiation effect cannot occur. Current regulatory policy assumes that at any dose there is some finite probability associated with the occurrence of the initiation event.

CPF is an estimate of the cancer risk associated with a dose of one milligram per kilogram of body weight per day (risk per mg/kg/day). A mathematical model describing the relationship between dose and the cancer development process is used to calculate the CPF. Several models have been developed, each based on a different hypothesis regarding cancer development. The linearized multistage model is preferred by U.S. EPA and Cal/EPA when it is applicable. The CPFs of most of the chemicals in the IRIS database and on the Cal/EPA (1992) list of CPFs were using with the linearized multistage model. The CPF produced by the model is the 95-percent UCL of the potency.

Cancer risk is expressed as a probability and is calculated by multiplying the estimated dose of a given carcinogen by the CPF developed for the carcinogen. The resulting number represents the probability that a person receiving the estimated dose will develop cancer during his/her lifetime. Because cancer risk is a probability estimate, the cancer risk presented by different carcinogens can be added to obtain an estimate of overall risk. Cancer burden is the number of people in a population that will develop cancer and is calculated by multiplying the cancer risk to the individual by the number of people in the population at risk.

In this risk assessment, two sets of cancer risk estimates will be developed. The first set of estimates will be obtained using U.S. EPA CPFs exclusively. The second set will be obtained using available Cal/EPA CPFs and defaulting to U.S. EPA CPFs when Cal/EPA CPFs are not available.

Although the DON agrees at this time to display Cal/EPA CPFs, it clearly and expressly reserves the right to reject their use at a later date if it determines they are not adequately supported. The DON has not endorsed the utilization of Cal/EPA CPFs in the RI/FS, Proposed Plan, or ROD; and it reserves the right to decline their use if it is determined that they are not appropriate.

4.3.4.2 QUANTIFICATION OF NONCANCER RISK

In risk assessments, noncancer effects are those that result primarily from chemically induced impairment of biochemical and/or physiological function and manifest themselves in an illness. It has been well demonstrated that noncancer effects do not occur below a certain dose called the threshold dose. This dose is chemical-specific and therefore differs from chemical to chemical. The presence of a threshold dose means that there is a dose below which a specific chemical is not toxic. The RfD is a representation of the nontoxic dose. For some chemicals, it may be the threshold dose or very close to it. For others, it may be below the threshold dose. Regardless of its position in the range of nontoxic doses, the RfD is regarded in risk assessment as a dose above which toxic effects may occur. Therefore, the occurrence of toxic effects (i.e., noncancer effects) is

measured by calculating the ratio of the estimated dose and the RfD. This ratio is called a hazard quotient.

A hazard quotient of less than 1.0 indicates that the estimated dose is less than the RfD and toxic effects should not occur. A hazard quotient of 1.0 reflects a borderline situation where effects may or may not occur, depending on the proximity of the RfD to the threshold dose. A hazard quotient larger than 1.0 indicates that the estimated dose exceeds the RfD and that toxic effects are likely. This likelihood increases as the ratio increases above 1.0.

A conservative estimate of the hazard associated with exposure to all chemicals by a specific pathway, such as the inhalation pathway, is obtained by summing the hazard quotients of the chemicals associated with the pathway. The sum of hazard quotients is called a hazard index. A conservative estimate of the hazard associated with an exposure scenario is obtained by summing the hazard indices of the pathways associated with the exposure scenario. This is called the total hazard.

4.3.4.3 EVALUATION OF LEAD

At present there is no RfD for lead. The current approach recommended by the U.S. EPA for assessing the risk presented by lead is to predict the level of lead in the blood using a pharmacokinetic model developed by the U.S. EPA and determining if the predicted level exceeds the current "safe" level of 10 micrograms per deciliter (µg/dL).

Cal/EPA has also developed a blood-lead model (LEADSPREAD) to calculate the lead concentration in the blood of children and adults. Lead will be assessed using the Cal/EPA LEADSPREAD model to the hypothetical current or future on-site residents, office workers, and excavation workers utilizing the above-referenced model.

4.3.5 Characterization of Higher-Risk Locations

Use of the 95-percent UCL on the arithmetic mean to estimate the risk presented by COPCs found in the soil at a site assumes that the chemicals and their concentrations are normally distributed in the media in which they are found and that the concentrations of the chemicals are uniform throughout the site. This approach does not account for the potential risk associated with measured chemical concentrations above the 95-percent UCL. Depending on the number of samples in which a chemical is found and the variance of the measured concentrations, the highest measured concentration could be substantially higher or lower than the 95-percent UCL.

For this project, higher-risk locations are defined as soil sampling points at which the highest measured concentration of any chemical exceeds a cancer risk of 10^{-6} or a hazard quotient of 1.0. If, up to this point in the assessment, the results indicate that the overall risk presented by the COPCs is less than 10^{-4}, the higher-risk locations will be identified by recalculating the risk presented by the highest measured concentration of each chemical and identifying the sample where the cancer risk of a chemical exceeds 10^{-6} or the hazard quotient of a chemical exceeds 1.0.

The risk presented by the highest concentration of the chemicals in the sample from each higher risk location will be calculated and summed as usual. These higher-risk locations and the estimates of total risk associated with each location will be identified on a site map.

4.3.6 Analysis of Uncertainties

There are many uncertainties inherent in conducting a risk assessment of chemicals released to the environment. These uncertainties can have a large impact on the characterization of risk. In risk assessments performed on Superfund sites, the intent is to overestimate risk to protect public health. By overestimating risk, a comfortable level of confidence is obtained when the results of the risk assessment indicate (or more correctly, a decision is made by risk managers) that risk is not significant. When the results of an assessment indicate that risk is significant, the possibility exists that the true risk is much lower. In such a case, a refined risk assessment may be recommended.

For this risk assessment, a qualitative analysis of uncertainty will be performed. It will consist of identifying the factors that tend to overestimate or underestimate risk.

4.4 STREAMLINED RISK ASSESSMENT

A streamlined risk assessment is defined by the U.S. EPA (U.S. EPA 1993a) as an evaluation that is intermediate in scope between a baseline risk assessment and a screening risk assessment and is applied only to removal action sites. It is used to justify a removal action after a decision for removal action has been made. That decision is usually based on the results of the risk screening assessment.

Streamlined risk assessments focus on the particular medium that is the object of the removal action and, therefore, do not necessarily deal with all of the COPCs. They usually deal only with the chemicals that present a significant risk.

4.4.1 Streamlined Risk Assessments to Justify Removal Action

The streamlined risk assessments will be performed in accordance with interim guidelines developed by SWDIV (1994a,b). Those guidelines are based on U.S. EPA guidance provided in Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA (U.S. EPA 1993a). The assessment will:

- identify COPCs and summarize risk assessments that have already been performed on a site;
- identify populations at risk;
- identify exposure pathways (documented and potential);
- describe the toxicological properties of each COPC;
- describe the results of risk assessment performed by others;
- describe the results of screening risk assessment (concentration/PRG rations);

- describe the ecological concerns; and
- qualitatively assess the degree of endangerment to human health and the environment and identify documented exposure pathways or potential exposure pathways.

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Section 5
ECOLOGICAL RISK ASSESSMENT

This section presents the methods and procedures for assessing risks to the ecological receptors on of the sites and the immediately surrounding areas. Included in this section are objectives, regulatory requirements, and procedures to be implemented in the risk assessment process.

5.1 OVERVIEW OF THE ECOLOGICAL RISK ASSESSMENT PROCESS

In general, ecological risk assessments quantitatively or qualitatively evaluate the potential adverse effects of hazardous materials associated with waste sites on an ecosystem. An ecological risk assessment differs from a human health risk assessment in that assessment endpoints do not necessarily focus on the individual (as with human risk assessments) but on populations and communities, with a final goal of evaluating the ecosystem. Thus, a certain degree of impact to individuals and species is considered within the context of impacts at a higher ecological organization. The ecological risk assessment will be used in conjunction with the human health risk assessment to assess total risks at the site and to review alternative remedial actions.

The ecological risk assessment at MCAS El Toro is structured in three stages following guidelines of the Department of Toxic Substances Control (DTSC) (1994a,b). These three stages consist of:

- screening ecological risk assessment,
- predictive ecological risk assessment, and
- validation ecological risk assessment.

As discussed below, the screening ecological risk assessment was essentially completed as part of the Phase I RI (Jacobs Engineering 1993b).

Under the Phase II RI/FS, a predictive ecological risk assessment will be used to address current and potential impacts to plants and wildlife that may be exposed to chemicals of potential ecological concern (COPECs) in soils, surface water, and sediment. The primary concern at MCAS El Toro is the potential effect that metals and organic compounds adsorbing to and migrating from soil and sediment particles, and gases migrating upward from landfills may have on the ecology at the sites. Therefore, one goal of the predictive ecological risk assessment for MCAS El Toro is to identify any concentrations of these chemicals in sediment, soil, and soil gas that might be associated with adverse ecological effects at the site.

The predictive ecological risk assessment is a process that compares measured or predicted concentrations of chemicals in environmental samples (i.e., soil, sediment, water, animal tissue) to criteria considered protective of ecological receptors. The hazard index calculated from this process indicates whether a site poses a threat to ecological receptors.

This information on potential impacts to ecological receptors will be subsequently used in making risk management decisions to protect the environment. Risk management decisions will also consider contamination of an ecosystem that is not necessarily related to adverse impacts to that system. These decisions are a separate process from the ecological risk assessment.

5.1.1 Objective of the Ecological Risk Assessment

The objective of the MCAS El Toro ecological risk assessment is to assess current and potential risks to the environment posed by chemical contamination. The ecological risk assessment will identify:

- COPECs associated with sites in OU-2 and -3;
- sensitive habitats and species present at MCAS El Toro;
- site and species-specific exposure pathways and chemical exposure concentrations in these habitats;
- likelihood of adverse effects to individuals and populations in the environment with emphasis on special-status species; and
- whether further investigations are warranted.

5.1.2 Guidance on the Ecological Risk Assessment Approach and Specific Methodology

The predictive ecological risk assessment will evaluate the risks to organisms resulting from exposure to chemicals associated with activities at the base. This ecological risk assessment will follow the four-step methodology by the U.S. EPA Risk Assessment Forum for assessing stressor (i.e., chemical and nonchemical) risks to the environment (U.S. EPA 1992a,b,c) and the National Academy of Sciences for assessing human health risks (NRC 1983). In particular, the ecological risk assessment will incorporate ecology, chemistry, and toxicology components in the risk assessment (Suter 1993; U.S. EPA 1989a,b). The four-step method involves the following issues.

- **Problem Formulation**. Defines the ecological assessment objectives and involves a description of the potentially impacted areas. This focuses efforts on collecting information to assess exposure and ecological effects. Assessment and measurement endpoints are defined. The end product is a conceptual model of the site that outlines sources of chemicals and potential pathways of exposure.
- **Exposure Assessment**. Quantifies the magnitude and type of actual and/or potential exposure of receptors to chemicals emitted from the site with emphasis on characterizing receptors and quantifying exposure point concentrations of chemicals.
- **Biological Effects Assessment**. Attempts to quantitatively link concentrations of chemicals to potential adverse effects in receptors, including communities and ecosystems. The biological effects assessment presents toxicology information from literature, field, and/or laboratory studies that relate concentrations of chemicals in various media to potential adverse biological effects in organisms.

- **Risk Characterization**. Risk characterization compares the results of the exposure assessment with the results of the biological effects assessment. The outcome provides an assessment on whether adverse effects are occurring or could occur as a result of chemicals present at the site. It also describes uncertainties in the assessment and interprets ecological significance.

The guidelines that will be used to evaluate ecological risks include:

- Ecological Assessment at Hazardous Waste Sites: A Field and Laboratory Reference (U.S. EPA 1989c);
- Ecological Assessment of Superfund Sites: An Overview (U.S. EPA 1991);
- Eco Updates (U.S. EPA 1991, 1992d) which supersede earlier guidance for conducting ecological evaluations for the baseline risk assessment (U.S. EPA 1989b);
- Framework for Ecological Risk Assessment (U.S. EPA 1992d);
- Draft Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities, Part A: Overview (DTSC 1994a);
- Draft Guidance for Ecological Risk Assessment at Hazardous Wastes Sites and Permitted Facilities, Part B: Scoping (DTSC 1994b); and Wildlife Exposure Factors Handbook (U.S. EPA 1993b).

Additional reference documents will be consulted regarding habitat and species found in California, including California Department of Forestry and Fire Protection: A Guide to Wildlife Habitats of California (Mayer and Laudenslayer 1988), California Department of Fish and Game: Volume 1, Amphibians and Reptiles (Zeiner et al. 1988), Volume 2, Birds (Zeiner et al. 1990a), and Volume 3, Mammals (Zeiner et al. 1990b), and A Biological Inventory of MCAS El Toro (U.S. Fish and Wildlife Service 1993).

5.1.3 Results of Screening Ecological Risk Assessment

A screening ecological risk assessment was prepared for the Phase I RI Draft Technical Memorandum (Jacobs Engineering 1993b) for MCAS El Toro. The screening ecological risk assessment (preliminary baseline ecological risk assessment) was a conservative screening process intended to identify COPECs and areas or sites where habitat or receptors could be impacted. Surface soil, sediment and surface water analytical data from the Phase I RI were used in this assessment. Chemicals in surficial soils were evaluated for potential effects on mammals using derived ingestion doses as compared to estimated ingestion doses, which are based on a highly conservative assumption of a rat ingesting 100-percent soil for its diet. The results that do not exceed this criteria are not expected to result in toxicity to mammals. Invertebrate and plant toxicity were assessed by direct comparison to values reported in the literature. Sediment chemical concentrations were evaluated by comparison to derived criteria. Criteria for organic compounds were derived by estimating the maximum concentration that could partition from sediment to pore water without exceeding ambient water quality criteria (AWQC). Inorganic compounds were compared to lowest effect concentrations based on literature

studies. Surface water results were compared to AWQC. If AWQC were unavailable, results were compared to lowest-observed-adverse-effect levels (LOAELS) reported in the literature. COPECs in surficial soils, sediments, and surface water exceeding criteria are presented on a site-by-site basis in Appendix A (Tables A-1, A-2, and A-3).

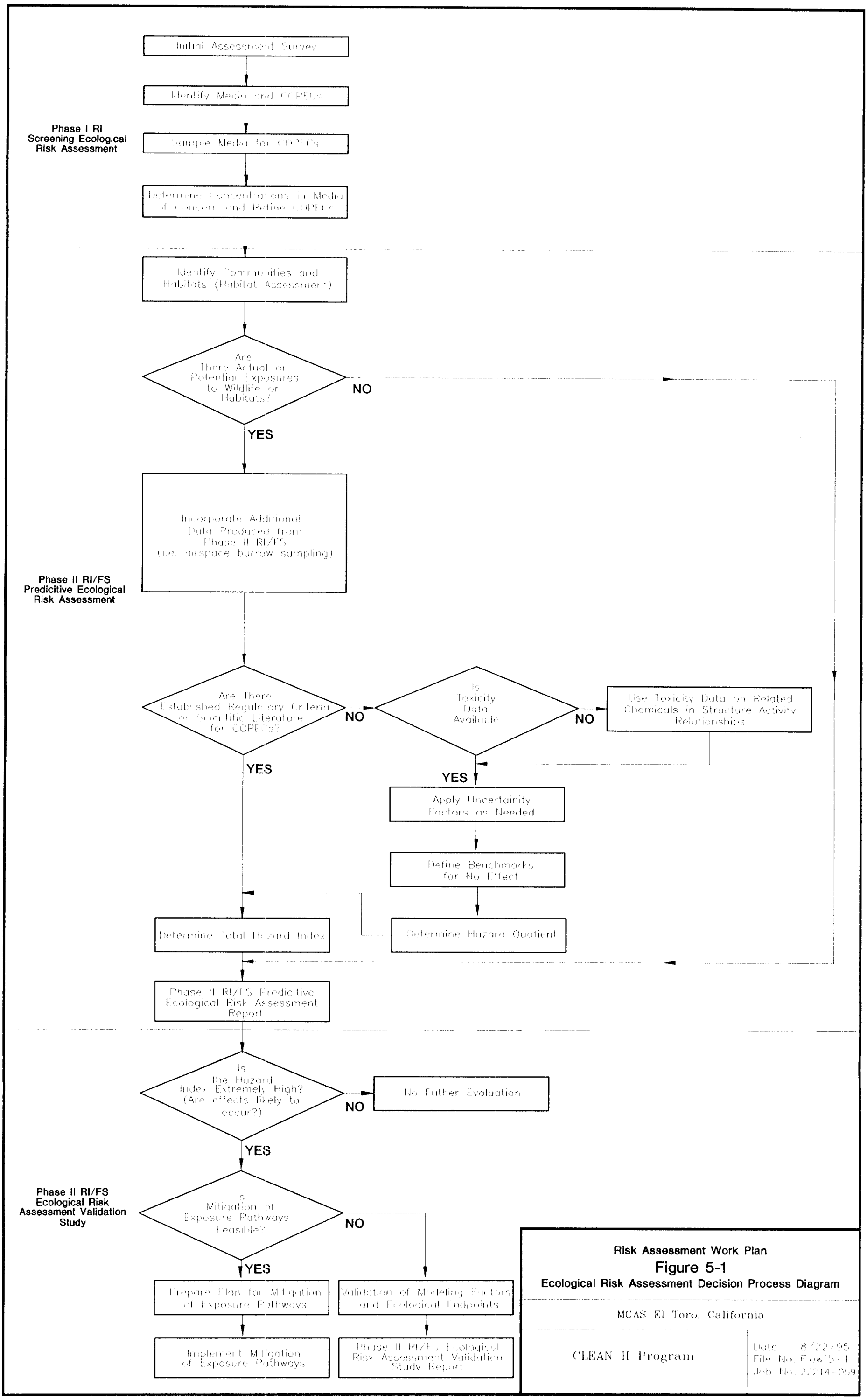
The potential for ecological effects to mammals, invertebrates, and plants was not assessed for many organic compounds in surficial soils due to the lack of available toxicity criteria (Appendix A, Table A-1). Based on available information, benzo(a)pyrene and benzo(a)anthracene presented a potential threat to plants and mammals, respectively, on Sites 4, 7, 8, 10, 12, 13, 14, 17, 19, 20, 21, and 22. PCB-1254, detected at Sites 8 and 12, could also pose a potential threat to plant life. Inorganics exceeding criteria included aluminum, arsenic, barium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, vanadium, and zinc. Criteria were not available to evaluate antimony, barium (invertebrates and plants), beryllium (invertebrates only), manganese, selenium, silver (plants only), and thallium.

Some organic compounds were consistently detected in sediments at concentrations exceeding derived criteria, including DDT, DDE, DDD, and bis(2-ethylhexyl) phthalate (Appendix A, Table A-2). DDT and its metabolites were generally detected at higher concentrations in upstream sediments in Bee Canyon Wash and Marshburn Channel, and at Sites 2, 3, 12, and 21. Cadmium and mercury frequently exceeded lowest effect concentrations for sediment. Arsenic, copper, lead, and zinc intermittently exceeded lowest effect concentrations. Criteria were unavailable to assess aluminum, antimony, barium, beryllium, cobalt, selenium, silver, thallium, or vanadium.

Organic compounds were not detected in surface water samples at concentrations exceeding criteria with any regularity (Appendix A, Table A-3). In addition, concentrations did not increase in downstream samples. Inorganic compounds exceeding criteria were aluminum, cadmium, copper, lead, mercury, and zinc. Criteria were unavailable for barium, cobalt, cyanide, manganese, and vanadium. The organic and inorganic chemicals of concern that exceeded criteria in surface water samples have high soil adsorption properties (e.g., metals and DDT) and would not likely be immediately bioavailable.

5.1.4 Assessment Approach

A phased approach will be used to satisfy the assessment and measurement endpoints (Section 5.2.3) selected for MCAS El Toro as suggested by U.S. EPA (1992c) (Figure 5-1). The Phase I RI screening ecological risk assessment evaluated the presence and levels of chemicals at the sites, determined if ecological receptors were present, and evaluated whether exposure pathways to the ecological receptors existed. This phase also compared chemical concentrations at likely exposure point concentrations with existing ecological criteria, standards, or reference values (ecological benchmarks). The comparisons were made at the screening level, using maximum potential exposures. However, additional information is required to continue the ecological risk assessment. This information includes:



Risk Assessment Work Plan

Figure 5-1

Ecological Risk Assessment Decision Process Diagram

MCAS El Toro, California

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Job No. 22214-059

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- additional information on ecological effects associated with chemicals in soil and sediment;
- measurement of potential VOCs in the air space of burrowing animals;
- sampling and analysis of surface water;
- assessment of site-specific bioaccumulation or biomagnification factors; and
- a habitat assessment to identify areas of potential ecological concern on the basis of COPECs and ecological receptors on or near the individual sites.

The Phase II RI/FS predictive ecological risk assessment will involve collecting this additional information on potentially contaminated media and potential ecological receptors. In particular, the Phase II RI/FS predictive ecological risk assessment will involve additional surveys of the plants and animals within or near each RI site identified on MCAS El Toro to identify site-specific ecological resources and potential impacts to those resources. Because some COPECs are known to bioaccumulate in plants and animals, samples of biological material will be collected and analyzed to evaluate potential effects on higher trophic level organisms at two sites. Information generated in the Phase I RI ecological risk assessment will also be included with the information that will be generated in the Phase II RI/FS. Information collected during all phases will be used to help make decisions about response alternatives.

The majority of sites containing annual grassland and planted ornamentals will not be considered to represent important habitats. For the most part, these sites also do not contain special status plant species. Phytotoxicological effects from COPECs will not be considered in the ecological assessment of these sites; however, their contribution as a link between soil and terrestrial animal food will be included in this assessment.

Based on results obtained in the Phase II RI predictive ecological risk assessment or on the need to reduce uncertainty, a validation phase of the ecological risk assessment may be needed that will involve field and laboratory bioassay testing to determine if media at the RI sites are available at toxic concentrations to the receptors in the area.

5.1.4.1 NATURE AND EXTENT OF CONTAMINATION

The predictive ecological risk assessment will use information about the nature and extent of contamination to assess potential impacts to ecological receptors. In particular, chemical analytical results will be compiled from soil, sediment, surface water, and biological tissues and will be used in the predictive model.

Chemical concentrations will be determined for surficial soil (top 2 inches) and shallow soil (0 to 10 feet below ground surface [bgs]). Comparison of site data with reference or background levels will also help in selecting COPECs. The soil chemical information will be used in the ecological risk assessment to evaluate soil exposure point concentrations for potential ecological receptors.

Chemical concentrations will be determined for the surficial sediments (2 to 6 inches bgs) in the four major drainages. Comparison of site data with reference or background levels will assist in selecting COPECs. This information will be used in the ecological risk assessment to evaluate sediment exposure point concentrations for potential ecological receptors.

Chemical concentrations will be determined for surface water in the four major drainages during stream flow. The information will be used in the ecological risk assessment to evaluate surface water exposure point concentrations for potential ecological receptors.

Specific sampling of various media will be completed to support the ecological risk assessment during the Phase II RI/FS. Sample locations, methodology, and analyses are presented in Appendix B and the Field Sampling Plan (FSP) for Phase II RI/FS (BNI 1995). These specific sampling activities are as follows:

- collecting and performing chemical analyses for surficial soil (top 2 inches) and shallow soil samples (0 to 10 feet);
- conducting soil gas surveys and direct air space sampling (i.e., burrows) to characterize potential VOCs in shallow soil at Sites 2 and 17;
- collecting and analyzing sediment samples in addition to the Phase I RI samples in the major drainages at a depth of 2 to 6 inches bgs upstream and downstream from selected sites; and
- collecting surface water samples when stream flow is present, upstream and downstream from the Station from the four major drainages at the Station (Agua Chinon Wash, Bee Canyon Wash, Borrego Canyon Wash, and Marshburn Channel) (The upstream and downstream samples will identify chemical loading from other potential off-base sources).

The activities presented below will be performed during the Phase II RI/FS to specifically support the ecological risk assessment.

- A habitat assessment will be conducted to better characterize habitat and ecological receptors on a site-specific basis. The assessment will be conducted by qualified field biologist, experienced in southern California ecology to identify plant and animal species within or near the individual sites. The habitat assessment may also provide information regarding potential evidence of damage or stress to plants via yellowing or browning that may be due to the presence of high levels of chemicals. Specific activities will include habitat delineation, vegetative cover survey, and wildlife survey.
- Sampling and residue analyses of plants and small mammals at Sites 2 and 17 to assess the potential transfer up the food chain in special-status species (Appendix B).

This additional information will be integrated into the existing database generated from previous site investigations and will be evaluated with regard to relevance to the needs of the ecological risk assessment (i.e., receptors, pathways). In addition, concentrations of

COPECs will be compared to reference site concentrations to distinguish site-related contamination from naturally occurring or other non-site-related levels of chemicals.

The daily uptake by various exposure pathways followed by the determination of a hazard quotient will be estimated for each pathway for selected ecological receptors. Exposure point concentrations in media (i.e., soil, sediment, surface water) will be used to quantify daily intakes for selected indicator species. For each representative species under evaluation, a hazard quotient will be calculated for each pathway by comparing the daily intake by a receptor with a reference concentration (RfC) for aquatic species or a reference dose (RfD) for terrestrial species. Hazard quotients are summed to determine a chemical-specific hazard index when chemicals have a mechanism of action or target organ in common.

5.2 PROBLEM FORMULATION

In the initial step of an ecological risk assessment, the observed or perceived ecological problems at the base are initially identified alongside the information needs for an adequate assessment of ecological risks and the specific approach designed to satisfy those needs. The problem formulation step also reviews existing ecological documentation for the area, the results of any site visits, and data generated during previous and current field investigations. The majority of this information will be obtained from previously conducted ecological reviews. The final product derived from this step will be a refined conceptual site model that describes COPECs, exposure pathways and routes of concern, receptors of concern, and endpoints of concern.

5.2.1 Identification of Potential Ecological Problems

Past activities at the base have resulted in organic and inorganic releases to groundwater, soil, sediment, and surface water. Results from previous investigations have shown that concentrations of metals in soil and surface water exceeded general criteria for ecological receptors (Jacobs Engineering 1993b). The Phase I RI ecological risk assessment approach presented a preliminary set of chemical releases at the site and potential ecological problems. This section provides a preliminary description of the ecological receptors of concern and the likely pathways of their exposure that is based on existing information, previous site investigations, conceptual model, and information available since completion of the Phase I RI.

5.2.1.1 SENSITIVE HABITATS

Over 90 percent of the native habitat has been cleared for agriculture, housing, and operations at MCAS El Toro (Jacobs Engineering 1993c). Over the remaining area, three habitats predominate: annual grassland, coastal sage scrub, and riparian woodland. Wetlands are limited to small areas within the washes (Figure 5-2).

The California Natural Diversity Database (CNDDB 1993) has identified several sensitive natural communities potentially occurring at or near MCAS El Toro:

- southern coast live oak riparian forest,
- southern sycamore alder riparian woodland,
- southern cottonwood willow riparian forest,
- southern riparian scrub, and
- valley needlegrass grassland.

In addition, previous investigations have documented the sensitive habitat of coastal sage scrub throughout the foothills (Jacobs Engineering 1993c).

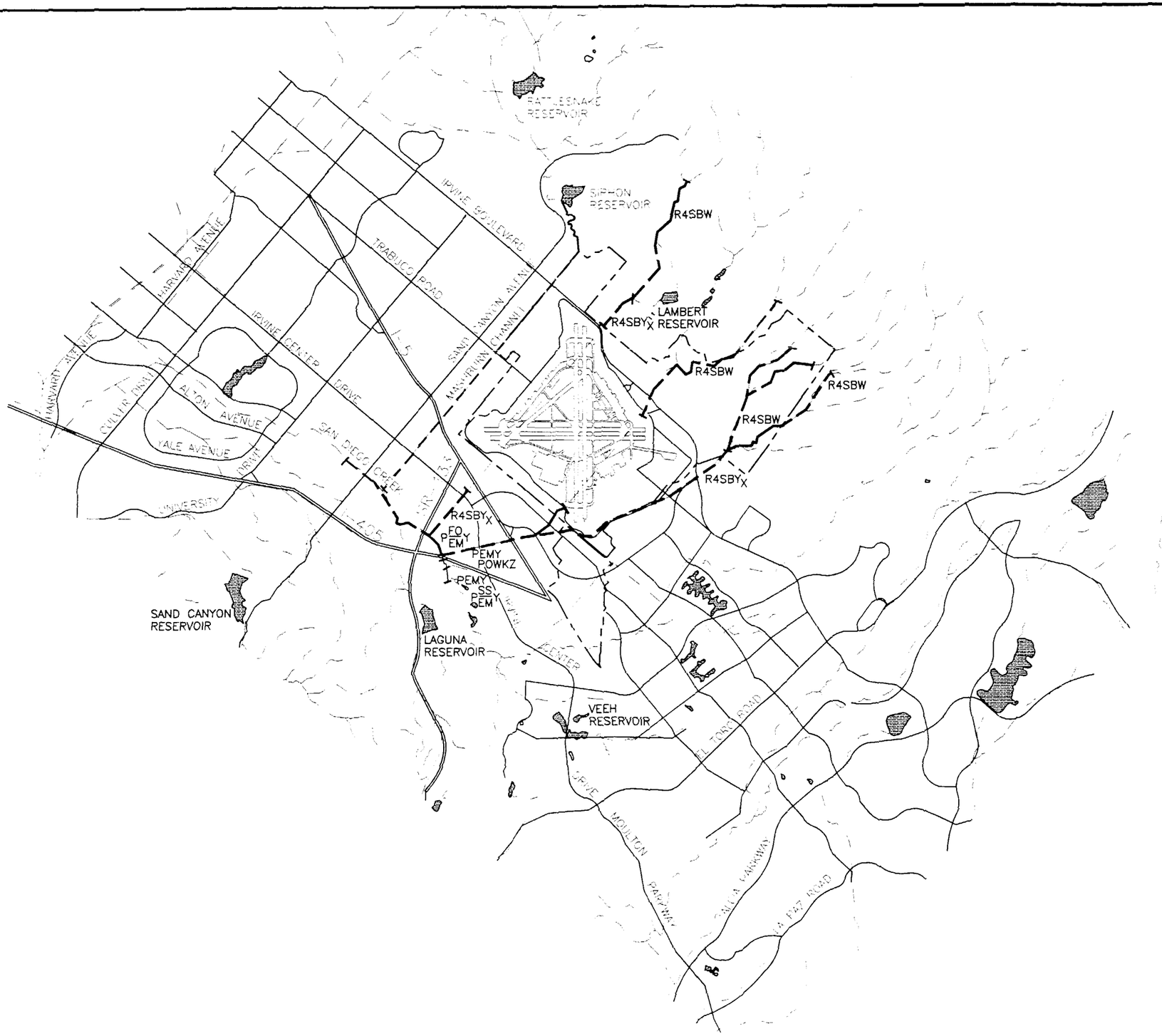
5.2.1.2 CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN

Not all chemicals require equal attention in the risk assessment. A number of factors will be considered in identifying COPECs, including environmental concentration in media representing ecological exposure pathways, frequency of occurrence, comparison to background levels for metals, ambient concentrations of pesticides, potential for bioaccumulation or biomagnification, and toxicity. Additional information generated in this risk assessment will be added to the existing database for MCAS El Toro.

Metals are naturally occurring constituents of soil and water. Consequently, metal concentrations detected in soil and surface water samples during the Phase I RI that appeared elevated when compared to background concentrations were assumed to be anthropogenic (Jacobs Engineering 1993b). Metal concentrations for soil and sediments were compared with soil background levels. When metal concentrations exceeded background levels during the Phase I RI, they were considered to be COPECs; those metals detected on-site that were below background levels were not considered COPECs.

During the Phase II RI/FS, COPECs in the three media evaluated (i.e., shallow soil, sediment, and surface water) will be chosen for further evaluation in the risk assessment and will be based on the following criteria:

- positively detected in a given medium (e.g., soil, water) representing ecological exposure pathways;
- detected above screening criteria developed during the Phase I RI (Appendix A, Tables A-4, A-5, and A-6);



LEGEND:

	BASE BOUNDARY
	WETLAND
	WASH OR STREAM
	ROAD
	LAKE OR RESERVOIR
R4SBW AND R4SBY	RIVERINE STREAM B2DS
PEMY AND PSSY EM	PALUSTRINE SCRUB/SHRUB OR EMERGENT WETLANDS
POWKZ	ARTIFICIAL PALUSTRINE OPEN WATER
PFOY EM	FORESTED/EMERGENT PALUSTRINE WETLANDS
PSSY FL	SCRUB-SHRUB/FLAT PALUSTRINE WETLANDS

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Risk Assessment Work Plan

Figure 5-2

Wetlands Habitat in the Vicinity of MCAS El Toro

MCAS El Toro, California

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- highly persistent chemicals; and
- potential for bioaccumulation or bioconcentration based on its physical-chemical properties and its tendency to occur in biota at higher concentrations than the surrounding environment.

During the Phase II RI/FS, chemicals detected in each of the media evaluated (shallow soil, sediment, and surface water) may not be chosen for further evaluation in the risk assessment based on the following characteristics:

- inorganic constituents commonly found in the environment at relatively nontoxic levels, including calcium, chloride, iron, magnesium, nitrate, phosphorous, potassium, sodium, and sulfate;
- metal concentrations below background levels in soil (Appendix A, Table A-7); and
- common laboratory contaminants (i.e., acetone, 2-butanone, methylene chloride, toluene, and phthalate esters) for which the concentrations in the samples are less than 10 times the concentrations in corresponding blank samples.

Tables 5-1, 5-2, and 5-3 present the COPECs for the Phase II RI/FS by site in soil, sediment, and surface water. Results from the additional soil, sediment, and surface water sampling to be conducted during the Phase II RI/FS will be included in the existing database for MCAS El Toro. From the expanded database, the COPECs will be assessed using the above criteria to determine which COPECs will be further evaluated in the predictive ecological risk assessment.

5.2.1.3 ECOLOGICAL RECEPTORS AND EXPOSURE PATHWAYS

Table 5-4 lists the animal species that were tentatively identified at MCAS El Toro. Tables A-8 and A-9 in Appendix A list the animal and plant species, respectively, that are known or have the potential to occupy habitat at MCAS El Toro based on field reconnaissance surveys, CNDDB searches, U.S. Fish and Wildlife surveys (USFWS 1993), and development of a Conservation Area Management Plan for a portion of MCAS El Toro (Dames and Moore 1995).

Soil Invertebrates

Numerous studies are available on the potential impacts associated with chemicals in soil and elevated tissue burdens in soil invertebrates (Hartenstein et al. 1980; Bouche 1988; Marquenie et al. 1987). Soil invertebrates are important in any terrestrial ecological risk assessment because they:

- ingest soil particles,
- occupy the lower levels of many terrestrial food chains,
- are important in recycling nutrients,

Table 5-1
Chemicals of Potential Ecological Concern in Soil

	IR PROGRAM SITES																					
Compounds	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
ORGANIC																						
1,1,1-Trichloroethane									X					X								
1,2-Dichloroethlene										X												
2,4,5-Trichlorophenoxy-proprionic acid																					X	
2,4-DB																	X					
2,4-Dichlorophenoxy acetic acid												X										
2,4-Dimethyl-phenol																	X					
2-Butanone																X						
2-Hexanone		X				X		X								X				X		X
2-Methylnaphthalene				X												X			X			X
4,4-DDD		X	X	X			X	X			X	X	X				X			X	X	X
4,4-DDE		X	X	X			X	X			X	X					X			X	X	X
4,4-DDT		X	X	X	X		X	X			X	X	X				X			X	X	X
4-Methyl phenol																	X					
4-Methyl-2-pentanone		X																				
Acenaphthene																			X			
Acenaphthylene																			X			
Acetone																X						
Aldrin		X																				
Anthracene														X					X			
Benzene							X									X						
Benzo(a)anthracene							X			X		X		X			X		X			X
Benzo(a)pyrene				X			X	X		X		X	X	X			X		X	X		X
benzo(b)fluoranthene				X			X			X		X	X	X					X			X

(table continues)

Table 5-1 (continued)

Compounds	IR PROGRAM SITES																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
ORGANIC (continued)																						
Benzo(g,h,i)perylene							X	X		X		X	X	X			X		X	X		
Benzo(k)fluoranthene				X			X			X		X	X	X					X			X
Benzyl butyl phthalate		X		X		X	X	X					X		X							
BHC				X				X					X				X			X	X	
Bis(2-ethylhexyl) phthalate		X		X		X	X	X	X	X		X	X	X	X	X			X	X		X
Carbazole							X							X					X			X
Carbon tetrachloride	X					X	X		X			X		X		X				X		
Chlordane				X				X				X					X			X	X	
Chrysene				X			X	X		X		X	X	X	X		X		X			X
D-n-butyl phthalate								X														
Dalapon		X										X					X				X	
Dibenzo(a,h)anthracene							X					X		X					X			
Dibenzofuran																X			X			
Dichloroprop		X																				
Dieldrin				X			X	X				X					X			X		
Diethyl phthalate							X			X												
Dimethyl phthalate								X	X													
Endosulfan				X			X	X			X	X	X				X			X		
Endrin				X			X	X			X	X	X				X			X		
Ethylbenzene		X						X								X						
Fluoranthene				X		X	X	X		X		X	X	X		X	X		X			X
Fluorene																X			X			
Heptachlor epoxide																	X					
Hexachloroethane								X														
Indeno(1,2,3-c,d)pyrene							X	X		X		X	X	X			X		X			X

(table continues)

Table 5-1 (continued)

	IR PROGRAM SITES																					
Compounds	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
ORGANIC (continued)																						
MCPA																	X					
MCPP		X			X							X										
Methoxychlor				X	X			X				X					X					
Methylene chloride						X	X	X				X			X	X	X			X		
Naphthalene				X												X			X			X
Octachlorodibenzo-p-dioxins			X																			
Aroclor 1248								X														
Aroclor 1254								X				X										
Aroclor 1260								X			X	X										
Phenanthrene							X			X		X		X	X	X			X			X
Phenol				X																		
Pyrene				X		X	X	X		X		X	X	X		X	X		X	X		X
Tetrachloroethylene								X		X												
Toluene	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X	X	X
Xylene		X		X		X	X	X				X			X	X				X		
INORGANIC																						
Aluminum				X		X		X	X			X										
Antimony				X			X	X				X	X	X	X	X			X	X		X
Barium						X	X	X	X			X		X	X	X						
Cadmium								X														
Chromium						X											X					
Cobalt							X												X			
Copper								X														
Lead			X	X	X	X	X	X	X			X	X	X	X	X	X			X		X
Magnesium									X													

(table continues)

Table 5-1 (continued)

	IR PROGRAM SITES																					
Compounds	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
ORGANIC (continued)																						
Manganese																						
Mercury		X	X	X			X	X				X	X	X						X		X
Selenium				X										X			X					
Silver		X	X	X		X		X	X	X		X	X	X	X	X	X		X	X	X	
Thallium																X						
Vanadium																						
Zinc				X		X		X				X		X		X	X			X		

Source: Jacobs Engineering 1993b

Table 5-2
Chemicals of Potential Ecological Concern in Sediment

Compound	Site 2	Site 3	SITE 25 Agua Chinon Wash	Bee Canyon Wash	Borrego Canyon Wash	Marshburn Canyon
INORGANIC						
Antimony	X					
Mercury						X
Silver				X		
ORGANIC						
2,4,5-TP						X
2-4DB	X		X			X
2-Hexanone		X				
4,4-DDD		X				
4,4-DDE		X		X		X
4,4-DDT	X	X		X		X
Benzene	X					
Benzyl butyl phthalate	X					
BHC						X
Bis(2-ethylhexyl) phthalate	X	X		X		
Carbon tetrachloride	X					
Chlordane	X					
Dichloroprop				X		X
Endosulfan						X
MCPP	X					
Methyl Chloride	X		X	X		X
Toluene	X	X				
Trichloroethylene	X					

Source: Jacobs Engineering 1993b

Table 5-3
Chemicals of Potential Ecological Concern in Surface Water

Compound	Site 2	Site 3	SITE 25 Agua Chinon Wash	SITE 25 Bee Canyon Wash	SITE 25 Borrego Canyon Wash	SITE 25 Marshburn Channel
INORGANIC						
Aluminum	X	X	X	X	X	X
Antimony		X	X	X	X	X
Arsenic	X	X	X	X	X	X
Barium	X	X	X	X	X	X
Beryllium	X	X	X	X	X	X
Cadmium	X	X	X	X	X	X
Chromium	X	X	X	X	X	X
Cobalt	X	X	X	X	X	X
Copper	X	X	X	X	X	X
Iron	X	X	X	X	X	X
Lead	X	X	X	X	X	X
Magnesium	X	X	X	X	X	X
Manganese	X	X	X	X	X	X
Mercury						X
Nickel	X	X	X	X	X	X
Selenium	X	X	X	X	X	
Silver			X			
Thallium	X		X			X
Vanadium	X	X	X	X	X	X
Zinc	X	X	X	X	X	X
ORGANIC						
2-Butanone		X	X			
2-Methylnaphthalene			X			
4,4-DDE						X
4,4-DDT			X			X
4-Nitrophenal			X	X		
Benzyl butyl phthalate			X			
BHC			X			
Bis(2-ethylhexyl) phthalate		X	X	X		
Carbon tetrachloride				X		
Chlordane		X		X		X
Chlorodibromomethane		X				
Methyl chloride		X	X	X	X	X
Toluene						X

Source: Jacobs Engineering 1993b

- have wide natural dispersal, and
- have a close relationship with other biomass (i.e., litter, microorganisms, roots, and other soil animals) (Bouche 1988; Marquenie et al. 1987).

Impacts to soil invertebrate communities have far-reaching consequences for native vegetative communities through changes in nutrient availability and alterations of physical characteristics of the soil, and for potential transfer of chemicals through the food web to higher-trophic organisms.

Birds

The 1972 Migratory Bird Treaty Act protects almost all species of birds from unregulated take, including poisoning by hazardous waste. Numerous species of birds utilize many of the habitat plants present at MCAS El Toro. In addition, special-status species of birds are present that may utilize the site for breeding, feeding, and/or nesting purposes.

Reptiles and Amphibians

Reptiles and amphibians, by their natural behavior, are in contact with chemicals in soils and sediments at the site. They also consume insects, small mammals, other reptiles and amphibians that have been exposed to site chemicals. Many reptiles and amphibians are also important food sources for higher-trophic level organisms. In addition, several reptiles and amphibians have special-status designation and may be present at sites.

Mammals

Because small mammals tend to live in burrows, impacts of potential concern to small mammals are inhalation of soil gases (i.e., VOCs), and ingestion of and direct contact with chemicals in soils. Small mammals also consume seeds, vegetative parts, and insects also exposed to site chemicals. In addition, many small mammals (i.e., field mice, gophers, ground squirrels, and meadow voles) form important food sources for predatory birds and other predators (i.e., foxes and coyotes). A specific concern at MCAS El Toro is the transfer of chemicals from small mammals to birds of prey and other predators that have a large range off-Station.

Threatened and Endangered Species

Fourteen special-status species are known to occur or expected to occur near or at MCAS El Toro (Table 5-4). Special-status animal species include the following:

- animals listed or proposed for listing as threatened or endangered under the federal Endangered Species Act of 1973 or animals that are Category 1 (sufficient information for listing as threatened or endangered) or Category 2 (further information required to determine status) candidates for listing as threatened or endangered under the federal Endangered Species Act;
- animals listed or proposed for listing under the California Endangered Species Act;

Table 5-4
Special-Status Receptors[a] at MCAS El Toro for the Phase II RI/FS Predictive Ecological Risk Assessment[b]

Receptors	SITES																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25
Threatened and Endangered																								
Bell's sage sparrow	X	X															X							
Bewick's wren	X	X															X							
Burrowing owl																X								
Black-shouldered kite	X	X															X							
Cactus wren	X																X							
California gnatcatcher	X	X															X							
Coastal horned lizard	X	X															X							
Coastal western whiptail	X	X			X												X							
Coopers hawk	X	X															X							
Ferruginous hawk	X	X															X							
Grasshopper sparrow	X	X															X							
Logger-head shrike	X	X				X						X												
Northwestern San Diego pocket mouse	X	X															X							
Orange-throated whiptail	X	X															X							
Pacific pocket mouse		X															X							
Prairie falcon	X	X															X							
San Diego desert woodrat	X	X															X							
San Diego horned lizard		X																						
San Diego black-tailed jackrabbit	X	X															X							
Sharp-shinned hawk	X	X															X							
Southern California rufous-crowned sparrow	X	X															X							
Southern grasshopper mouse	X	X															X							
Western spadefoot toad	X	X															X							

[a] List derived from CNDDB 1993
[b] Field reconnaissance performed in May 1995 for CLEAN II Program.

- animals fully protected by the California Fish and Game Code which prohibits the taking or possession of protected animals or part thereof;
- animals meeting the definitions of rare or endangered under California Environmental Quality Act (CEQA); and
- species of special concern to the California Department of Fish and Game.

Vegetation

Some metals and organic compounds are known to be accumulated by many plant species, a process that is dependent on soil characteristics that govern bioavailability. Potential impacts to plants from the presence of chemicals could include reduced productivity, inhibition of root and shoot growth, exclusion of plant species, and susceptibility to secondary stresses such as insect infestations and drought. In addition, the potential accumulation of metals and organic compounds in aboveground and belowground plant parts is of concern because of the potential transfer through the food web to higher-trophic organisms.

Two sensitive vegetation communities are recognized on MCAS El Toro: coastal sage scrub and coast live oak woodland (Dames and Moore 1995; USFWS 1993). No endangered or threatened plant species have been located in this previous work; however, several special status species are reported, including spineflower (*chorizantha procumbens* var. *albiflora*), golden daisy (*Pentacheata aurea*), clovertern (*Marsilea vestita*), oak (*Quercus agrifolia*), and sycamore (*Platanus racemos*).

5.2.1.4 SUMMARY OF INITIAL ECOLOGICAL CONCERNS

Based on information presented in the Phase I RI ecological risk assessment (Jacobs Engineering 1993c), a number of ecological concerns have been identified at MCAS El Toro:

- metals and organic compounds may be elevated in site soils, sediments, and surface water, which may be impacting soil invertebrates, vegetation, and wildlife;
- VOCs may be impacting burrowing animals;
- small mammals, birds, and reptiles may consume terrestrial vegetation and/or soil invertebrates and become exposed to elevated chemical levels in food items;
- higher-trophic organisms may be exposed to elevated chemical levels in lower trophic organisms of the food web and vegetation;
- biomagnification of site chemicals may be impacting higher-trophic level organisms through trophic level transfer;
- even in the absence of overt acute effects, potential chronic sublethal and subtle effects may occur; and
- possible nonchemical effects may include habitat alteration or destruction.

These concerns will form the basis for the design of the ecological risk assessment approach. From these concerns and previous site data, a variety of information needs were identified in order to focus the risk assessment tasks (i.e., risk assessment endpoints).

5.2.2 Site Information Needs

The Phase I RI ecological risk assessment (Jacobs Engineering 1993b) identified the presence and levels of chemicals at MCAS El Toro, assessed whether ecological receptors were present, and evaluated the existence of exposure pathways to ecological receptors. It also compared chemical concentrations at likely exposure points to the available average national background criteria, standards, or ecological benchmark reference values. These comparisons conservatively used maximum concentrations and exposure parameters for the 23 sites identified at MCAS El Toro.

Based on these results, several objectives were developed for the Phase II RI/FS predictive ecological risk assessments to facilitate a better understanding of potential ecological risks at MCAS El Toro:

- perform additional sampling to better characterize chemical releases in habitats of concern (i.e., the most diverse and complex habitats are found at landfill sites);
- perform a habitat assessment to characterize ecological receptors present in sensitive habitats at MCAS El Toro, and to provide site-specific knowledge to evaluate each community and each ecosystem;
- analyze by direct measurement the chemicals in air present in animal burrows and determine potential impacts to burrowing animals (i.e., gophers, voles, ground squirrels) at landfill sites and those sites;
- sample surface water and perform analyses on filtered samples (i.e., surface water samples that were collected during heavy runoff events resulted in elevated levels of chemicals associated with suspended particulates);
- perform additional shallow soil (0 to 10 feet bgs) sampling to better characterize chemical concentrations that may potentially impact ecological receptors (i.e., animals and plants);
- integrate new information with already existing information, calculate a chemical-specific 95-percent UCL of the arithmetic mean for each site; and
- perform focused biological sampling that will include plant foliage, and small burrowing mammals at Sites 2 and 17 and a reference site.

5.2.3 Assessment and Measurement Endpoints

The information presented above is used to formulate ecologically based endpoints that are relevant to decisions made regarding the protection of the environment. As defined in the U.S. EPA framework for ecological risk assessment (1992d), an endpoint is a characteristic of an ecological component that may be affected by a stressor (i.e.,

chemical or nonchemical). Assessment endpoints are the ecological components that are to be evaluated and that will focus on remediation to mitigate ecological risks. (Suter 1993). Measurement endpoints are measurable responses that provide the data for evaluating the assessment endpoints (U.S. EPA 1992c).

Ecological assessment endpoints are frequently associated with different levels of ecological organization. Two key assessment endpoints for the MCAS El Toro risk assessment are:

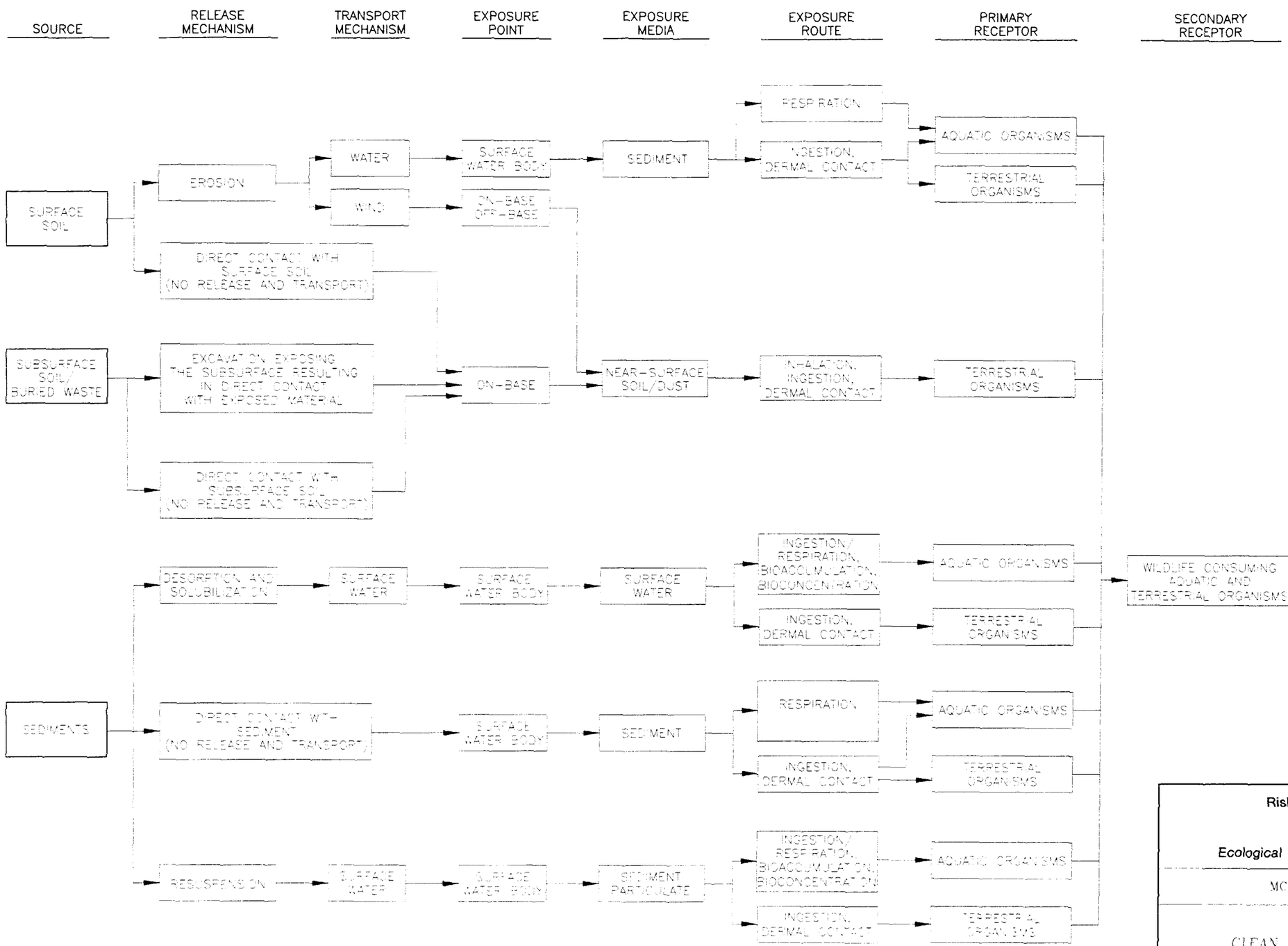
- evaluation of potential impacts to terrestrial communities associated with chemicals in soil and sediment; and
- protection of natural resources, especially for sensitive habitats (i.e., coastal sage scrub and coast live oak woodlands) and special-status plant and animal species.

Measurement endpoints that will be considered in assessing ecological risk associated with chemicals at the sites are:

- direct measurement of chemical loadings in soil, sediment, and surface water and comparison with regulatory criteria, benchmark values, and scientific literature;
- focused biological sampling at Sites 2 and 17 and a reference site with chemical analyses of samples;
- selection of COPECs based on criteria identified in Section 5.2.1.2. and relevant to exposure pathways (i.e., ingestion of soil, surface water, and dermal contact with soil and sediments) for receptors of concern for each site; and
- quantification of uptake by receptors of concern by direct measurement or modeling and comparison with regulatory criteria; benchmark values comparison of site-specific results to reference site results; and scientific literature using a hazard quotient method to determine potential impacts.

5.2.4 Conceptual Site Model

A conceptual site model for the predictive ecological risk assessment was developed for MCAS El Toro, based on a review of existing data on the environmental setting, physical and biological habitats, and nature of chemical releases (Figure 5-3). The conceptual site model is an illustrated representation of the site, the environmental media (i.e., soil, sediment, water) that are affected, and the ways that wildlife can be potentially exposed to these chemicals. This type of model is preliminary to the actual risk assessment, but is useful for visualizing and discussing the potential exposure pathways at a site during the design of the approach to the risk assessment. The conceptual site model aids the risk assessment process by providing a foundation for further refinement of exposure pathways and their quantitation. The ecological risk assessment will analyze the exposure pathways identified in the model and evaluate present and potential future risks that may occur in the absence of remediation. Figure 5-3 depicts exposure routes of site-related chemicals to ecological receptors. Routes of exposure that may be important to



Risk Assessment Work Plan

Figure 5-3

Ecological Exposure Routes and Receptors

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ecological exposures at the site include ingestion of chemicals in soils, sediments, surface water, and food items (e.g., vegetation, invertebrate organisms); inhalation of volatile organic compounds in soil gas; and direct contact with chemicals in soil, sediment, and surface water. This model will be refined using the information obtained from the sampling for the assessment.

5.3 EXPOSURE ASSESSMENT

The exposure assessment determines the exposure routes and quantifies the magnitude, frequency, and duration of exposure of ecological receptors to chemicals. The key components of the exposure assessment will include:

- analyses of environmental media for COPECs and the potential for chemical releases or uptake by biota;
- identification of exposure factors (i.e., estimates of intake, body weight, duration of exposure, and frequency of exposure);
- identification of potential exposure pathways;
- identification of potentially exposed populations; and
- estimation of exposure point or intake concentrations and identification of prominent exposure contact areas (i.e., hot spots).

The result of the exposure assessment will be combined with chemical-specific toxicity information to characterize current and potential risks to ecosystem components at MCAS El Toro using a hazard quotient method as described in the risk characterization section.

5.3.1 Exposure Pathways of Concern

An exposure pathway is the link between a source of release and a receptor. Potential routes of exposure identified for ecological receptors at each site will include the following exposure pathways:

- ingestion of COPECs in soil, sediment, and/or surface water;
- ingestion of plant and animal items exposed to COPECs in soil, water, and/or sediment with subsequent transfer through the food chain;
- direct contact with COPECs in soil, sediment, and/or surface water; and
- inhalation of VOCs in soil gas.

Ingestion of soil, sediment, and surface water may result from a number of different behaviors. An organism may inadvertently ingest soil while grooming, burrowing, or consuming plants, insects, or burrowing invertebrates found in the soil. Some animals deliberately ingest soil as a source of minerals. Terrestrial organisms may also ingest waterborne chemicals if affected waters are used as drinking water or for bathing.

Ecological receptors may be exposed to COPECs in soils via dermal contact. Significant exposure via dermal contact would be limited to organic chemicals that are lipophilic and can cross the epidermis of the exposed organism. Terrestrial organisms may come in contact with waterborne chemicals as a result of wading, swimming, or bathing in contaminated water.

Inhalation of organic vapors would be limited to those chemicals considered volatile based on vapor pressure and other physical-chemical processes. Terrestrial organisms may be exposed to organic vapors resulting from the volatilization of organics in soil or water. At MCAS El Toro, the potential for a burrowing animal to be exposed to organic vapors from the surrounding soils is significant. No significant exposure to volatiles via water are expected at MCAS El Toro.

Exposure via inhalation of fugitive dust would be limited to chemicals present in near-surface soils at or near a site that is devoid of vegetation or a hardscape that prevents soil erosion. Intake via such pathways is minimal relative to other pathways. However, transport of soil to off-site locations may result in the exposure of organisms that are not present at the site.

Exposure via secondary pathways would be limited to chemicals that bioaccumulate within the food chain, including chemicals bioaccumulated from soil into plants or into animals. These plants and/or animals may be consumed by animals higher on the food chain. Waterborne chemicals may bioaccumulate into aquatic organisms, plants, or animals that frequent the waters. These chemicals may be passed up the food chain or affect organisms within the next ecological tier. Appendix A, Table A-10 presents bioaccumulation factors for a number of chemicals and receptors. Organochlorines and metals are the class of chemicals of greatest concern for food-chain bioaccumulation.

Appendix A, Table A-8 presents the ecological receptors that will be evaluated in the predictive ecological risk assessment on a site-specific-basis. Figure 5-2 presents the potential complete exposure pathways that will be evaluated for the receptors identified in Appendix A, Table A-8.

5.3.2 Site-Specific Concentration Data

The concentrations of COPECs will be estimated for each medium to which the identified receptors are exposed. For potentially impacted habitats and receptors, potential exposure pathways will be identified. Exposure concentrations will be estimated for the pathways relevant to the site.

If the chemical is known to bioaccumulate or biomagnify, bioaccumulation factors (BAFs) or biomagnification factors (BMFs) will be used to predict transfer in the food web. Bioaccumulation is defined as the net accumulation of a chemical by an organisms from all routes of exposure (Suter 1993). Biomagnification is defined as the tendency of some chemicals to accumulate to higher concentrations at higher levels in the food web through dietary accumulation (Suter 1993). Sources of BAFs and BMFs will include the

scientific literature and information previously presented in the Phase I RI ecological risk assessment (Appendix A, Table A-10).

In addition to using data from the Phase I RI, sampling will be conducted during the Phase II RI that will be used to support the ecological risk assessment. Proposed sampling will collect biological material, soil, sediment, and surface water for analyses of COPECs. Sampling procedures for biological material are included in Appendix B. Soil, sediment, and surface water sampling procedures are described in the FSP (BNI 1995b).

5.3.2.1 BIOTA SAMPLES

Samples of biota will be collected at Sites 2 and 17 to provide additional data to the proposed predictive model of the Phase II RI/FS ecological risk assessment. The purpose of the proposed biota is twofold:

- to provide a quantitative assessment of potential uptake of contaminants into the food chain, and
- to provide data that will be used to evaluate remedial alternatives.

The ecological risk assessment for the Phase II RI/FS will rely principally on a predictive model to asses potential ecological impacts. However, the ecosystems present at Sites 2 and 17 are known to consist of sensitive habitats and species. Because these sites are landfills with known contaminants, a potential ecological risk may be present.

To assess this potential ecological risk and provide data that will be useful to evaluation or remedial alternatives, small mammals, such as deer mice, and foliage from California sagebrush, will be collected from each site and a reference site near Sites 2 and 17 (an area that is not suspected of being contaminated). Up to 15 samples will be collected from the three sites and submitted for whole-body chemical analysis. Sampling locations will be established by constructing a grid to provide 50 evenly spaced sampling points at each site (Site 2, Site 17, and a reference site). The 15 sampling locations will be randomly selected at each site. The sampling procedures are presented in Appendix B.

Biota samples will be placed in clean glass jars and submitted for analyses of pesticides by U.S. EPA Method 8080, SVOCs by U.S. EPA Method 8270, and metals by U.S. EPA Method Series 6000/7000. Approximately 60 grams wet weight of tissues are required from each sample to conduct these analyses.

Prior to chemical analyses, the sample will be homogenized to obtain a uniform tissue sample. Homogenization will occur at the analytical laboratory, thus eliminating the need for chemical preservative during shipping; however, the samples will be shipped in a chilled cooler.

5.3.2.2 SOILS

In addition to data generated by the Phase I RI, shallow soil data generated during the Phase II RI/FS will be included in the evaluation of the soil data for the Phase II RI/FS predictive ecological risk assessment. The location of soil samples will correspond to

small mammal sample locations as discussed in Appendix B. The evaluation will also include a comparison of sample metal concentrations to background values (Appendix A, Table A-7), as well as assessment of spatial distributions and trends of the COPECs, and areas of special concern (i.e., hot spots). The additional data generated during the Phase II RI/FS will also be used to refine the list of COPECs in the ecological risk assessment. In addition, soil gas samples will be collected from areas of known VOC chemical releases and in areas susceptible to gas generation (i.e., landfills).

5.3.2.3 SEDIMENTS

In addition to Phase I RI data, the Phase II RI/FS will include an evaluation of the sediment data for ecological risk assessment. Sediment sample locations are presented in Attachments B and X in the FSP for Sites 2 and 25 (BNI 1995b). The Phase II RI/FS sediment results combined with Phase I RI sediment data will be used to evaluate potential ecological impacts associated with chemicals in the sediments. Sediment sample metal concentrations will be compared to background values (Appendix A, Table A-7).

5.3.2.4 SURFACE WATER

During the Phase II RI/FS, surface water samples will be collected upstream and downstream in the four major drainages at the station and at locations upstream and downstream of Sites 2 when stream flow is present. Surface water sample locations are presented in Attachments B and X in the FSP (BNI 1995b). Surface water samples collected for metal analysis will be filtered. This will allow metal concentrations in surface water to be more accurately characterized. Phase I RI surface water samples were not filtered for metal analyses. Surface water samples will be compared with acute ambient water quality criteria, rather than chronic criteria.

5.3.3 Dose Calculation

The estimated exposure (expressed as a daily intake dose), adjusted for species, contact rate, duration, and pathway, is divided by an acceptable toxicity-based benchmark value (normally chronic in duration), which is adjusted for the identical variables as the dose. If the hazard quotient exceeds unity (one), it is assumed that a potential effect associated with a particular chemical could occur. The following equation (DTSC 1994a) will be used to estimate a receptor's daily intake:

$$\text{Daily Intake} = \frac{CM \times CR \times FI \times AF \times CF}{BW}$$

where:

Daily intake is measured in mg/kg/day

CM = concentration of chemicals in media of concern. A source of chemicals is generally characterized by analysis, whereas movement into other media may be measured or modeled.

CR = contact rate for each medium (including plant and animal food items) and pathway of concern for each representative species are expressed as quantity of medium (weight or volume) per day. If contact rates are not available for selected species, they may be estimated from surrogate species.
FI = fraction of time spent in contact with chemicals in the media.
AF = absorption fraction that may be used if data indicate that absorption by the route in question is a fraction of the route for which the RfD was determined.
CF = unit correction factor.
BW = body weight of the animal.

The concentration term (*CM*) in the intake equation is the estimate of the arithmetic average concentration for a chemical based on a set of previous and current sampling results. Because of the uncertainty associated with estimating the true average concentration at a site, the 95-percent UCL of the arithmetic mean will be used as the point-estimate of the concentration term. An estimate of average concentration is used because it is most representative of the concentration that would be contacted at a site over time. It is assumed that an exposed individual moves randomly across an exposure area. If the data set is lognormally distributed, the 95-percent UCL of the arithmetic mean is first calculated by transforming the data using the natural logarithm ($ln(x)$). After transforming the data, the following equation is used to calculate the 95-percent UCL:

$$\text{UCL} = e^{\left[\left(x + 0.5s^2 + sH\right) \Big/ \sqrt{(n-1)}\right]}$$

where:

UCL = upper confidence limit
e = constant (base of the natural log, equal to 2.718)
x = mean of the transformed data
s = standard deviation of the transformed data
H = H-statistic
n = number of samples

If the data set is normally distributed, the 95-percent UCL of the arithmetic mean is calculated using the following equation:

$$\text{UCL} = x + \left(t\left(\frac{s}{\sqrt{n}}\right)\right)$$

where:

UCL = upper confidence limit
x = mean of the untransformed data
t = Student's-t statistic
s = standard deviation of the untransformed data
n = number of samples

Exposure parameters for the selected site-specific receptors will be taken from the scientific literature and *Wildlife Exposure Factors Handbook* (U.S. EPA 1993b). If exposure parameters are unavailable for a selected receptor, a surrogate species will be used instead. Exposure parameters will include information on animal (e.g., invertebrates, small mammals) and vegetation (e.g., grasses, fruits, leaves, roots, shoots) intake rates, incidental soil ingestion, water ingestion, exposure frequency, exposure duration, and body weights.

Chemical uptake and transfer to plant food source media will be modeled. Chemical concentrations in plant parts can be predicted based on soil concentrations. Concentrations in plant part can be calculated by the equation:

$$C_{trans} = (C_s) \times (UF)$$

where:

C_{trans} = concentration from translocation of chemical through the root of the plan (mg/kg)
C_s = concentration of chemical in soil (mg/kg)
UF = uptake factor (mg/kg vegetable divided by mg/kg soil)

For inorganic chemicals, the uptake factors based on soil concentration presented by Baes et al. (1984) will be used to determine chemical concentrations in plant parts.

Uptake of organic compounds into leaf plants can be estimated using the equations developed by Topp et al. (1986) and Travis and Arms (1988). The regression equation developed by Topp et al. (1986) is as follows:

$$UF_{Topp} = (8.77 \times 10^5) \times (M^{-2.385})$$

where:

UF_{Topp} = uptake factor (mg/kg plant per mg/kg soil)
M = molecular weight (g/mole)

The equation developed by Travis and Arms (1988) is as follows:

$$UF_{T\text{-}A} = 10^{(1.588-0.578 \log Kow)}$$

where:

$UF_{T\text{-}A}$ = uptake factor (mg/kg plant per mg/kg soil)
K_{ow} = octanol:water partition coefficient

The values obtained from the two above equations are arithmetically averaged to produce the uptake factors for vine and leafy plants:

$$UF = (UF_{Topp} + UF_{T\text{-}A})/2$$

To estimate organic compounds in plant roots, the uptake from the soil consists of the chemical being sorbed to the root (rather than been taken up into the root). Briggs et al. (1982) defined the root concentration factor as the concentration of chemical in the root

divided by the concentration of chemical in solution surrounding the root, and related it to the K_{ow}. The plant root uptake factor can be estimated using the following equation:

$$UF = (0.03[K_{ow}]^{0.77}) + (0.82\ [(K_{oc}]\ [f_{oc}])$$

where:

UF = uptake factor (mg/kg plant per mg/kg soil)
K_{ow} = chemical-specific octanol:water partition coefficient
K_{oc} = organic carbon partition coefficient
f_{oc} = fraction organic carbon in soil

5.4 BIOLOGICAL EFFECTS ASSESSMENT

The biological effects assessment will summarize available information concerning potential toxicological effects resulting from exposure to MCAS El Toro site chemicals. The predictive ecological risk assessment will use toxicological information from regulatory criteria and/or from the scientific literature. Site-specific information at Sites 2 and 17 will supplement existing data. For the purposes of the predictive ecological risk assessment, the approach is to use chemical-specific toxicity derived from the literature as denominators. Information presented in the Phase I RI ecological risk assessment will also be included in the Phase II predictive ecological risk assessment.

5.4.1 Literature Review

Evaluating the toxicity of a chemical requires description of specific effects or endpoints of concern, including the organism tested or observed, the nature of the effect, the concentration or dose needed to produce an effect, the duration of exposure needed to produce an effect, and the environmental conditions under which effects were observed. Acute toxicity refers to adverse physiological effects to organisms immediately or shortly after exposure to the chemical. Chronic toxicity involves long-term, cumulative effects of smaller doses or diluted concentrations of the chemical. Both effects may lead to death or disruption of vital functions, or sublethal physiological effects. The information described above will be obtained by conducting a review of pertinent documents and databases.

5.4.1.1 INFORMATION SOURCES

Assessment endpoints and measurement endpoints listed in Section 5.2.3 will be discussed for the exposure routes. The data sources to be reviewed are listed below.

- Chemical Information System (CIS), including Aquatic Information Retrieval (AQUIRE), Registry of Chemical Substances (RTECS), and Hazardous Substances Data Bank (HSDB). These databases provide toxicological information on aquatic and terrestrial organisms.
- AWQC documents (U.S. EPA by chemical). These documents served as a primary data source for studies relating to potential toxic effects on aquatic life.

- Wildlife Society Data Base, which provides toxicity information for terrestrial receptors.
- Agency for Toxic Substances and Disease Registry (ATSDR). These documents provide important information regarding NOAELs and LOAELs for a number of chemicals.
- National Oceanic and Atmospheric Administration Sediment Criteria.
- California Water Resources Control Board Objective Plan for Enclosed Bays and Estuaries, Inland Surface Waters, or Ocean Plan; Local and regional toxicity studies conducted in southern California (i.e., Camp Pendleton).

Data on representative species from these sources will be interpreted with caution, since conditions in the laboratory and at other sites limit direct comparisons with data from the MCAS El Toro site. For example, differences in physiology between closely related species or subspecies often complicate interpretations of toxicity bioassay results.

5.4.1.2 TOXICITY DATA

For the risk assessment, species representative of the site will be selected for toxicological comparison to assess potential environmental risks associated with COPECs at MCAS El Toro. For more subtle or chronic effects, the toxicity values are NOAELs and the LOAELs. The NOAEL is a concentration or dose that did not produce any observable toxicity in the test organism. The LOAEL is the lowest dose that produces an observable toxic effect and is useful only in identifying toxic levels to determine a hazard index. In general, an actual threshold for the toxic effect exists somewhere between these two values. However, these values are used in the risk characterization section in the analysis of the potential effects resulting from direct exposure and trophic transfer of chemicals at the site. Potential risks will be assessed by comparing concentrations of chemicals in soil, sediment, surface water, or ecological receptors with these estimates of toxic and nontoxic values. In addition, toxicity data generated from the screening ecological risk assessment for MCAS El Toro will also be used in the predictive ecological risk assessment as provided in Appendix A.

If reference concentrations for aquatic species or reference doses for terrestrial species are not available from the above sources, the U.S. EPA and DTSC will be consulted to determine the appropriate action level for the protection of aquatic and terrestrial receptors. Uncertainty factors may be needed to account for conditions under which a surrogate criterion was developed that do not match those being assessed. Uncertainties may include the following:

- lack of consideration of exposure via the food chain that may contribute significantly to total exposure;
- studies that do not address sensitive indicators of toxicity, such as reproduction, behavior, or pathology;

- short-term studies where maximum tissue concentrations and/or toxic effect were not attained;
- no data on the relevant species or a closely related species;
- lack of evaluation of a sufficiently sensitive endpoint; and
- inadequate controls and documentation of exposure.

Consideration will be given to adapting criterion for one medium (e.g., sediment) from another medium (e.g., for water by using the partition coefficient between the two media) or deriving a reference concentration or dose from published toxicity information, using appropriate uncertainty factors and adjustments, if warranted and acceptable.

Information addressing toxicity to terrestrial receptors, plants, and aquatic receptors generated in the Phase I RI screening ecological risk assessment will also be used in the predictive ecological risk assessment. This information will complement other surrogate toxicity criteria for COPECs not addressed in the screening risk assessment. Surrogate toxicity criteria generated from the screening risk assessment are presented in Appendix A, Tables A-11, A-12, and A-13.

5.4.1.3 ECOLOGICAL DATA

Background information available regarding the presence of wildlife, plant species, and area use will be collected and reviewed. Data sources may include, but will not be limited to, the CNDDB and the California Wildlife-Habitat Relationships (WHR) System. These data sources are maintained by the California Department of Fish and Game. These data sources will provide information on resident and migratory species that may utilize the areas as well as determining the occurrence of state or federal special-status species or habitats that are considered rare within the areas. Information generated from previous site investigations will also be incorporated.

A habitat assessment will be conducted for each of the sites, including the washes. The habitat assessment will consist of a habitat delineation, vegetative cover survey, and wildlife survey. The habitat assessment will provide information on whether suitable habitat is present at each of the individual sites and whether ecological receptors (plant and animal) are present at those sites.

5.5 CHARACTERIZATION OF ECOLOGICAL RISKS

The final step in the ecological risk assessment is the characterization of risks. In this step, current and potential risks to receptors and ecological components (which may be organisms [i.e., individual receptors], populations, communities, or ecosystems) are estimated.

Chemical concentrations in environmental media and doses will be compared to available toxicity information or benchmark values for biological effects through a hazard quotient. The ecological risk characterization will identify those media that may pose a potential

risk or hazard to ecological receptors. The risk characterization step will conclude with a risk or hazard description which:

- includes a summary of the risks or hazards and uncertainties, and
- interprets the ecological significance of the observed or predicted ecological effects resulting from chemical releases from MCAS El Toro.

5.5.1 Hazard Quotient Approach to Characterize Risk

The potential for chronic adverse effects will be evaluated by comparing exposure levels with a chronic toxicity benchmark value using the following equation:

$$HQ = Dose/NOAEL$$

where:

HQ = hazard quotient; ratio of toxicity exposure
Dose = exposure level of intake (mg/kg/day)
NOAEL = no-observed-adverse-effect-level (mg/kg/day)

The NOAEL is the highest dose administered during a chronic toxicity study that does not produce observable, adverse toxic effects. NOAELs for the COPECs will be obtained from the scientific literature. If NOAELs have not been developed for certain COPECs or have not been developed for the specific indicator species chosen, NOAELs from surrogate species will be used to calculate the hazard quotient. Uncertainty factors and adjustments will be used in case of interspecies extrapolation of NOAELs. The resulting effect of an uncertainty factor is to derive a more protective estimate of sensitivity to a chemical due to inherent uncertainties associated with different species.

Hazard quotients will be summed to derive a chemical-specific hazard index. Hazard indices are additive between chemicals if the chemicals have the same mechanism of action or common target organ. Hazard indices less than one for each chemical mode of action or common target organ are reasonably good indicators that adverse effects on assessment endpoints are unlikely and that chemicals concentrations have not been underestimated.

This method is likely to overestimate rather than underestimate potential risk. This method also accounts for individual compounds rather than cumulative effects of complex chemical mixtures, unless each of the COPECs in the mixture is addressed.

Because species-specific toxicity testing for chemicals in soil, sediment, and surface water may be absent, it may not be possible to determine the toxicity of each COPEC to each type of organism. Accordingly, the basic dose-response information to be incorporated in the risk assessment is from existing guidelines or scientific literature for the most sensitive organism. This may require acute-to-chronic, route-to-route, species-to-species, and other types of extrapolation to address potential toxic effects to specific receptors.

5.5.2 Ecological Significance

The ecological significance of the risk assessment results is essential to evaluate the overall risks to the ecosystem. For each parameter modeled or measured, the potential impact on a community or ecosystem level (or its supportive role in evaluating such an impact) will be addressed in an analysis of ecological significance. Risk managers depend on an adequate description of the significance of the risk findings in making decisions about managing affected ecosystems.

The interpretation of ecological significance in the ecological risk assessment places risk estimates in the context of the types and extent of anticipated effects. It is a link between the estimation of risk and the communication of the assessment results. Some aspects that may be considered in the discussion of the ecological significance include the nature and magnitude of effects, the spatial and temporal pattern of effects, and the potential for recovery once a stressor is removed. These are discussed below.

- **Nature and magnitude of the effects**: Concerned with the effects chemicals may have on ecosystems and where the greatest impacts are likely to occur; the ecological context associated with population-dependent and independent factors that may influence the expression of the effect; and the magnitude and likelihood of the effect occurring.
- **Spatial and temporal patterns of the effects**: Concerned with the extent of chemical spill or release and associated degradation of that resource; and the persistence of the chemical and how often it is likely to occur in the environment, especially during critical life stages of organisms.
- **Potential for recovery**: Places potential ecological risks into broader ecological context and considers the effects on other ecological receptors not specifically addressed in the risk assessment.
- **Potential to reach exposure point of an organism**: Depends on characteristics of the chemical, the organism, and the environment as well as factors that would influence organism exposure and intake, including the following:
  - ambient concentrations of a chemical in the media to which the organism is most often exposed;
  - bioavailability of the chemical, which may be influenced by pH, action exchange capacity, organic carbon concentration, or other factors;
  - physical characteristics of the organism, such as age, gender, size, surface area, morphological structure, and physiological components;
  - metabolic processes that reflect species-specific rates of accumulation, storage, degradation, or excretion of compounds; and
  - feeding behavior that may vary with season and life stage, and the ability to detect and avoid affected media or food.

5.5.3 Uncertainty Analysis

Uncertainties in estimating ecological risks are often of greater magnitude than those for estimating human health risks, such as uncertainties in routes and magnitudes of intake by ecological receptors. The nature of these uncertainties will be discussed in the risk assessment with regard to relevant exposure pathways for ecological risks.

Section 6
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APPENDIX A

SUMMARY TABLES

Table A-1

MCAS El Toro Chemicals of Potential Ecological Concern in Soil Exceeding Criteria
MCAS El Toro Phase I RI Technical Memorandum

Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
ORGANICSs																						
1,1,1-Trichloroethane									-nn													
1,2-Dichloroethene(total)										-nn												
2,4,5-T																					nnn	
2,4,5-Trichloro phenoxy proprionic acid			-nn		-nn																	
2,4-D												nnn										
2,4-DB		nnn															nnn					
2,4-Dimethyl phenol																	nnn					
2-Butanone (MEK)		-nn	-nn					-nn	-nn			-nn				-nn				-nn		-nn
2-Hexanone		nnn	nnn					nnn								nnn				n		nnn
2-Methylnaphthalene				nnn												nnn			nnn	nnn	nnn	nnn
4',4'-DDD		n-n	n-n	n-n			n-n	n-n			n-n	n-n					n-n			n-n	n-n	
4',4'-DDE		nnn	nnn	nnn			nnn	nnn			nnn	nnn					nnn			nnn	nnn	
4',4'-DDT												I										
4-Methyl-2-pentanone		nnn																				
4-Methylphenol																	nnn					
Acenaphthene																			n-n		n-n	
Acenaphthylene																			nnn		nnn	
Acetone		--n	--n	--n		--n	--n			--n		--n	--n	--n	--n	--n	--n		--n	--n	--n	--n
Aldrin		-n-																				
Alpha chlordane		-nn		-nn				-nn				-nn					-nn				-nn	
Anthracene														-nn					-nn		-nn	

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Benzene		--n					--n									--n						
Benzo(a)anthracene							Mnn			Mnn		Mnn		M-nn			Mnn		Mnn		Mnn	Mnn
Benzo(a)pyrene				--P			--P	--P		--P		--P	--P	--P			--P		--P	--P	--P	--P
Benzo(b)fluoranthene				-nn			-nn			-nn		-nn	-nn	-nn					-nn		-nn	-nn
Benzo(g,h,i)perylene							nnn	nnn		nnn		nnn	nnn	nnn			nnn		nnn	nnn	nnn	
Benzo(k)fluoranthene				-nn			-nn			-nn		-nn	-nn	-nn					-nn		-nn	-nn
Benzyl butyl phthalate		nn		-nn		-nn		-nn					-nn		-nn						-nn	
Beta chlordane								nn														
Alpha-BHC								nnn												nnn		
Delta-BHC				-n-													-n-			-n-		
Gamma BHC																					nnn	
Bis(2-ethylhexyl)phthalate		--n	--n	--n		--n	--n	--n		--n		--n	--n	--n	--n	--n			--n	--n	--n	--n
Carbazole							nnn							nnn					nnn		nnn	nnn
Carbon disulfide												-nn										
Carbon Tetrachloride		nnn	nnn			nnn	nnn		nnn			nnn		nnn		nnn				nnn		
Chrysene				-nn			-nn	-nn		-nn		-nn	-nn	-nn	-nn		-nn		-nn		-nn	-nn
Dalapon		-nn										-nn									-nn	
Dibenzofuran																-nn			-nn		-nn	
Di-n-butylphthalate								--n														
Dichlorprop		-nn																				
Dieldrin																						
Diethylphthalate							n-n			n-n												
Dimethylphthalate								-nn	-nn													

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Endosulfan I				-n-				-n-													-n-	
Endosulfan II				-nn				-nn			nn										-nn	
Endosulfan sulfate				nnn			nnn	nnn				nnn					nnn			nnn	nnn	
Endrin				-nn			-nn	-nn			nn									-nn	-nn	
Endrin aldehyde				nnn				nnn			nnn	nnn										
Endrin ketone				nnn			nnn	nnn				nnn					nnn			nnn	nnn	
Ethyl benzene		--n						--n								--n						
Fluoranthene				--n		--n	--n	--n		--n		--n	--n	--n		--n	--n		--n		--n	--n
Fluorene																n-n			n-n		n-n	
Gamma chlordane		nn		-nn				-nn				-nn					-nn			-nn	-nn	
Heptachlor epoxide																	-nn					
Hexachloroethane								nnn														
Indeno(1,2,3-cd)pyrene							-nn	-nn		-nn		-nn	-nn	-nn			-nn		-nn		-nn	-nn
Isophorone																						nnn
Methoxychlor				-nn	-nn			-nn				-nn					-nn				-nn	
Methylene chloride		--n	--n			--n	--n	--n				--n		--n	--n	--n	--n			--n	--n	
MCPP		nnn										nnn										
Naphthalene				--n												--n			--n	--n		--n
Octachlorodibenzo -p-dioxin			nnn																			
PCB 1248								nnn														
PCB 1254								nP				nnP										
PCB 1260								-nn			nn											

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Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Phenanthrene							-nn			-nn		-nn	-nn	-nn	-nn	-nn			-nn		-nn	-nn
Phenol				-nn																		
Pyrene				-nn		-nn	-nn	-nn		-nn		-nn	-nn	-nn		-nn	-nn		-nn	-nn	-nn	-nn
Tetrachloroethene								nnn		nnn												
Toluene	--n	--n	--n	--n	--n	--n	--n	--n	--n	--n		--n	--n	--n	--n	--n	--n		--n	--n	--n	--n
Petroleum hydrocarbons (total recoverable)	nnn	nnn	nnn		nnn	nnn	nnn	nnn	nnn	nnn		nnn	nnn	nnn	nnn	nnn	nnn		nnn	nnn	nnn	nnn
TFH-diesel	nnn	nnn	nnn			nnn	nnn	nnn	nnn	nnn		nnn	nnn		nnn		nnn		nnn		nnn	nnn
TFH-gasoline	nnn	nnn	nnn	nnn	nnn	nnn	nnn	nnn	nnn	nnn		nnn	nnn	nnn	nnn	nnn	nnn		nnn	nnn	nnn	nnn
Trichloroethylene		--n																				
Xylenes (total)		nn		-nn			-nn	-nn				-nn				-nn				-nn		
INORGANICS																						
Aluminum	MIP	MIP	MIP	MIP	MIP	MIP	MIP	MIP	MIP	MIP		MIP	MIP	MIP	MIP	MIP	MIP		MIP	MIP	MIP	MIP
Antimony	nnn	nnn		nnn		nnn		nnn					nnn	nnn		nnn	nnn		nnn	nnn		nnn
Arsenic		P	P	P	P	P	P	P	P	P		P	P	P	P	P	P		P	P	P	P
Barium	Mnn	Mnn	Mnn	Mnn	Mnn	Mnn	Mnn	Mnn	Mnn	Mnn		Mnn	Mnn	Mnn	Mnn	Mnn	Mnn		Mnn	Mnn	Mnn	Mnn
Beryllium		-n-	-n-	-n-	-n-	-n-	-n-	-n-		-n-		-n-	-n-	-n-	-n-	-n-	-n-		-n-	n-	-n-	-n-
Cadmium		M	M	MIP	M	MP	M	MIP	M	M		MP	M	MP	M	M	MP		M	MP	M	M
Chromium		MP	MP	MP	MP	MIP	MP	MIP	MP	MP		MP	MP	MP	MP	MP	MIP		MP	MP	MP	MP
Cobalt	M	M	M	M	M	M	MP	M	M	M		M	M	M	M	M	M		MP	MP	M	M
Copper								MIP								P	P			MIP		
Lead	M	MI	MIP	MIP	MIP	MIP	MIP	MIP	MIP	IM		MIP	MIP	MIP	MIP	MIP	MIP		M	MIP	IMP	IMP
Manganese	-nn	-nn	-nn	-nn	-nn	-nn	-nn	-nn	-nn	-nn		-nn	-nn	-nn	-nn	-nn	-nn		-nn	-nn	-nn	-nn

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MCAS El Toro Phase I RI Technical Memorandum

Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Mercury	Mn	M	M	M	M	M	M	MIP		M		MP	M	MP	M	M	M		M	M	M	M
Nickel								MP				MP					MIP			P		
Selenium	nnn	nnn			nnn	nnn	nnn	nnn	nnn	nnn		nnn	nnn	nnn	nnn	nnn	nnn		nnn	nnn	nnn	nnn
Silver		-n	-n	-n	-n	-n		-nP		-n		-nP	-n	-nP	-n	-n	-n		-n	-n		
Thallium		nn	nn	nn	nn	nn	nn	nn	nn	nn		nn	nn	nn	nn	nn	nn		nn	nn	nn	nn
Vanadium	M	MP	MP	MP	MP	MP	MP	MP	MP	MP		MIP	MP	MP	MP	MP	M		MP	MP	MP	MP
Zinc				IP		I	I	MIP				IP		I		I	I			MIP	I	

Notes: (blank means chemical not detected or did not exceed criteria)

M Mammalian soil ingestion dose exceeded acceptable ingestion dose for a rat (Appendix H3).
I Invertebrate criteria were exceeded by maximum soil concentration (Table 7-29).
P Plant criteria were exceeded by maximum soil concentration (Table 7-30).
n no toxicity values available for mammals, invertebrate, plants (e.g., --n means not criteria for plant toxicity).

Source: Jacobs Engineering, 1993a.

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Table A-2

MCAS El Toro Chemicals of Potential Ecological Concern in Sediment
Comparison to Sediment Criteria
MCAS El Toro Phase I RI Technical Memorandum

Chemical	Site Number[a]																		
							18[b]												
							Borrego Canyon	Agua Chinon		Bee Canyon		Marshburn Channel		San Diego Creek					
	2	3	4	6	12	14	Dn[c]	Up[d]	Dn[c]	Up[d]	Dn[c]	Up[d]	Dn[c]	Up[d]	AC[e]	BC[f]	MC[g]	20	21
ORGANICS																			
2,4,5-Trichlorophenoxy proprionic acid	--	--	--	--	--	--	--	--	--	--	--	--	C/C	--	--	--	--	--	--
2,4-DB	C/C	--	--	--	--	--	--	C/C	--	--	--	--	C/C	--	--	--	--	--	--
2-Butanone	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	C/C	--	--	--
2-Hexanone		C/C																	
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N/C
4,4'-DDD	--	N/N	--	--	Y/Y	--	--	--	--	--	--	--	--	--	--	--	--	--	Y/Y
4,4'-DDE	--	N/E	--	--	Y/Y	--	--	--	--	Y/Y	--	Y/Y	N/Y	--	--	--	--	--	Y/Y
4',4'-DDT	Y/N	Y/Y	--	--	Y/Y	--	--	--	--	Y/Y	--	Y/Y	Y/Y	--	--	N/N	--	--	Y/Y
4-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	C/C	C/C	--	--
Acenaphthene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N/C
Acenaphthylene[h]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N/C
Acetone	C/C	C/C	C/C	--	C/C	C/C		C/C		C/C	--	C/C		C/C	C/C	--	--	C/C	C/C
Alpha chlordane	N/N	--	--	--	N/N	--	--	--	--	--	--	--	--	--	--	--	--	--	N/Y
Anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N/C
Benzene	C/C																		
Benzo(a)anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N/C
Benzo(a)pyrene	--	--	--	--	N/N	--	--	--	--	--	--	--	--	--	--	--	--	--	N/C
Benzo(b)fluoranthene	--	--	--	--	N/C	--	--	--	--	--	--	--	--	--	--	--	--	--	N/C

Table A-2

MCAS El Toro Chemicals of Potential Ecological Concern in Sediment
Comparison to Sediment Criteria
MCAS El Toro Phase I RI Technical Memorandum

Chemical	Site Number[a]																		
							18[b]												
							Borrego Canyon	Agua Chinon		Bee Canyon		Marshburn Channel		San Diego Creek					
	2	3	4	6	12	14	Dn[c]	Up[d]	Dn[c]	Up[d]	Dn[c]	Up[d]	Dn[c]	Up[d]	AC[e]	BC[f]	MC[g]	20	21
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N/C
Benzo(k)fluoranthene	--	--	--	--	N/N	--	--	--	--	--	--	--	--	--	--	--	--	--	N/C
Benzyl butyl phthalate	Y/C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N/C
Bis(2-ethylhexyl) phthalate	Y/C	Y/C	--	Y/C	Y/C	Y/C	--	--	--	--	Y/C	--	--	--	--	--	--	Y/C	Y/C
Carbazole	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	C/C
Carbon tetrachloride	C/C	--	--	--	C/C	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chrysene	--	--	--	--	N/C	--	--	--	--	--	--	--	--	--	--	--	--	--	N/C
Dalapon	--	--	--	--	C/C	--	--	--	--	--	--	--	--	--	C/C	--	--	--	--
Delta BHC	--	--	--	--	--	--	--	--	--	--	--	E/C	--	--	--	--	--	--	--
Dibenzo(a,h) anthracene	--	--	--	--	N/C	--	--	--	--	--	--	--	--	--	--	--	--	--	N/C
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	C/C
Dichloroprop	--	--	--	--	--	--	--	--	--	--	C/C	--	C/C	C/C	--	--	--	--	--
Dieldrin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	N/N
Endosulfan sulfate	--	--	--	--	N/C	--	--	--	--	--	--	Y/C	--	--	--	--	--	--	--
Fluoranthene	--	--	--	--	N/C	N/C	--	--	--	--	--	--	--	--	--	--	--	--	N/C
Fluorene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	C/C
Gamma chlordane	N/N	--	--	--	N/N	--	--	--	--	--	--	--	--	--	--	--	--	--	N/E
Indeno(1,2,3-cd)pyrene	--	--	--	--	N/C	N/C	--	--	--	--	--	--	--	--	--	--	--	--	N/C

Table A-2

MCAS El Toro Chemicals of Potential Ecological Concern in Sediment
Comparison to Sediment Criteria
MCAS El Toro Phase I RI Technical Memorandum

Chemical	Site Number[a]																		
							18[b]												
							Borrego Canyon	Agua Chinon		Bee Canyon		Marshburn Channel		San Diego Creek					
	2	3	4	6	12	14	Dn[c]	Up[d]	Dn[c]	Up[d]	Dn[c]	Up[d]	Dn[c]	Up[d]	AC[e]	BC[f]	MC[g]	20	21
MCPP	C/C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methoxychlor																			C/C
Methylene chloride	N/C	--	--	N/C	N/C	--	--	N/C	--	N/C	--	N/C	N/C	--	--	--	--	N/C	N/C
Petroleum Hydrocarbons (total recoverable)	C/C	C/C	--	C/C	C/C	C/C	--	--	--	--	--	--	C/C	--	--	--	--	C/C	C/C
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Y/C
Pyrene	--	--	--	--	N/C	N/C	--	--	--	--	--	--	--	--	--	--	--	--	N/C
Toluene	N/C	N/C	--	N/C	N/C	--	--	--	--	--	--	--	--	--	--	--	--	--	N/C
Trichloroethylene	C/C																		
TFH-diesel	--	C/C	--	C/C	C/C	C/C	--	--	--	--	--	--	--	--	--	--	--	C/C	C/C
TFH-gasoline	C/C	C/C	--	C/C	C/C	C/C	--	--	C/C	--	--	C/C	--	--	--	C/C	--	C/C	C/C
INORGANICS																			
Aluminum	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C
Antimony	C/C	--	C/C	--	--	--	--	--	--	--	--	--	--	--	--	C/C	C/C	C/C	--
Arsenic	C/N	C/N	C/N	C/N	C/Y	C/N	--	C/N	C/N	C/Y	C/N	C/N	C/N	--	C/N	C/N	C/N	C/Y	C/Y
Barium	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C
Beryllium	C/C	C/C	--	--	--	--	--	--	--	C/C	--	--	--	--	--	--	--	--	--
Cadmium[i]	C/Y	C/Y	C/Y	C/Y	C/Y	C/Y	--	C/E	C/N	C/Y	C/N	C/Y	C/E	C/N	--	C/Y	C/Y	C/Y	C/Y
Chromium[i]	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/Y	C/N
Cobalt	C/C	C/C	C/C	C/C	C/C	C/C	--	C/C	C/C	C/C	C/C	C/C	C/C	--	C/C	C/C	C/C	C/C	C/C

Table A-2

MCAS El Toro Chemicals of Potential Ecological Concern in Sediment
Comparison to Sediment Criteria
MCAS El Toro Phase I RI Technical Memorandum

Sheet 4 of 5

Chemical	Site Number[a]																		
							18[b]												
							Borrego Canyon	Agua Chinon		Bee Canyon		Marshburn Channel		San Diego Creek					
	2	3	4	6	12	14	Dn[c]	Up[d]	Dn[c]	Up[d]	Dn[c]	Up[d]	Dn[c]	Up[d]	AC[e]	BC[f]	MC[g]	20	21
Copper[i]	C/N	C/N	C/Y	C/N	C/N	C/N	--	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/Y	C/Y
Lead[i]	C/N	C/N	C/Y	C/Y	C/Y	C/N	--	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/Y	C/Y
Manganese	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/Y
Mercury	--	--	C/E	--	C/Y	C/Y	C/Y	--	C/Y	--	C/Y	--	C/Y	C/Y	C/Y	--	C/Y	--	C/Y
Nickel[i]	C/N	C/N	C/N	C/N	C/N	C/N	--	C/N	C/N	C/N	C/N	C/N	C/N	--	C/N	C/N	C/N	C/Y	C/N
Selenium	C/C	--	--	--	--	--	--	--	--	C/C	--	--	C/C	--	--	C/C	--	C/C	C/C
Silver	--	--	C/C	C/C	C/C	--	--	--	--	C/C	--	--	--	--	--	--	C/C	--	--
Thallium[h]	C/C	--	--	--	C/C	--	--	--	--	C/C	--	C/C	C/C	--	--	C/C	--	--	C/C
Vanadium	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C	--

Table A-2

MCAS El Toro Chemicals of Potential Ecological Concern in Sediment
Comparison to Sediment Criteria
MCAS El Toro Phase I RI Technical Memorandum

Chemical	Site Number[a]																		
							18[b]												
							Borrego Canyon	Agua Chinon		Bee Canyon		Marshburn Channel		San Diego Creek					
	2	3	4	6	12	14	Dn[c]	Up[d]	Dn[c]	Up[d]	Dn[c]	Up[d]	Dn[c]	Up[d]	AC[e]	BC[f]	MC[g]	20	21
Zinc[i]	C/N	C/N	C/Y	C/N	C/Y	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/N	C/Y	C/Y

Notes:

[a]Sediment samples were not taken at Sites 1, 5, 7, 8, 9, 10, 11, 13, 15, 16, 17, 19, and 22.
[b]Maximum concentration used in comparison taken from the 4/2 database. All other sites used maximums reported in the 3/29 database.
[c]Dn=Downstream sampling station.
[d]Up=Upstream sampling station.
[e]AC=Confluence of Agua Chinon Wash and San Diego Creek.
[f]BC=Confluence of Bee Canyon Wash and San Diego Creek.
[g]MC=Confluence of Marshburn Channel and San Diego Creek.
[h]Data insufficient to develop criteria. Value used in comparison was a LOEL.
[i]Criteria used in comparison is hardness dependent.

_/_ Maximum concentration compared to EqP based criteria/maximum concentration compared to LEL criteria.

Y=Maximum concentration exceeds sediment criteria.
N=Maximum concentration does not exceed sediment criteria.
E=Maximum concentration equal sediment criteria (within 0.5).
C=Sediment criteria not available for chemical.

Source: Jacobs Engineering, 1993a.

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Table A-3

MCAS El Toro Chemicals of Potential Concern
In Surface Water Runoff
Comparison to Water Quality Criteria
MCAS El Toro Phase I RI Technical Memorandum

Chemical	Site Number[a]												
			18[b]										
			Borrego Canyon	Agua Chinon		Bee Canyon		Marshburn Channel		San Diego Creek			
	2	3	Dn[c]	Up[d]	Dn[c]	Up[d]	Dn[c]	Up[d]	Dn[c]	Up[d]	AC[e]	BC[f]	MC[g]
ORGANICS													
1,1,1-Trichloroethane	--	--	--	--	--	--	--	--	--	--	--	--	N
2-Butanone	--	--	--	--	NA	--	--	--	--	--	--	--	--
4,4'-DDE	--	--	--	--	--	--	--	--	Y	--	--	--	--
4,4'-DDT	--	--	--	--	--	--	--	Y	--	--	--	--	--
4-Nitrophenol	--	--	--	--	N,I	--	N,I	--	--	--	--	--	--
Acetone	NA	NA	--	--	--	--	NA	NA	--	NA	--	--	--
Benzyl butyl phthalate	--	--	--	--	E,I	--	--	--	--	--	--	--	E,I
Beta-BHC	--	--	--	N,I	Y	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	N	--	--	N	--	N	--	--	--	--	--	--
Chloroform	--	--	--	N,I	--	--	--	N,I	--	--	--	--	--
Delta-BHC	--	--	--	--	N,I	--	--	--	N,I	--	--	--	--
Endosulfan sulfate	--	--	--	--	--	--	--	Y	--	--	--	--	--
Gamma Chlordane	--	--	--	--	--	Y	--	--	E	--	--	Y	--
Methyl chloride	--	--	N	N	N	N	--	N	--	--	N	N	N
Methylene chloride	--	N	--	--	--	--	--	N	--	--	--	--	--
TFH - diesel	NA	NA	--	NA	--	--	NA	--	--	--	--	--	--
Toluene	--	--	--	--	--	--	--	N	--	--	--	--	--

Table A-3

MCAS El Toro Chemicals of Potential Concern
In Surface Water Runoff
Comparison to Water Quality Criteria
MCAS El Toro Phase I RI Technical Memorandum

Chemical	Site Number[a]												
	2	3	18[b]										
			Borrego Canyon	Agua Chinon		Bee Canyon		Marshburn Channel		San Diego Creek			
INORGANICS													
Aluminum	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Antimony	N	N	N	N	N	N	--	N	N	N	N	N	N
Arsenic	N	N	N	N	N	N	N	N	N	N	N	N	N
Barium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	Y,I	E,I	Y,I	N,I	N,I	Y,I	N,I	E,I	N,I	N,I	Y,I	N,I	N,I
Cadmium	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h
Chromium	N,h	N,h	N,h	N,h	N,h	N,h	N,h	N,h	N,h	N,h	N,h	N,h	N,h
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h
Cyanide	--	NA	--	--	NA	--	NA	NA	NA	NA	--	NA	--
Lead	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h	Y,h
Manganese	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	Y	Y	Y	Y	Y	NA	Y	Y	Y	Y	Y	NA
Nickel	N,h	N,h	N,h	N,h	N,h	N,h	N,h	N,h	N,h	N,h	N,h	N,h	N,h
Selenium	Y	Y	N	--	N	--	--	--	--	N	--	N	--
Silver	--	--	--	--	Y	--	--	--	--	--	--	--	--
Thallium	N,I	--	--	--	N,I	--	--	N,I	--	--	N,I	N,I	--
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A-3

MCAS El Toro Chemicals of Potential Concern
In Surface Water Runoff
Comparison to Water Quality Criteria
MCAS El Toro Phase I RI Technical Memorandum

Chemical	Site Number[a]												
	2	3	18[b]										
			Borrego Canyon	Agua Chinon		Bee Canyon		Marshburn Channel		San Diego Creek			
Zinc	Y,h	Y,h	Y,h	Y,h	N,h	Y,h	Y,h	Y,h	N,h	N,h	Y,h	N,h	Y,h

Notes:

[a]Surface runoff samples were collected at Sites 2, 3, and 18 only.
[b]Maximum detected concentrations for Site 18 taken from the 4/2/93 database. Maximums for all other sites taken from the 3/29/93 database.
[c]Dn = Downstream sampling station.
[d]Up = Upstream sampling station.
[e]AC = Confluence of Agua Chinon Wash with San Diego Creek.
[f]BC = Confluence of Bee Canyon Wash with San Diego Creek.
[g]MC = Confluence of Marshburn Channel with San Diego Creek.

Y = Maximum detected concentration exceeds criteria
N = Maximum detected concentration did not exceed water quality criteria.
E = Maximum detected concentration within 0.05 ug/L of the water quality criteria.
h = Water quality criterion is based on water hardness.
l = Water quality criterion could not be developed; comparison value used was a LOEL.

NA = Water quality criteria not available.
-- Chemical not detected at site.

Source: Jacobs Engineering, 1993a.

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Table A-4

Ecological Risk Screening Criteria-Surface Soil
MCAS El Toro Phase II RI Work Plan

Chemical	Vertebrates		Bioaccumulation: soil - earthworms - birds (mg/kg)	Invertebrates[a] (mg/kg)	Plants[a] (mg/kg)
	Dose[a,b] (mg/kg-bw/day)	Calculated Criteria[c] (mg/kg)			
Organics:					
1,1,1-Trichloroethane	500	6,700	nc	–	–
1,2-Dichloroethene (total)	17 (mouse)	142	nc	–	–
2,4,5-Trichlorophenoxy proprionic acid	–	–	nc	–	–
2,4,5-T	–	–	nc	–	–
2,4-D	–	–	nc	–	–
2,4-DB	–	–	nc	–	–
2,4-Dimethylphenol	–	–	nc	–	–
2-Butanone	173	2,306	nc	–	–
2-Hexanone	–	–	nc	–	–
2-Methylnaphthalene	–	–	nc	–	–
4',4-DDD	–	–	0.35	–	–
4',4-DDE	–	–	0.028	–	–
4',4-DDT	113	1,506	0.5	3	12.5
4-Methyl-2-pentanone	–	–	nc	–	–
4-Methylphenol	–	–	nc	–	–
Acenaphthene	–	–	nc	–	25
Acenaphthylene	–	–	nc	–	–
Acetone	9,750	130,000	nc	–	–
Aldrin	67	893	nc	–	12.5
Anthracene	3,300	44,000	nc	–	–
Benzene	17.65	235	nc	–	–
Benzo(a)anthracene	2	26	nc	–	–
Benzo(a)pyrene	50	667	nc	–	0.01
Benzo(b)fluoranthene	40	533	nc	–	–
Benzo(g,h,i)perylene	–	–	nc	–	–
Benzo(k)fluoranthene	72	960	nc	–	–

Table A-4

Ecological Risk Screening Criteria-Surface Soil
MCAS El Toro Phase II RI Work Plan

Chemical	Vertebrates		Bioaccumulation : soil - earthworms - birds (mg/kg)	Invertebrates[a] (mg/kg)	Plants[a] (mg/kg)
	Dose[a,b] (mg/kg-bw/day)	Calculated Criteria[c] (mg/kg)			
Benzo(k)fluoranthene	72	960	nc	–	–
Benzylbutyl phthalate	–	–	nc	–	–
BHC-alpha	–	–	nc	–	–
BHC-beta	–	–	nc	–	–
BHC-delta	–	–	nc	–	12.5
BHC-gamma	–	–	nc	–	–
di-n-Butylphthalate	8,000	106,600	nc	–	–
Carbazole	–	–	nc	–	–
Carbon disulfide	11	142	nc	–	–
Carbon tetrachloride	–	–	nc	–	–
Chlordane-alpha	457	6,093	0.1	19.2	–
Chlordane-beta	–	–	nc	–	–
Chlordane-gamma	457	6,093	nc	–	–
Chrysene	99	1,320	nc	–	–
Dalapon	15	200	nc	–	–
Dibenzofuran	1	13	nc	–	–
Dichloroprop	–	–	nc	–	–
Dieldrin	46	613	0.038	25	0.51
Diethylphthalate	–	–	nc	–	–
Dimethylphthalate	7,200 (mouse)	60,000	nc	–	–
Endosulfan I	2	26.7	nc	–	1,000
Endosulfan II	200 (mallard)	2,000	nc	–	–
Endosulfan sulfate	–	–	nc	–	–
Endrin	7.5	100	nc	–	–
Endrin aldehyde	–	–	nc	–	–
Endrin ketone	–	–	nc	–	–

Table A-4

Ecological Risk Screening Criteria-Surface Soil
MCAS El Toro Phase II RI Work Plan

Chemical	Vertebrates		Bioaccumulation : soil - earthworms - birds (mg/kg)	Invertebrates[a] (mg/kg)	Plants[a] (mg/kg)
	Dose[a,b] (mg/kg-bw/day)	Calculated Criteria[c] (mg/kg)			
Ethylbenzene	97.1	1,295	nc	–	–
bis(2-Ethylhexyl)phthalate	65	867	nc	–	–
Fluoranthene	125 (mouse)	1,042	nc	–	–
Fluorene	–	–	nc	173	–
Heptachlor epoxide	0.25	3.3	nc	–	–
Hexachloroethane	–	–	nc	–	–
Indeno(1,2,3-cd)pyrene	72	960	nc	–	–
Isophorone	–	–	nc	–	–
MCPP	–	–	nc	–	–
Methoxychlor	2,000 (mallard)	20,000	nc	–	–
Methylene chloride	5.85	78	nc	–	–
Naphthalene	41	547	nc	–	100
Octachlorodibenzo-p-dioxin	–	–	nc	–	–
PCB 1248	–	–	nc	–	–
PCB 1254	5	67	nc	–	1
PCB 1260	841	11,213	nc	–	–
Petroleum hydrocarbons (total recoverable)	–	–	nc	–	–
Phenanthrene	10 (mouse)	83	nc	–	–
Phenol	60	800	nc	–	–
Pyrene	125 (mouse)	1,042	nc	–	–
Tetrachloroethene	–	–	nc	–	–
TFH diesel	–	–	nc	–	–
TFH gasoline	–	–	nc	–	–
Toluene	223	2,970	nc	–	1000
Trichloroethylene	17.9 (mouse)	149	nc	–	–

Table A-4

Ecological Risk Screening Criteria-Surface Soil
MCAS El Toro Phase II RI Work Plan

Chemical	Vertebrates		Bioaccumulation : soil - earthworms - birds (mg/kg)	Invertebrates[a] (mg/kg)	Plants[a] (mg/kg)
	Dose[a,b] (mg/kg-bw/day)	Calculated Criteria[c] (mg/kg)			
Xylene	179	2,390	nc	--	1000
Inorganics:					
Aluminum	14	187	nc	2500	0.1
Antimony	--	--	nc	--	5
Arsenic	6.4	85	4.8	230	2
Barium	0.25	3.3	nc	--	--
Beryllium	0.54	7.2	nc	--	10
Cadmium	0.004	0.05	0.01	0.2	3
Chromium	0.46	6.1	nc	100	50
Cobalt	0.05	0.67	nc	82.5	20
Copper	12.5	167	nc	2.7	23
Lead	0.45	6	28	15	20
Manganese	930	12,400	nc	--	1500
Mercury	0.003	0.04	0.05	10	0.3
Nickel	5	66.7	nc	500	20
Selenium	--	--	nc	--	--
Silver	181.2	2,416	nc	--	--

Table A-4

Ecological Risk Screening Criteria-Surface Soil
MCAS El Toro Phase II RI Work Plan

Chemical	Vertebrates		Bioaccumulation : soil - earthworms - birds (mg/kg)	Invertebrates[a] (mg/kg)	Plants[a] (mg/kg)
	Dose[a,b] (mg/kg-bw/day)	Calculated Criteria[c] (mg/kg)			
Thallium	–	–	nc	–	1
Vanadium	0.7	9.3	nc	500	50
Zinc	98.3	1,310	3	662	70

Notes:
– = Not available.
nc = Not calculated because chemical does not significantly bioaccumulate.
[a]Sources for ecological risk criteria for vertebrates, invertebrates, and plants is presented in the Phase I tech memo.
[b]Toxicity dose is for rats unless otherwise specified.
[c]Vertebrate criteria were calculated using the following equation:

$$\text{Criteria} = \frac{TV \times BW}{IR \times CF}$$

where:
TV: toxicity value or dose (mg/kg bw/day)
BW: test animal body weight (kg bw)
IR: test animal ingestion rate (mg/day)
CF: soil conversion factor (1 x 10-6 kg/mg)

Body weights used for calculations are: rat (0.2 kg), mouse (0.025 kg), and mallard (0.2.5 kg).
Ingestion rates used for calculations are: rat (15,000 mg/day), mouse (3,000 mg/day), and mallard (250,000 mg/day).

Source: Jacobs Engineering, 1993b.

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Table A-5

Ecological Risk Screening Criteria-Surface Water
MCAS El Toro Phase II RI Work Plan

Chemical	EPA or State Water Quality Criteria[a]	
	Acute[b]	Chronic[b]
Organics: (µg/l)		
1,1,1-Trichloroethane	--	18,000
2-Butanone	--	--
2-Methylnaphthalene	--	--
4',4-DDE	1050	0.001
4',4-DDT	1.1	0.001
4-Nitrophenol	--	150
Acetone	--	--
Benzylbutyl phthalate	--	3
BHC-beta	--	0.08
BHC-delta	--	0.08
Carbon disulfide	--	--
Carbon tetrachloride	--	--
Chlordane-gamma	2.4	0.0043
Chlorodibromomethane	--	--
Chloroform	28,900	1,240
Endosulfan sulfate	--	0.056
bis(2-Ethylhexyl)phthalate	400	360
Methyl chloride	--	11,000
Methylene chloride	--	11,000
TFH-diesel	--	--
Toluene	--	17,500
Inorganics: (mg/l)		
Aluminum	750	87
Antimony	88	30
Arsenic	360	190
Barium	--	--
Beryllium	130	5.3
Cadmium	19/3.9/12	3.6/1.2/2.5

Table A-5

Ecological Risk Screening Criteria-Surface Water
MCAS El Toro Phase II RI Work Plan

Chemical	EPA or State Water Quality Criteria[a]	
	Acute[b]	Chronic[b]
Chromium	5,405/1,737/4,306	694/212/474
Cobalt	--	--
Copper	65/18/47	42/12/28
Cyanide	22	5.2
Lead	477/82/303	20.9/3.3/11.5
Manganese	--	--
Mercury	2.4	0.012
Nickel	4,582/1,420/3,385	550/162/371
Selenium	20	5
Silver	na/na/24	0.12
Thallium	1,400	40
Vanadium	--	--
Zinc	379/117/280	371/109/250
Radionuclides: (pCi/l)		
Gross alpha	--	--
Gross beta	--	--

Notes:
-- = Not available.
[a]Sources for EPA and State Water Quality Criteria are presented in the Phase I technical memorandum.
[b]Criteria that are hardness dependent are listed as follows: site 2/ site 3/ site 25. The hardness for each site in mgCaCO3/l is >400 for site 2, 103 for site 3, and 275 for site 25.

Source: Jacobs Engineering, 1993b.

Table A-6

Ecological Risk Screening Criteria-Sediment
MCAS El Toro Phase II RI Work Plan

Chemical	Sediment Criteria[a]	
	EqP Based[b]	Sediment LEL[c]
Organics: (µg/kg)		
2,4,5-Trichlorophenoxy proprionic acid	--	--
2,4-DB	--	--
2-Butanone	--	--
2-Hexanone	--	--
2-Methylnaphthalene	105,400	--
4',4-DDD	15.4	8
4',4-DDE	88	5
4',4-DDT	4.86	9
4-Methylphenol	--	--
Acenaphthene	2,800	--
Acenaphthylene	31,000	--
Acetone	--	--
Anthracene	173,600	--
Benzene	--	--
Benzo(a)anthracene	17,000,000	--
Benzo(a)pyrene	68,000,000	--
Benzo(b)fluoranthene	6,800,000	--
Benzo(g,h,i)perylene	20,000,000	--
Benzo(k)fluoranthene	6,800,000	--
Benzylbutyl phthalate	1,020	--
BHC-delta	10.6	--
Carbazole	--	--
Carbon tetrachloride	--	--
Chlordane-alpha	12.04	5
Chlordane-gamma	12.04	8
Chrysene	2,480,000	--
Dalapon	--	--
Dibenzo(a,h)anthracene	40,920,000	--

Table A-6

Ecological Risk Screening Criteria-Sediment
MCAS El Toro Phase II RI Work Plan

Chemical	Sediment Criteria[a]	
Dibenzofuran	–	–
Dichloroprop	–	–
Dieldrin	180	19
Endosulfan II	–	–
Endosulfan sulfate	2.63	–
Endrin	–	–
Endrin ketone	–	–
bis(2-Ethylhexyl)phthalate	8.64	–
Fluoranthene	20,400	–
Fluorene	–	–
Indeno(1,2,3-cd)pyrene	20,000,000	–
MCPP	–	–
Methoxychlor	–	–
Methylene chloride	1,936	–
Petroleum hydrocarbons (total)	–	–
Phenanthrene	2,460	–
Pyrene	470,000	–
Toluene	105,000	–
Trichloroethylene	–	–
TFH-diesel	–	–
TFH-gasoline	–	–
Inorganics:(mg/kg)		
Aluminum	–	–
Antimony	–	–
Arsenic	–	5.5
Barium	–	–
Beryllium	–	–
Cadmium	–	1
Chromium	–	31
Cobalt	–	–

Table A-6

Ecological Risk Screening Criteria-Sediment
MCAS El Toro Phase II RI Work Plan

	Sediment Criteria[a]	
Copper Chemical	–	25
Lead	–	31
Manganese	–	457
Mercury	–	0.12
Nickel	–	160
Selenium	–	–
Silver	–	–
Thallium	–	–
Vanadium	–	–
Zinc	–	110

Notes:
– = Not available.
[a]Sources for ecological risk criteria for sediment are presented in the Phase I technical memorandum.
[b]EqP based sediment criteria were calculated as function of TOC (20 g/kg).
[c]Lowest Effect Level used for inorganic comparisons.

Source: Jacobs Engineering, 1993b.

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Table A-7

Results of Background Statistical Analysis - Metals
MCAS El Toro Phase II RI Work Plan

Parameter	Number Stations	Arith. Mean	Estimated Mean	CV	99th Percentile 50% Conf.	Units
Silver	11	.3	.3	.30	.55	MG/KG
Aluminum	11	7212.0	7307.1	.53	25396.26	MG/KG
Arsenic	11	1.9	2.3	2.18	37.61	MG/KG
Barium	11	69.6	70.4	.60	281.01	MG/KG
Beryllium	11	.3	.3	.55	1.20	MG/KG
Calcium	11	8651.6	6645.9	1.28	62164.12	MG/KG
Cadmium	11	1.6	1.5	2.09	23.11	MG/KG
Cobalt	11	3.2	3.6	1.19	31.02	MG/KG
Chromium	11	11.1	11.6	1.45	124.81	MG/KG
Copper	11	7.7	7.9	1.41	82.91	MG/KG
Iron	11	8404.3	8881.8	.88	54001.66	MG/KG
Mercury	11	.1	.1	1.01	.37	MG/KG
Potassium	11	2150.2	2258.5	.92	14399.89	MG/KG
Magnesium	11	3359.5	3377.4	.78	18014.29	MG/KG
Manganese	11	170.4	181.8	.89	1114.98	MG/KG
Sodium	11	228.3	228.8	.38	592.31	MG/KG
Nickel	11	13.1	13.0	2.00	193.61	MG/KG
Lead	11	6.0	6.3	.71	29.91	MG/KG
Antimony	11	1.4	1.4	.26	2.81	MG/KG
Selenium	11	.1	.1	.69	.48	MG/KG
Thallium	11	.2	.2	.53	.60	MG/KG
Vanadium	11	30.4	30.8	1.27	285.55	MG/KG
Zinc	11	31.9	32.3	.81	179.47	MG/KG

Source: Jacobs Engineering, 1993b.

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Table A-8
Wildlife Known to Occur at MCAS El Toro and Habitat Utilization

Common Name	Scientific Name	Special Status	Habitat Annual Grassland	Habitat Coastal Sage Scrub	Habitat Riparian
Amphibians					
Western toad	*Bufo boreas*		X	X	
Pacific treefrog	*Hyla regilla*			X	
Bullfrog	*Rana catesbeiana*			X	
Reptiles					
Western fence lizard	*Sceloporus occidentalis*		X	X	
Side-blotched lizard	*Uta stransburiana*		X	X	
San Diego horned lizard	*Phrynosoma coronatum*	X		X	
Coast horned lizard	*Phrynosoma coronatum*		X	X	
California whipsnake	*Masticophis lateralis*		X		
Gopher snake	*Pituophis melanoleucus*		X	X	
Common kingsnake	*Lampropeltis getulus*		X	X	
Orange-throated whiptail	*Cnemidophorus hyperrythus*	X		X	
Rosy boa	*Lichanura trivirgata*			X	
Western blind snake	*Leptotyphlops humilis*			X	
Western skink	*Eumeces skiltonianus*			X	
Western rattlesnake	*Crotalus viridis*		X	X	
Birds					
Western screech owl	*Otus kennicottii*			X	
Great horned owl	*Bubo virginianus*			X	
Rufous-sided towhee	*Pipilo erythrophthalmus*			X	
Turkey vulture	*Cathartes aura*		X		
Black-shouldered kite	*Elanus caeruleus*		X		
Northern harrier	*Circus cyaneus*	X	X		
Cooper's hawk	*Accipiter cooperii*	X	X	X	
Red-shouldered hawk	*Buteo lineatus*		X		
Red-tailed hawk	*Buteo jamaicensis*		X	X	X
Golden eagle	*Aquila chrysaetos*	X	X		
Common raven	*Corvus corax*				X
Black-headed grosbeak	*Pheucticus melanocephalus*			X	

(table continues)

Table A-8 (continued)

Common Name	Scientific Name	Special Status	Habitat Annual Grassland	Habitat Coastal Sage Scrub	Habitat Riparian
Birds (continued)					
Plain titmouse	*Parus inornatus*				X
California quail	*Callipepla californica*		X	X	X
Bushtit	*Psaltriparas minimus*				X
Mourning dove	*Zenaida macroura*		X	X	
Greater roadrunner	*Geococcyx californianus*		X	X	
Common barn owl	*Tyto alba*		X	X	
Anna's hummingbird	*Calypte anna*			X	
Say's phoebe	*Sayornis saya*			X	
Black phoebe	*Sayornis nigricans*				X
Hermit thrush	*Catharus guttatus*			X	
California gnatcatcher	*Polioptila californica*	X		X	
Ash-throated flycatcher	*Myiarchus cinerascens*			X	
Horned lark	*Eremophila alpestris*	X	X		
Cactus wren	*Camopylorhynchus brunneicapillus*	X		X	
Northern mockingbird	*Mimus polyglottos*		X	X	
Loggerhead shrike	*Lanius ludovicianus*	X	X	X	
California towhee	*Pipilo fuscus*			X	
Black-chinned sparrow	*Spizella atrogularis*			X	
Sage sparrow	*Amphispiza belli*	X		X	
Rufous-crowned sparrow	*Aimophila ruficeps*		X		
White-crowned sparrow	*Zonotrichia leucophrys*			X	
Lark sparrow	*Chondestes grammacus*		X		
Grasshopper sparrow	*Ammooramus savannarum*		X		
Western meadowlark	*Sturnella neglecta*		X	X	
Mallard	*Anas platyrhynchos*			X	
Lesser goldfinch	*Carduelis psaltria*				X
Mammals					
Pallid bat	*Antrozous pallidus*	X		X	
Brush rabbit	*Sylvilagus bachmani*			X	X
Desert cottontail	*Sylvilagus audubonii*			X	

(table continues)

Table A-8 (continued)

Common Name	Scientific Name	Special Status	Annual Grassland	Habitat Coastal Sage Scrub	Riparian
Mammals (continued)					
Black-tailed hare	*Lepus californicus*	X	X	X	
Racoon	*Procyon lotor*			X	
California ground squirrel	*Spermophilus beecheyi*		X		
Southwestern pocket gopher	*Thomomys bottae*			X	X
Pacific kangaroo rat	*Dipodomys agilis*			X	
California pocket mouse	*Chaetodipus californicus*		X	X	
Little pocket mouse	*Perognathus longimembris*	X		X	
San Diego pocket mouse	*Chaetodipus fallax*	X		X	
Western harvest mouse	*Reithrodontomys megalotis*		X		
Deer mouse	*Peromyscus maniculatus*		X	X	
Cactus mouse	*Peromyscus eremicus*			X	
California mouse	*Peromyscus californicus*			X	
Dusky-footed woodrat	*Neotoma fuscipes*		X		
California vole	*Microtus californicus*		X		
Coyote	*Canis latrans*		X	X	X
Gray fox	*Urocyon cinereoargenteus*			X	
Striped skunk	*Mephitis mephitis*			X	

Source: Jacobs Engineering 1993a,b

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Table A-9
Plant Species Known to Occur at MCAS El Toro

Common Name	Scientific Name	LOCATION Base Area	Conservation Area	Special Status
Nongrasses				
Pigweed	*Amaranthus* sp.	X		
Scarlet pimpernel	*Anagallis arvensis*	X		
California sage	*Artemesia californica*		X	
Mulefat	*Baccharis salicifolia*		X	
Black mustard	*Brassica nigra*	X	X	
False flax	*Camelina microcarpa*	X	X	
Purple owl's clover	*Castilleja* sp.		X	
Star thistle	*Centaura calcitrapa*	X	X	
Spurge	*Chamaesyce prostrata*	X		
Pineapple weed	*Chamomilla suaveolens*	X		
Chrysanthemum	*Chrysanthemum coronarium*		X	
Summer holly	*Comarostaphyllis diversifolia* ssp. *diversifolia*		X	X
Bindweed	*Convolvulus arvensis*	X		
Horseweed	*Conyza canadensis*	X	X	
San Fernando Valley spineflower	*Corizanthe parryi* ssp. *fernandina*		X	X
Parry's spineflower	*Corizanthe parryi ssp. parryi*		X	X
Cryptantha	*Cryptantha* sp.		X	
Calabazilla	*Cucurbita foetidissima*		X	
Coyote melon	*Curcubita palmata*		X	
Cuscuta	*Cuscuta californica*		X	
Artichoke thistle	*Cynara cardunculus*		X	
Jimsonweed	*Datura wrightii*		X	
Tansy mustard	*Descurania* sp.		X	
Blochman's dudleya	*Dudleya blochmaniae* ssp. *blochmaniae*		X	X
Many-stemmed dudleya	*Dudleya multicaulis*		X	X
Laguna Beach live-forever	*Dudleya stolonifera*		X	X
Sticky-leaved dudleya	*Dudleya viscida*		X	X
Encelia	*Encelia californica*		X	
Dove weed	*Eremocarpus setigerus*		X	
California buckwheat	*Eriogonum fasciculatum*		X	
Filaree	*Erodium botrys*	X	X	
Red-stemmed filaree	*Erodium cicutarium*		X	
Eucalyptus	*Eucalyptus* sp.	X	X	
Spurge	*Euphorbia* sp.	X		

(table continues)

Table A-9 (continued)

Common Name	Scientific Name	LOCATION Base Area	Conservation Area	Special Status
Everlasting	*Gnaphalium californicum*		X	
Cudweed	*Gnaphalium luteo-album*	X	X	
Palmer's grappling hook	*Harpagonella palmeri*		X	X
Southern spikeweed	*Hemizonia australis*		X	X
Los Angeles sunflower	*Helianthus nuttallii* ssp. *parishii*		X	X
Toyon	*Heteromeles arbutifolia*		X	
Telegraphweed	*Heterotheca grandiflora*	X	X	
Hawkweed	*Hieracium* sp.	X		
Prickly lettuce	*Lactuca serriola*	X		
Heart-leaved pitcher sage	*Lepechinia cardiophylla*		X	X
Scale broom	*Lepidospartum squamatum*		X	
Humbolt's tiger lily	*Lilium humboltii* spp. *ocellatum*		X	X
Deer weed	*Lotus scoparius*	X	X	
Miniature lupine	*Lupinus bicolor*		X	
Arroyo lupine	*Lupinus succulentus*		X	
Mallow	*Malacothamus fasciculatus*		X	
Little mallow	*Malva parviflora*	X	X	
Sourclover	*Melilotus indica*		X	
Monkey flower	*Mimulus aurantiacus*		X	
Gray mondardella	*Monardella cinerea*		X	X
Oleander	*Nerium* sp.	X		
Tree tobacco	*Nicotina glabra*		X	
Cactus	*Opuntia basilaris*		X	
Gairdner's yampah	*Perideridia gairdneri* ssp. *gairdneri*		X	X
Santiago Peak phacelia	*Phacelia suaveolens* ssp. *keckii*		X	X
Date palm	*Phoenix dactylifera*	X		
Bristly ox-tongue	*Picris echioides*	X	X	
Pine	*Pinus* sp.	X		
Western sycamore	*Plantanus racemosa*		X	
Knotweed	*Polygonum* sp.		X	
Coast live oak	*Quercus agrifolia*		X	
Wild raddish	*Raphanus sativus*	X	X	
Laurel sumac	*Rhus laurina*		X	
Castor bean	*Ricinus communis*	X	X	
Black willow	*Salix goodingii*		X	
Arroyo willow	*Salix lasiolepis*		X	
Russian thistle	*Salsola tragus*	X	X	
Black sage	*Salvia mellifera*		X	

(table continues)

Table A-9 (continued)

Common Name	Scientific Name	LOCATION Base Area	Conservation Area	Special Status
Blue elderberry	*Sambucus mexicana*		X	
Brazillian pepper tree	*Schinus terebinthifolius*	X		
Groundsel	*Senecio vulgaris*	X		
Nightshade	*Solanum* sp.	X	X	
Prickly sow thistle	*Sonchus asper*	X	X	
San Diego button bush	*Tetracoccus dioicus*		X	X
Poison oak	*Toxicodendron diversilobum*		X	
Vinegar weed	*Trichostema lancelatum*		X	
Vetch	*Vicia* sp.		X	
Fan palm	*Washingtonia filifera*	X		
Grasses				
Slender wild oat	*Avena barbata*	X	X	
Ripgut	*Bromus diandrus*	X	X	
Smooth brome	*Bromus hordeaceus*	X		
Red brome	*Bromus madritensis* ssp. *rubens*	X	X	
Soft chess	*Bromus mollis*		X	
Brome	*Bromus secalinus*	X		
Bermuda grass	*Cynodon dactylon*	X		
Wild rye	*Elymus* sp.		X	
Foxtail	*Hordeum marinum* ssp. *leporium*	X	X	
Common barley	*Hordeum vulgare*		X	
Italian rye grass	*Lolium multiflorum*	X		
Chaparral beargrass	*Nolina cismontana*		X	X
Dallis grass	*Paspalum dilatatum*	X		
Pennisetum	*Pennisetum setaceum*	X		
Mediterranean grass	*Schismus barbatus*	X	X	
Purple needlegrass	*Stipa pulchra*		X	
Vulpia	*Vulpia myuros*	X	X	

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Table A-10

Chemicals Detected at El Toro: Bioconcentration Factors
MCAS El Toro Phase I RI Technical Memorandum

Chemical	BCF	Exposure Duration	Species	BCF Source
ORGANICS:				
1,1,1-Trichloroethane	8.9	28 days	Bluegill sunfish (Lepomis macrochirus)	xx
1,2-Dichloroethene (total)	15 (cis) 22 (trans)		Calculated Calculated	xx xx
2,4,5-Trichlorophenoxy propnonic acid				
2,4-DB				
2,4-D				
2,4,5-T				
2,4-Dimethyl phenol	15.1	28 days	Bluegill sunfish (Lepomis macrochirus)	w
2-Butanone	1			mm
2-Hexanone				
2-Methylnaphthalene				
4,4'-DDD	2720 4460		Alga Snail	rr rr
4,4'-DDE	59,000 59,000 51,000 25,000	 32 days	Snail Mosquito larvae Fathead minnow (Pimephales promelas) Sculpin	rr rr uu uu
4,4'-DDT	3600-34,500 1210 5060 29,400; 37,000	 30 days 30 days 32 days	Snail Duckweed Crayfish Fathead minnow (Pimephales promelas)	rr rr rr uu
4-Methyl-2-pentanone				
4-Methylphenol (p-cresol)				
4-Nitrophenol				
Acenaphthene	380.2		Fish	ww
Acenaphthylene	242		Fish	e
Acetone	0.69 0.03		Adult haddock ?	mm nn
Aldrin				
Alpha chlordane				
Alpha-BHC	130		Fish	e
Anthracene	100-2000 760 3500 485	1 hour 24 hours 28 hours 2-3 days	Water flea (Daphnia magna) Daphnia pulex Mayfly Fathead minnow (Pimephales promelas)	nn oo oo pp
Benzene	3.5 4.4 4.3		Eels (Anguilla japonica) Pacific herring (Clupea harengus pallasi) Goldfish (Carassius auratus)	xx xx xx

Table A-10

Chemicals Detected at El Toro: Bioconcentration Factors
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Chemical	BCF	Exposure Duration	Species	BCF Source
Benzo(a)anthracene				
Benzo(a)pyrene				
Benzo(b)fluoranthene				
Benzo(g,h,i)perylene				
Benzo(k)fluoranthene				
Benzyl butyl phthalate	776.2		Fish	ww
Beta BHC				
Bis(2-ethylhexyl)phthalate	91-569 54-2700	56 days	Fathead minnow (Pimephales promelas) Aquatic organisms	oo qq
Carbazole				
Carbon Disulfide	7.9		Calculated	yy
Carbon tetrachloride	17.4		Fish	ww
Chloroform	6 3.34-10.35 1.6-2.5 2.9-3.1 3.3-3.7		Bluegill sunfish (Lepomis macrochirus) Rainbow trout (Salmo gairdneri) Bluegill (Lepomis macrochirus) Largemouth bass (Micropterus salmoides) Catfish (Ictalurus punctatus)	xx xx xx xx xx
Chrysene				
Dalapon	3 <1	3 days 3 days	Fish Snails	tt tt
Delta-BHC	130		Fish	e
Dibenzo(a,h)anthracene				
Dibenzofuran				
Di-n-butyl phthalate	31.6 16.6 11.7		American oyster Brown shrimp Sheepshead minnow	yy yy yy
Dicamba				
Dichloroprop				
Dieldrin	4760		Fish	e
Diethylphthalate	117 15-16		Bluegill sunfish (Lepomis Macrochirus) Mullet (mugil cephalus)	yy yy
Dimethyl phthalate	4.7 5.4	24 hours 24 hours	Brown shrimp Sheepshead minnow	yy yy
Endosulfan I				
Endosulfan II				
Endosulfan sulfate				
Endrin				
Endrin aldehyde				

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Chemical	BCF	Exposure Duration	Species	BCF Source
Endrin ketone				
Ethylbenzene	15.5 4.7		Goldfish (Carassius auratus) Clams	yy yy
Fluoranthene	1150		Fish	e
Fluorene	1288.2		Fish	ww
Gamma chlordane				
Heptachlor epoxide	15,700		Fish	e
Hexachloroethane	138		Fish	ww
Indeno(1,2,3-cd)pyrene				
Isophorone	7.08		Fish	ww
Lindane	323.6		Fish	ww
MCPP				
Methoxychlor				
Methyl chloride				
Methylene chloride				
Naphthalene	426.6		Fish	ww
Octachlorodibenzo-p-dioxin				
PCB 1248	100000 (PCB's)		Fish	e
PCB 1254	100000 (PCB's)		Fish	e
PCB 1260	100000 (PCB's)		Fish	e
Petroleum hydrocarbons (total recoverable)	N/A			
Phenanthrene	2630.3		Fish	ww
Phenol	1.9 227 20 200 3.5		Goldfish (Carassius auratus) Water flea (Daphnia magna) Gold orfe Algae(Chlorella fusca) Freshwater phytoplankter (Scenedesmus quadricauda)	yy yy yy yy yy
Pyrene	2691.5		Fish	ww
Tetrachloroethene	38.9 49		Fathead minnow (Pimephales promelas) Bluegill sunfish (Lepomis macrochirus)	xx xx
Toluene	26-27.1			nn
TFH-diesel	N/A			
TFH-gasoline	N/A			

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Chemical	BCF	Exposure Duration	Species	BCF Source
Trichloroethylene	17		Bluegill sunfish (Lepomis macrochirus)	xx
	39		Rainbow trout (Salmo gairdenri)	xx
Xylenes (total)	1,2-Xylene			
	21.4		Eels (Anguilla japonica)	xx
	6.2		Clams	xx
	1,3-Xylene			
	23.4		Eels (Anguilla japonica)	xx
	6.0		Clams	xx
	1,4-Xylene			
	23.4		Eels (Anguilla japonica)	xx
	158.5		Fish	xx
INORGANICS:				
Aluminum				
Antimony	0		Fish	e
Arsenic	Arsenic III			
	3	28 days	Snail	
	10	21 days	Water flea (Daphnia magna)	
	9	28 days	Stonefly	
	4.	28 days	Bluegill sunfish (Lepomis macrochirus)	
	Arsenic IV			
	3	28 days	Snail	
	4	21 days	Water flea (Daphnia magna)	
	7	28 days	Stonefly	
	219	28 days	Water flea (Daphnia magna)	q
Barium	120		Plankton	r
	260		Brown algae	r
				r
Beryllium	100		Freshwater/marine plants, invertebrates, fish	t
			Bluegill sunfish	
	19			s
Cadmium	4100	8 weeks	Gambusia affinis	w
	2550	1.4 weeks	algae (Chlorella vulgaris)	w
	116-131	3 weeks	molluscs	w
	3500	66 weeks	Crustaceans	w
	2.6		Formica sanguinea	x
	3-8		Helix aspersa	x
	0.6-93. 5		Lumbricus rubellus	x
Chromium	1	30 days	Rainbow trout (Salmo gairdneri)	
	2.8	180 days	Rainbow trout (Salmo gairdneri)	
Cobalt	100-4000		Marine fish	r
	40-1000		Freshwater fish	r
Copper	1.5-10		Helix aspersa	x
	11.4		Lumbricus terrestris	x
	0.01-0.6		Lumbricus rubellus	x
	2000	20 hours	Algae(Chlorelle regularis)	y
Cyanide				

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Chemicals Detected at El Toro: Bioconcentration Factors
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Chemical	BCF	Exposure Duration	Species	BCF Source
Lead	1700	120 days	Snail	
	738	28 days	Stonefly	
	45		Bluegill sunfish (Lepomis macrochirus)	
	2366	14 days	Mayfly	
	0.01-4, 1-3		Lumbricus rubellus	x
	1.3, 1.1		Helix pomatia	x
	26,000	28 days	Alga (S. capricornutum)	z
	1000-9000	28 days	Aquatic invertebrates	z
Manganese	2500-6300		Phytoplankton	aa
	35-930		Coastal fish	aa
	100-600		Fish	bb
Mercury	13,000	14 days	Alga	ee
	91	29 days	Bluegill sunfish	ee
	27,000	30 days	Mosquitofish	ee
	179; 200; 14; 360	24 hours	Marine copepod	dd
Nickel	40-100		Fish	cc
	36		Carnivorous fish	gg
	100	12 weeks	Mussels	hh
Selenium	460	2 days	Mosquitofish	ii
	32,000	2 days	Freshwater gastopod	ii
	2100	2 days	Daphnids	ii
	2600	2 days	Plankton	ii
	3300	2 days	Killifish	ii
	>680	2 days	Freshwater diatoms	ii
Silver	3080		Fish	
Thallium	18.2		Clams	r
	11.7		Mussels	r
	34		Bluegill sunfish (Lepomis macrochirus)	r
Vanadium	10,000		Seasquirts	r
Zinc	1-9		Helix pomtia	jj
	0.15-2.8		Lumbricus rubellus	jj
	0.3-2		Helix aspersa	jj
	51-1130		Freshwater animals	kk
	1000		Fish	ll
	10,000		Aquatic Invertebrates	ll

NOTE: Updated as of March 18, 1993

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Chemicals Detected at El Toro: Bioconcentration Factors
MCAS El Toro Phase I RI Technical Memorandum

Chemical	BCF	Exposure Duration	Species	BCF Source

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Chemical	BCF	Exposure Duration	Species	BCF Source

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Literature Toxicity Values for the Protection of Terrestrial Mammals and Birds for COPEC in Soil
MCAS El Toro Phase I RI Technical Memorandum

Chemical	Criteria Protective of Animals			Reference
	Species	Toxicity Value	Description	
Organic Chemicals (µg/kg)				
1,1,1-Trichloroethane				
1,2-Dichloroethene (total)				
2,4,5-Trichlorophenoxy Proprionic Acid				
2,4,5-T				
2,4-D				
2,4-DB				
2,4-Dimethylphenol				
2-Butanone	Rat	173 mg/kg bw/day	Subchronic NOAEL	Ralston et al., 1985
	Rat	1,080 mg/kg bw/day	Acute LOAEL	Brown and Hewitt, 1984
2-Hexanone				
2-Methylnaphthalene				
4,4'-DDD	Rat	3.4 g/kg	Acute oral LD_{50}	Vershueren, 1983
4,4'-DDE				
	White-throated sparrow	4 ppm	Adverse effect	Beyer and Gish, 1980
4,4'-DDT	Rat	113 mg/kg bw/day	Acute oral LD_{50}	Vershueren, 1983
	Bullfrog	>2,000 mg/kg bw/day	LD_{50}	USFWS, 1984
	Mallard	>2,240 mg/kg bw/day	LD_{50}	USFWS, 1984
	California Quail	595 mg/kg bw/day	LD_{50}	USFWS, 1984
	Sandhill Crane	>1,200 mg/kg bw/day	LD_{50}	USFWS, 1984
	Rat	2,510 mg/kg	Acute oral dermal LD_{50}	Vershueren, 1983
	Quail and pheasants	311-1,869 mg/kg	LC_{50}	Beyer and Gish, 1980
	Robin	53-204 ppm	Toxic	Beyer and Gish, 1980
	Thrushes	13-29 mg/kg bw/day	Toxic	Beyer and Gish, 1980
	White-throated sparrows	5-25 ppm	Adverse effect	Beyer and Gish, 1980
4-Methyl-2-pentanone				
4-Methylphenol				
Acenaphthene				
Acenaphthylene				
Acetone	Rabbit	10 ml/kg	Acute lethal dose	Vershueren, 1983
	Dog	8,000 gm/kg	Acute lethal dose	Vershueren, 1983
	Rat	9,750 mg/kg bw/day	Acute LD_{50}	Vershueren, 1983
Aldrin	Rat	67 mg/kg bw/day	Acute LD_{50}	Vershueren, 1983
	Rat	98 to 200 mg/kg bw/day	Acute dermal LD_{50}	Vershueren, 1983

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MCAS El Toro Phase I RI Technical Memorandum

Chemical	Criteria Protective of Animals			Reference
	Species	Toxicity Value	Description	
Aldrin (continued)	Mallard	520 mg/kg bw/day	LD_{50}	USFWS, 1984
	Bobwhite Quail	6.59 mg/kg bw/day	LD_{50}	USFWS, 1984
	Pheasant	16.8 mg/kg bw/day	LD_{50}	USFWS, 1984
	Mule Deer	18.8 to 37.5 mg/kg	LD_{50}	USFWS, 1984
Anthracene	Rat	25 mg/kg bw/day	Chronic LOAEL	Vershueren, 1983
	Rodent	3,300 mg/kg bw/day	Chronic effect	Eisler, 1987a
	Northern Bobwhite Qual	5,760 mg/kg diet	LD_{50}	Eisler, 1987a
	Mallard	19,650 mg/kg diet	Acute LD_{50}	Eisler, 1987a
Benzene	Rat	2.35 mg/kg bw/day	Acute NOAEL	Deichman et al., 1963
	Rat	17.65 mg/kg bw/day	Subchronic NOAEL	EPA, 1980
Benzo(a)anthracene	Rodent	0.006 mg/kg bw	Chronic effect	Eisler, 1987a
Benzo(a)pyrene	Mallard	4,000 mg/kg diet	Effects obs	Eisler, 1987a
	Rat	50 mg/kg bw/day	Acute oral LD_{50}	Eisler, 1987a
	Rodent	0.002 mg/kg	Chronic effect	Eisler, 1987a
Benzo(b)fluoranthene	Rodent	4.0 mg/kg	Chronic effect	Eisler, 1987a
Benzo(g,h,i)perylene				
Benzo(k)fluoranthene	Rodent	72 mg/kg bw/day	Chronic effect	Eisler, 1987a
Benzyl butyl phthalate	Rat	735 mg/kg	Acute oral LD_{50}	Vershueren, 1983
	Mouse	568 mg/kg	Acute oral LD_{50}	Vershueren, 1983
	Rat	2,330 mg/kg	Acute oral LD_{50}	IARC, 1980a
BHC alpha				
BHC delta	Rat	88 to 91 mg/kg	Acute oral LD_{50}	Vershueren, 1983
	Rat	900 to 1,000 mg/kg	Acute dermal	Vershueren, 1983
Gamma BHC (lindane)				
Bis(2-ethylhexyl)phthalate	Rat	65 mg/kg bw/day	Chronic NOAEL	Carpenter et al., 1953
	Rat	200 mg/kg bw/day	Chronic LOAEL	Carpenter et al., 1953
	Rat	31 g/kg	Oral LD_{50}	USDHHS, 1983
Carbazole				
Carbon disulfide				
α Chlordane	Rat	457 to 590 mg/kg	Acute oral LD_{50}	Vershueren, 1983
	Mallard	1,200 mg/kg bw/day	LD_{50}	USFWS, 1984
	California Quail	14.1 mg/kg bw/day	LD_{50}	USFWS, 1984
	Pheasant	24 to 72 mg/kg bw/day	LD_{50}	USFWS, 1984
	Rat	15 mg/kg bw/day	Acute LOAEL	Vershueren, 1983
	Rat	0.273 mg/kg bw/day	Chronic LOAEL	Velsicol, 1983
	Rat	0.055 mg/kg bw/day	Chronic NOAEL	Velsicol, 1983

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Literature Toxicity Values for the Protection of Terrestrial Mammals and Birds for COPEC in Soil
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Chemical	Criteria Protective of Animals			Reference
	Species	Toxicity Value	Description	
gamma Chlordane	Rat	457 to 590 mg/kg	Acute oral LD_{50}	Vershueren, 1983
	Rat	15 mg/kg	Acute LOAEL	Vershueren, 1983
Chrysene	Animals	99 mg/kg	Carcinogenicity	Sims and Overcasn, 1983
Dalapon	Rat	7,570 to 9,330 mg/kg bw/day	Acute LD50	Vershueren, 1983
	Rat	50 mg/kg bw/day	Chronic LOAEL	Vershueren, 1983
	Rat	15 mg/kg bw/day	Chronic NOAEL	Vershueren, 1983
Dibenzofuran	Rat	1 mg/kg bw/day	Acute NOAEL	Moore et al., 1976
	Mouse	6 mg/kg bw/day	Acute NOAEL	Moore et al., 1976
	Rat	6 mg/kg bw/day	Acute NOAEL	Moore et al., 1976
Di-n-butylphthalate	Rat	8,000 mg/kg bw/day	Acute LD_{50}	Lewis, 1992
Dichloroprop				
Dieldrin	Rat	46 to 63 mg/kg	Acute oral LD_{50}	Vershueren, 1983
	Mallard	381 mg/kg bw/day	LD_{50}	USFWS, 1984
	Pheasant	79 mg/kg bw/day	LD_{50}	USFWS, 1984
	Rock Dove	26.6 mg/kg bw/day	LD_{50}	USFWS, 1984
	House sparrow	47.6 mg/kg bw/day	LD_{50}	USFWS, 1984
	Rat	52 to 117 mg/kg	Acute dermal LD_{50}	Vershueren, 1983
	Quail and pheasant	37-169 mg/kg	LC_{50}	Beyer and Gish, 1980
	Thrush	12 ppm diet	Lethal	Beyer and Gish, 1980
	Loggerhead shrikes	2 ppm diet	Adverse effect	Beyer and Gish, 1980
	Mule deer	75 to 100 mg/kg bw/day	LD_{50}	Connell and Miller, 1984
	Domestic Goat	100 to 200 mg/kg bw/day	LD_{50}	Connell and Miller, 1984
Diethyl phthalate				
Dimethyl phthalate				
Endosulfan I	Rat	18 to 100 mg/kg	Acute oral LD_{50}	Vershueren, 1983
	Rat	74 to 359 mg/kg	Acute oral LD_{50}	Vershueren, 1983
	Rat	0.15 mg/kg	Chronic LOAEL	American Hoeschst, 1984
	Rat	2.0 mg/kg bw/day	NOAEL	American Hoeschst, 1984
Endosulfan II	Mallard duck	200 to 750 mg/kg bw	LD_{50}	Vershueren, 1983
Endosulfan sulfate				

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Chemical	Criteria Protective of Animals			Reference
	Species	Toxicity Value	Description	
Endrin	Rat	7.5 to 17.5 mg/kg	Acute oral LD_{50}	Vershueren, 1983
	Rock dove	2 to 5 mg/kg bw/day	LD_{50}	USFWS, 1984
	Mallard	5.64 mg/kg bw/day	LD_{50}	USFWS, 1984
	California Quail	1.19 mg/kg bw/day	LD_{50}	USFWS, 1984
	Pheasant	1.78 mg/kg bw/day	LD_{50}	USFWS, 1984
	Mule Deer	6.25 to 12.5 mg/kg bw/day	LD_{50}	USFWS, 1984
	Goat	25 to 50 mg/kg bw/day	LD_{50}	Connell and Miller, 1984
	Rat	15 mg/kg bw/day	Acute dermal LD_{50}	Vershueren, 1983
Endrin aldehyde				
Endrin ketone				
Ethylbenzene	Rat	97.1 mg/kg bw/day	Subchronic NOAEL	Wolf et al., 1956
	Rat	291 mg/kg bw/day	Subchronic LOAEL	Wolf et al., 1956
Fluoranthene	Mouse	125 mg/kg bw/day	Subchronic NOAEL	EPA, 1988a
	Mouse	250 mg/kg bw/day	Subchronic LOAEL	EPA, 1988a
	Rat	2,000 mg/kg	Oral LD_{50}	USDHHS, 1983
Fluorene				
Heptachlorepoxide	Rat	0.25 mg/kg bw/day	Chronic LOAEL	Verisicol, 1959
	Rat	0.25 mg/kg bw/day	Chronic NOAEL	Verisicol, 1954
Hexachloroethane				
Indeno(1,2,3)pyrene	Rodent	72 mg/kg bw/day	Chronic effect	Eisler, 1987a
Isophorone				
MCPP-				
Methoxychlor	Rat	6,000 mg/kg bw/day	Acute oral LD_{50}	Vershueren, 1983
	Mallard	>2,000 mg/kg bw/day	LD_{50}	USFWS, 1984
	California Quail	>2,000 mg/kg bw/day	LD_{50}	USFWS, 1984
Methylene chloride	Rat	5.85 to 6.47 mg/kg bw/day	Chronic NOAEL	NCA, 1982
	Rat	52.58 to 58.32 mg/kg bw/day	Chronic LOAEL	NCA, 1982
Naphthalene	Rat	41 mg/kg bw/day	Chronic NOAEL	Schmahl, 1955
	Mouse	300 mg/kg bw/day	Acute LOAEL	Plasterer, 1985
	Rat	1,780 mg/kg	Oral LD_{50}	USDHHS, 1983
Octachlorodibenzo-p-dioxin				
PCB 1248				

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Literature Toxicity Values for the Protection of Terrestrial Mammals and Birds for COPEC in Soil
MCAS El Toro Phase I RI Technical Memorandum

Chemical	Criteria Protective of Animals			Reference
	Species	Toxicity Value	Description	
PCB 1254	Rat	5 to 800 mg/kg bw/day	EC, diet	Vershueren, 1983
	Birds (mallard, pheasant, and quail)	745 to 5,000 mg/kg bw/day	LC_{50}	Connell and Miller, 1984
	Chickens	30 to 250 mg/kg bw/day	Toxic	Connell and Miller, 1984
	Rats, mice, rabbits	1.3 to 2.5 mg/kg bw/day	LD_{50}	Connell and Miller, 1984
PCB 1260	Birds (mallard, pheasant, quail)	745 to 500 mg/kg bw/day	LC_{50}	Connell and Miller, 1984
	Chickens	30 to 250 mg/kg bw/day	Toxic	Connell and Miller, 1984
	Rat	20 to 100 mg/kg bw/day	No effect	Wasserman et al., 1979
Phenanthrene	Mouse	10 mg/kg bw/day	Acute NOAEL	Mackenzie and Angervine, 1981
	Mouse	40 mg/kg bw/day	Acute LOAEL	Mackenzie and Angervine, 1981
Pyrene	Mouse	125 mg/kg bw/day	Subchronic NOAEL	EPA, 1988a
	Mouse	250 mg/kg bw/day	Subchronic LOAEL	EPA, 1988a
Tetrachloroethene				
Toluene	Rat	223 mg/kg bw/day	Acute NOAEL	NTP, 1989a
	Rat	446 mg/kg bw/day	Subchronic LOAEL	NTP, 1989a
	Rat	5,000 mg/kg	Oral LD_{50}	USDHHS, 1983
Trichloroethylene	Mouse	17.9 mg/kg bw/day	Subchronic NOAEL	NCI, 1976
	Mouse	393 mg/kg bw/day	Subchronic LOAEL	NCI, 1976
	Rat	4,950 mg/kg	Oral LD_{50}	Lewis, 1992
Xylene	Rat	179 mg/kg bw/day	Chronic NOAEL	NTP, 1986
	Rat	357 mg/kg bw/day	Chronic LOAEL	NTP, 1986
Inorganic Chemicals (mg/kg)				
Aluminum	Mouse	19 mg/kg bw/day	Chronic NOAEL	Paternain et al., 1988
	Rat	14 mg/kg bw/day	Subchronic LOAEL	Ondreicka et al., 1966
	Swine, poultry, horse, rabbit	200 ppm	a	NAS, 1980
	Cattle, sheep	1,000 ppm	a	NAS, 1980
Antimony				
Arsenic	Rat	6.4 mg/kg bw/day	Chronic LOAEL	Byron et al., 1967
	Cattle, sheep swine, poultry	50 ppm (inorganic)	a	NAS, 1980
	Cattle, sheep, swine, poultry	100 ppm (organic)	a	NAS, 1980

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Literature Toxicity Values for the Protection of Terrestrial Mammals and Birds for COPEC in Soil
MCAS El Toro Phase I RI Technical Memorandum

Chemical	Criteria Protective of Animals			Reference
	Species	Toxicity Value	Description	
Barium	Rat	0.25 mg/kg bw/day	Chronic NOAEL	Schroeder and Mitchner, 1975a
	Mouse	0.825 mg/kg bw/day	Chronic NOAEL	Schroeder and Mitchner, 1975a
	Cattle, sheep, swine, poultry, horse, rabbit	20 ppm	a	NAS, 1980
Beryllium	Rat	0.85 mg/kg bw/day	Chronic LOAEL	Schroeder and Mitchner, 1975a
	Rat	0.54 mg/kg bw/day	Chronic NOAEL	Schroeder and Mitchner, 1975a
Cadmium	Rat	0.004 mg/kg bw/day	Chronic NOAEL	Kopp et al., 1982
	Rat	0.014 mg/kg bw/day	Chronic LOAEL	Kopp et al., 1982
	Cattle, sheep, swine, poultry, horse, rabbit	0.5 ppm	a	NAS, 1980
Chromium (total)	Rat	0.46 mg/kg bw/day	Chronic NOAEL	Schroeder et al., 1965
	Cattle, sheep, swine, poultry, horse, rabbit	1,000 to 3,000 ppm	a	NAS, 1980
Cobalt	Rat	0.05 mg/kg bw/day	Subchronic NOAEL	Krasovski and Fridlyand, 1971
	Rat	0.5 mg/kg bw/day	Subchronic LOAEL	Krasovski and Fridlyand, 1971
Copper	Rat	12.5 mg/kg bw/day	Subchronic NOAEL	Murthy et al., 1981
	Mouse	4.2 mg/kg bw/day	Chronic LOAEL	Massie and Aiello, 1984
	Cattle	100 ppm	a	NAS, 1980
	Sheep	25 ppm	a	NAS, 1980
	Poultry	300 ppm	a	NAS, 1980
	Rabbit	200 ppm	a	NAS, 1980
Lead	Rat	0.45 mg/kg bw/day	Chronic NOAEL	Perry et al., 1988
	Rat	2.8 mg/kg bw/day	Chronic LOAEL	Azar et al., 1973
	Cattle, sheep, swine, poultry, rabbit	30 ppm	a	NAS, 1980
	Surface dwelling animals	0.1 ppm	LOAEL	EPA, 1992h
	Shrew	138.6 ppm reduced population		Quarles et al., 1974
Manganese				
Mercury	Rat	0.003 mg/kg bw/day	Chronic NOAEL	Fitzhugh et al., 1950
	Rat	0.015 mg/kg bw/day	Chronic LOAEL	Fitzhugh et al., 1950
	Cattle, sheep, swine, poultry, rabbit	2 ppm	a	NAS, 1980

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Literature Toxicity Values for the Protection of Terrestrial Mammals and Birds for COPEC in Soil
MCAS El Toro Phase I RI Technical Memorandum

Chemical	Criteria Protective of Animals			Reference
	Species	Toxicity Value	Description	
Nickel	Rat	5 mg/kg bw/day	Chronic NOAEL	Ambrose et al., 1976
	Rat	50 mg/kg bw/day	Chronic LOAEL	Ambrose et al., 1976
	Cattle, sheep, swine, poultry, rabbit	50 ppm	a	NAS, 1980
Selenium	Cattle, sheep, swine, poultry, rabbit	2 ppm	a	NAS, 1980
Silver	Rat	181.2 mg/kg bw/day	Acute NOAEL	Walker, 1971
	Mouse	18.1 mg/kg bw/day	Subchronic LOAEL	Rungby and Danscher, 1984
	Swine, poultry	100 ppm	a	NAS, 1980
Thallium	BD			
Vanadium	Rat	0.7 mg/kg bw/day	Chronic NOAEL	Schroeder et al., 1970
	Rat	2.8 mg/kg bw/day	Chronic LOAEL	Kowalski, 1988
	Cattle, sheep	50 ppm	a	NAS, 1980
	Swine, poultry, horse, rabbit	10 ppm	a	NAS, 1980
Zinc	Rat	98.3 mg/kg bw/day	Subchronic NOAEL	Drinker et al., 1927
	Mouse	38 mg/kg bw/day	Chronic LOAEL	Aughey et al., 1977
	Sheep	300 ppm	a	NAS, 1980
	Cattle, swine, poultry, horse, rabbit	500 ppm	a	NAS, 1980

[a]Maximum tolerance level of dietary minerals for domestic animals (concentration in ppm).
[b]Total Dose—was derived by multiplying the toxicity value by the average body weight of the organism tested (Rat = 0.2 kg; mouse = 0.025 kg; bird [wild specie] = 0.04 kg; chicken = 0.8 kg; duck = 2.5 kg; goat = 60 kg; quail = 0.1 kg; dog = 10 kg; rabbit = 2 kg; guinea pig = 0.5 kg).

Source: Jacobs Engineering, 1993a.

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Table A-12

Literature Criteria Protective of Terrestrial Invertebrates for COPEC in Soil
MCAS El Toro Phase 1 RI Technical Memorandum

Chemical	Effect Levels or Criteria Protective of Soil Invertebrates			Reference
	Species	Dose	Description	
Organic Chemicals				
1,1,1-Trichloroethane				
1,2-Dichloroethene (total)				
2,4,5-Trichlorophenoxy propionic Acid				
2,4,5-T				
2,4-D				
2,4-DB				
2,4-Dimethylphenol				
2-Butanone				
2-Hexanone				
2-Methylnaphthalene				
4,4'-DDD	Earthworm	2,000 ppm	LC50	Roberts and Dorough, 1983
4,4'-DDE				
4,4'-DDT	Earthworm	3 ppm	Weight loss	Johnson, 1976
4-Methyl-2-pentanone				
4-Methylphenol				
Acenaphthene	Earthworm	98 ppm[d]	LC50	Neuhauser et al., 1985a
Acenaphthylene				
Acetone	Earthworm	200 to 2,000 ppm	LC50	Roberts and Dorough, 1983
Aldrin				
Anthracene				
Benzene	Earthwortm	196 ppm	LC50	Neuhauser et al., 1985a
Benzo(a)anthracene				
Benzo(a)pyrene	Earthworm	2,000 ppm	LC50	Roberts and Dorough, 1983
Benzo(b)fluoranthene				
Benzo(g,h,i)perylene				
Benzo(k)fluoranthene				
Benzylbutyl phthalate				
Bis(2-ethylhexl)phthalate	Earthworm	50,000 ppm[d]	LC50	Neuhauser et al., 1985a
alpha-BHC				
Delta-BHC				
gamma-BHC				
Carbazole				
Carbon disulfide				
Carbon Tetrachloride				
α Chlordane	Nightcrawler	>32 lb ai/A	3 days LD50	Ruppel, 1977
beta Chlordane				
gamma Chlordane				
Chrysene				
Dalapon				
Dibenzofuran				
Di-n-butylphthalate	Earthwork	2,720 ppm	LC50	Neuhauser et al., 1985a
Dichlorprop				
Dieldrin	Earthworm (*Eisenia foetida*)	25 mg/kg	4 to 6 weeks, decrease growth, cocoon production	Neuhauser, 1990

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Literature Criteria Protective of Terrestrial Invertebrates for COPEC in Soil
MCAS El Toro Phase 1 RI Technical Memorandum

Chemical	Effect Levels or Criteria Protective of Soil Invertebrates			Reference
	Species	Dose	Description	
Diethylphthalate	Earthworm	1,700 ppm[a]	LC50	Neuhauser et al., 1985a
Dimethylphthalate				
Endosulfan I				
Endosulfan II				
Endosulfan sulfate				
Endrin				
Endrin aldehyde				
Endrin ketone				
Ethylbenzene	Earthworm	94 ppm[a]	LC50	Neuhauser et al., 1985a
Fluoranthene	Earthworm	4,320 ppm[a]	LC50	Neuhauser et al., 1985a
Fluorene	Earthworm	342 ppm[a]	LC50	Neuhauser et al., 1985a
	Earthworm	173 ppm	LC50	Neuhauser et al., 1985a
	Earthworm (*Eisenia foenda*)	23,600 mg/kg	Reproduction inhibition	Neuhauser, 1990
Heptachlor epoxide				
Hexachloroethane				
Indeno(1,2,3)pyrene				
Isophorone				
MCPP				
Methoxychlor				
Methylene chloride	Earthworm	1,216 µg/g	LC50	Neuhauser et al., 1985a
Naphthalene	Earthworm	9,340 ppm[a]	LC50	Neuhauser et al., 1985a
Octachlorodibenzo-p-dioxin				
PCB 1248				
PCB 1254				
PCB 1260				
Phenanthrene	Forest soil invertebrate	1 g/m^2	Adverse effects	Eisler, 1987a
	Soil invertebrate	1 to 5 g/m^2	Adverse effects	Eisler, 1987a
Phenol				
Pyrene				
Tetrachloroethene				
Toluene	Earthworm	150 ppm[a]	LC50	Neuhauser et al., 1985a
	Earthworm	1 percent	Growth inhibition	Hartenstein, 1982
Trichloroethylene	Earthworm	210 ppm[a]	LC50	Neuhauser et al., 1985a
Xylene				
Inorganic Chemicals				
Aluminum	Woodlouse (Porcello scaber)	2,500 to 2,800 ppm	55 to 75 percent survival	Beyer et al., 1985
Antimony				
Arsenic	Bacteria, nematodes, earthworms, fungi	230 to 972 ppm	Effects observed	Bisessar, 1982
Barium				
Beryllium				

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Literature Criteria Protective of Terrestrial Invertebrates for COPEC in Soil
MCAS El Toro Phase 1 RI Technical Memorandum

Chemical	Effect Levels or Criteria Protective of Soil Invertebrates			Reference
	Species	Dose	Description	
Cadmium	Earthworm	20 ppm	Threshold for effects	Neuhauser et al., 1985b
	Forest soil invertebrate	10 to 50 ppm	No effect	Bengtsson and Tranvik, 1989
	Earthworm	1,800 to 18,000 (ppm)	Growth inhibition	Hartenstein et al., 1981
	Soil invertebrates	0.2 µg/g	HC5[D]	van Straalen, 1993
	Dendrobaena rubida	100 µg/g dry weight	NOAEL	van Straalen, 1993
	Lumbricus rubellus	10 µg/g dry weight	NOAEL	van Straalen, 1993
	Eisenia foetida	25 µg/g dry weight	NOAEL	van Straalen, 1993
	Helix aspersa	10 µg/g dry weight	NOAEL	van Straalen, 1993
	Porcellio scaber	10 µg/g dry weight	NOAEL	van Straalen, 1993
	Orchesella cincta	56 µg/g dry weight	NOAEL	van Straalen, 1993
	Folsomia candida	73 µg/g dry weight	NOAEL	van Straalen, 1993
	Platynothrus peltifer	2.9 µg/g dry weight		van Straalen, 1993
	Earthworm (*Eisenia foetida*)	1,800 to 18,000 mg/kg	8 weeks, growth inhibition	Hartenstein, 1981
	Earthworm (*Eisenia foetida*)	3,500 to 35,000 mg/kg	8 weeks, toxic	Hartenstein, 1981
	Earthworm (*Eisenia foetida*)	100 µg/g	5 weeks, cocoon production decrease	Neuhauser, et al., 1984b
	Earthworm (*Eisenia foetida*)	100 ppm, dry weight	4 to 6 weeks, decreased growth rates	Malecki et al., 1982
	Earthworm (*Eisenia foetida*)	50 ppm, dry weight	20 weeks, reproduction inhibition	Malecki et al., 1982
	Marine Amphipod (*Ampelisca abdita*)	1.12E-04 g/gm	10 days, toxic	DiToro, 1992
	Marine Amphipod (*Rhepoxynius hudsoni*)	1.12E-04 g/gm	10 days, toxic	DiToro, 1992
	Freshwater snail (*Helisoma sp.*)	1.12E-04 g/gm	10 days, toxic	DiToro, 1992
	Freshwater Oligochaete (*Lumbricus variegatus*)	1.12E-04 g/gm	10 days, toxic	DiToro, 1992
Chromium (total)		100 ppm	Toxic	Cottenie, 1977
Cobalt	Earthworm	300 to 3,000 ppm	Growth inhibition	Hartenstein et al., 1981
	Earthworm (*Eisenia foetida*)	300 to 3,000 mg/kg	8 weeks, growth inhibition	Hartenstein et al., 1981
	Earthworm (*Eisenia foetida*)	30,000 mg/kg	8 weeks, toxic	Hartenstein et al., 1981
	Earthworm (*Eisenia foetida*)	82.5 µg/g food source	172 days, growth/ reproduction hibition	Neuhauser et al., 1984a
Copper	Forest soil invertebrate	<100 ppm	No effect	Bengtsson and Tranvik, 1989
	Earthworm	1,100 to 11,000 ppm	Growth inhibition	Hartenstein et al., 1981
	Soil invertebrates	2.7 µg/g	HC5[D]	van Straalen, 1993
	Earthworm	131 ppm	Threshold for effects	Ma et al., 1983
	Earthworm	60 ppm	Threshold for effects	Ma et al., 1983

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Literature Criteria Protective of Terrestrial Invertebrates for COPEC in Soil
MCAS El Toro Phase 1 RI Technical Memorandum

Chemical	Effect Levels or Criteria Protective of Soil Invertebrates			Reference
	Species	Dose	Description	
Lead (continued)	Earthworm (*Eisenia foetida*)	>5,000 ppm, dry weight	20 weeks, reproduction inhibition	Malecki et al., 1982
Manganese				
Mercury		10 ppm	Toxic	Horvarth et al., 1983
	Earthworm	480 to 4,800 ppm	Growth inhibition	Hartenstein et al., 1981
	Eisenia foetida	3.25 µg/g dry weight	NOAEL	van Straalen, 1993
	Octochaetes pattoni	0.25 µg/g dry weight	NOAEL	van Straalen, 1993
	Anion ater	10 µg/g dry weight	NOAEL	van Straalen, 1993
	Aiolopus thalassinus	0.12 µg/g dry weight	NOAEL	van Straalen, 1993
	Earthworm (*Eisenia foetida*)	480 to 4,800 mg/kg	8 weeks, growth inhibition	Hartenstein et al., 1981
	Earthworm (*Eisenia foetida*)	2,400 to 24,000 mg/kg	8 weeks, toxic	Hartenstein et al., 1981
Nickel	Earthworm	500 ppm	Reduced growth	Neuhauser et al., 1984
	Eisenia foetida	100 µg/g dry weight	NOAEL	van Straalen, 1993
	Lumbricus rubellus	50 µg/g dry weight	NOAEL	van Straalen, 1993
	Earthworm	1,200 to 12,000 ppm	Growth inhibition	Hartenstein et al., 1981
	Earthworm (*Eisenia foetida*)	1,200 to 12,000 mg/kg	8 weeks, growth inhibition	Hartenstein et al., 1981
	Earthworm (*Eisenia foetida*)	1,200 to 12,000 mg/kg	8 weeks, toxic	Hartenstein et al., 1981
	Earthworm (*Eisenia foetida*)	250 µg/g	5 weeks, cocoon production decrease	Neuhauser et al., 1984b
	Earthworm (*Eisenia foetida*)	200 ppm, dry weight	4 to 6 weeks, decreased growth rates	Malecki et al., 1982
	Earthworm (*Eisenia foetida*)	400 ppm, dry weight	20 weeks, reproduction inhibition	Malecki et al., 1982
Selenium				
Silver				
Thallium				
Vanadium		<500 ppm	No effect	Bengtsson and Tranvik, 1989
Zinc	Woodlouse	100 to 3,200 ppm	No adverse effect	Beyer and Anderson, 1985
	Earthworm	662 ppm	LC50	Neuhauser et al., 1985b
	Eisenia foetida	1,000 µg/g dry weight	NOAEL	van Straalen, 1993
	Anion ater	100 µg/g dry weight	NOAEL	van Straalen, 1993
	Porcellio scaber	398 µg/g dry weight	NOAEL	van Straalen, 1993
	Earthworm	1,300 to 13,000 ppm	Growth inhibition	Hartenstein et al., 1981
	Forest soil invertebrate	<500 ppm	No effect	Bengtsson and Tranvik, 1989
	Earthworm (*Eisenia foetida*)	1,300 to 13,000 mg/kg	8 weeks, growth inhibition	Hartenstein et al., 1981
	Earthworm (*Eisenia foetida*)	26,000 mg/kg	8 weeks, toxic	Hartenstein et al., 1981

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Literature Criteria Protective of Terrestrial Invertebrates for COPEC in Soil
MCAS El Toro Phase 1 RI Technical Memorandum

Chemical	Effect Levels or Criteria Protective of Soil Invertebrates			Reference
	Species	Dose	Description	
Zinc (continued)	Earthworm (*Eisenia foetida*)	2,500 µg/g	5 weeks, cocoon production decrease	Neuhauser et al., 1984b
	Earthworm (*Eisenia foetida*)	2,000 ppm, dry weight	4 to 6 weeks, decreased growth rates	Malecki et al., 1982
	Earthworm (*Eisenia foetida*)	>5,000 ppm, dry weight	20 weeks, reproduction inhibition	Malecki et al., 1982

[a]Values derived from Neuhauser et al., 1985a were converted to ppm (mg/kg).
[b]Hazardous concentration for 5 percent of the species.

Notes:

NOAEL = No observed adverse effect level.
LOAEL = Lowest observed adverse effect level.
ppm = mg chemical/kg soil

Source: Jacobs Engineering, 1993a.

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Table A-13

Literature Toxicity Values for the Protection of Terrestrial Plants for COPEC in Soil
MCAS El Toro Phase 1 RI Technical Memorandum

Chemical	Effect Levels or Criteria Protective of Plants			Reference
	Background (Normal)	Excessive (Toxic)	Tolerable	
Organic Chemicals				
1,1,1-Trichloroethane				
1,2-Dichloroethene (total)				
2,4,5-T				
2,4-D				
2,4-DB				
2,4-Dimethyl phenol				
2-Butanone				
2-Hexanone				
2-Methylnaphthalene		8E-05 m (allium cepa)		Phytotox, 1993
		1.6E-04 m (allium cepa)		Phytotox, 1993
		100% (lettuce)		Phytotox, 1993
4,4'-DDD				
4,4'-DDE				
4,4'-DDT		12.5 ppm 50 ppm 100 ppm		ICF, 1989
		30 ppm (soybean) 30 ppm (wheat) 50 ppm (wheat)		Phytotox, 1993
4-Methyl-2-pentanone				
4-Methylphenol				
Acenaphthene		0.00125 m(Phelum pratense) and (Allium Cepa)		Phytotox, 1993
		1 g/Petri dish (Allium fistulosum)		Phytotox, 1993
		100% (Brassica alboglabra)		Phytotox, 1993
Acenaphtylene				
Acetone		1 m (potato)		Phytotox, 1993
		4 mg/mL (Camellia sasarqua)		Phytotox, 1993
		25 µL (Deltapine 16)		Phytotox, 1993
		5 mL (lettuce)		Phytotox, 1993
Aldrin		12.5 ppm (maize) 50 ppm (maize) 100 ppm (maize)		Bengtsson and Tranvik, 1989
Anthracene		1E-04 (maize)		Phytotox, 1993
Benzene		8 mL (barley)		Phytotox, 1993
		2.7 m/L (barley)		Phytotox, 1993
		8 mL (carrot)		Phytotox, 1993
		8 mL (flax)		Phytotox, 1993
		100% (lettuce)		Phytotox, 1993
Benzo(a)anthracene		1E-06 (Nicotiana tabacum)		Phytotox, 1993
		1E-05 (Nicotiana tabacum)		Phytotox, 1993
Benzo(a)pyrene		0.01 ppm (mericopa)		Phytotox, 1993
		0.02 ppm (merit)		Phytotox, 1993
		0.0005 ppm (merit)		Phytotox, 1993
Benzo(b)fluoranthene				
Benzo(g,h,i)perylene				
Benzo(k)fluoranthene				
Benzyl butyl phthalate				
Bis(2-ethylhexl)phthalate				
alpha- BHC				

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Literature Toxicity Values for the Protection of Terrestrial Plants for COPEC in Soil
MCAS El Toro Phase 1 RI Technical Memorandum

Chemical	Effect Levels or Criteria Protective of Plants			Reference
	Background (Normal)	Excessive (Toxic)	Tolerable	
Delta-BHC		12.5 ppm (valentine beans)		ICF, 1989
		50 ppm		ICF, 1989
		100 ppm		ICF, 1989
BHC-gamma				
Carbazole				
Carbon disulfide				
Carbon tetrachloride				
α Chlordane				
beta Chlordane				
gamma Chlordane				
Chrysene				
Dalapon				
Dibenzofuran				
Di-n-butyl phthalate				
Dichloroprop				
Dieldrin		12.5 ppm (valentine beans) 50 ppm 100 ppm		ICF, 1989
		0.84 lb/A (cabbage) (0.51 ppm) 0.84 lb/A (eggplant) (0.51 ppm)		Phytotox, 1993
Diethyl phthalate				
Dimethyl phthalate				
Endosulfan I		1,000 ppm (tomato)		Phytotox, 1993
Endosulfan II				
Endosulfan sulfate				
Endrin				
Endrin aldehyde				
Endrin ketone				
Ethylbenzene		8 mL (carrot)		Phytotox, 1993
Fluoranthene				
Fluorene				
Heptachlor epoxide				
Hexachloroethane				
Indeno(1,2,3)pyrene				
Isophorone				
MCPP				
Methoxychlor				
Methylene chloride		0.5 L/m2 (acroptilon picris)		Phytotox, 1993
		6 tons/ha (acroptilon picris)		Phytotox, 1993
		0.3 L/m2 (acroptilon picris)		Phytotox, 1993
Naphthalene		3.12E-04 (allium cepa)		Phytotox, 1993
Octachlorodibenzo-p-dioxin				
PCB 1248				
PCB 1254		1,000 ppm (corn)		Phytotox, 1993
		1 ppm (soybean)		Phytotox, 1993
		1,000 ppm (soybean)		Phytotox, 1993
PCB 1260				
Phenanthrene		0.3 mg/L		Eisler, 1987a
Phenol				
Pyrene				
Tetrachlorothene				

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Literature Toxicity Values for the Protection of Terrestrial Plants for COPEC in Soil
MCAS El Toro Phase 1 RI Technical Memorandum

Chemical	Effect Levels or Criteria Protective of Plants			Reference
	Background (Normal)	Excessive (Toxic)	Tolerable	
Toluene		2 mL (Helianthus annus)		Phytotox, 1993
Trichloroethylene				
Xylene		1.6 lb/gal (tobacco)		Phytotox, 1993
Inorganic Chemicals (mg/kg)				
Aluminum		0.56 ppm (alfalfa)	0.5 ppm	Kabata-Pendias and Pendias, 1984
		0.1 to 6.8 ppm (reduction in crop yield)		Chapman, 1966
		2 to 80 ppm (reduction in grass yield)		Chapman, 1966
Antimony				
Arsenic	0.01 to 1.7 ppm	3 to 20 ppm	–	ICF, 1989
		3 to 10 ppm (phytotoxic level in foliage)		Chaney, 1985
		≤10 ppm (suspected growth inhibition)		Chapman, 1966
		>2 ppm (damage to alfalfa and barley)		Chapman, 1966
		70 ppm (toxicity to tomato plants)		Chapman, 1966
Barium				
Beryllium	<1 to 7 ppm	10 to 50 ppm		Kabata-Pendias and Pendias, 1984
Cadmium	0.1 to 0.8 ppm	5 to 700 ppm	3 ppm	Kabata-Pendias, and Pendias, 1984
Chromium (total)	0.01 to 1 ppm	5 to 30 ppm	2 ppm	Kabata-Pendias, and Pendias, 1984
		100 ppm (toxic level in soil)		Cottenie, 1977
		4 to 8 ppm (toxicity to corn)		Chapman, 1966
		18 to 34 ppm (toxicity to tobacco)		Chapman, 1966
		16 ppm (reduced growth to tomato, potato, oat, and kale)		Chapman, 1966
Cobalt	0.02 to 1 ppm	15 to 50 ppm	5 ppm	Kabata-Pendias, and Pendias, 1984
Copper	4 to 30 ppm	20 to 100 ppm	50 ppm	Kabata-Pendias, and Pendias, 1984
		100 ppm (toxic level in soil)		Cottenie, 1977
Lead	0.1 to 10 ppm	30 to 300 ppm	10 ppm	Kabata-Pendias, and Pendias, 1984
		100 ppm (toxic level in soil)		Cottenie, 1977
		1.7 ppm reduced root growth to rye grass		Khan and Frankland, 1984
		500 ppm reduced root biomass to oat		Wong and Bradshaw, 1982
Manganese				
Mercury		1 to 3 ppm		Kabata-Pendias, and Pendias, 1984
Nickel	0.1 to 5 ppm	50 to 100 ppm	50 ppm	Kabata-Pendias, and Pendias, 1984
		100 ppm (toxic level in soil)		Cottenie, 1977
		34 ppm (damage to oats)		Patterson, 1971
		20 ppm (damage to potatoes)		Patterson, 1971
Selenium				
Silver	0.5 ppm	5 to 10 ppm		Kabata-Pendias, and Pendias, 1984
Thallium		20 ppm		Kabata-Pendias, and Pendias, 1984
Vanadium		150 ppm (nce)	10 ppm	ICF, 1989
Zinc	8 to 150 ppm	>300 to 1,500 ppm	300 ppm	Kabata-Pendias, and Pendias, 1984
		100 ppm (toxic level in soil)		Cottenie, 1977

Notes:

ppm = mg/kg.

Source: Jacobs Engineering, 1993a.

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APPENDIX B

BIOTA SAMPLING PROCEDURES

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ACRONYMS/ABBREVIATIONS

BCT	Base Realignment and Closure Cleanup Team
BNI	Bechtel National, Inc.
BRAC	Base Realignment and Closure
MCAS	Marine Corps Air Station
U.S. EPA	United States Environmental Protection Agency

ACRONYMS/ABBREVIATIONS (continued)

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Section 1
INTRODUCTION

In addition to the predictive model proposed in the ecological risk assessment, the risk assessment of the landfill sites (Sites 2 and 17) will be supplemented by sampling and analyses of biota. The purpose of the biota sampling is twofold:

- to provide a quantitative assessment of potential uptake of contaminants into the food chain, and
- to provide information for evaluating remedial alternatives, especially for mitigation of the ecological risks.

The information to be collected in the field will include data on plant communities, observations of wildlife, small mammal samples, plant samples, and soil samples. The biota samples will be collected from Site 2 (magazine Road Landfill), Site 17 (Communication Station Landfill), and a reference site located outside the areas of contamination. This data will be compiled and analyzed in regard to assessing ecological risk and evaluation of remedial alternatives.

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Section 2
SAMPLING LOCATIONS

Prior to sampling, a vegetation map will be prepared of the two landfill sites and a selected reference site. This map will illustrate the distribution of plant communities across the sites, especially sensitive habitats such as coastal sage scrub and riparian woodlands. This map will be used to determine the number of sample locations randomly chosen in sensitive habitats and constraints that may be mitigated during development of remedial alternatives.

A grid will be established at each site (Site 2, Site 17, and reference sits) to provide 50 evenly spaced sampling locations. The exact spacing of the sampling locations will vary depending on the size of the site, however, sampling locations will be a minimum of 50 feet apart. Fifteen sampling locations will be randomly selected from each site, using a random number generator. Figures B2-1 and B2-2 illustrate a potential distribution of sampling locations. The reference site will be selected in consultation with the Base Realignment and Closure (BRAC) Cleanup Team (BCT) prior to field activities and will be representative of the surface cover currently at Sites 2 and 17.

These sampling locations will be surveyed by a certified land surveyor prior to sampling. Each location will be marked with a wooden stake. No clearing of vegetative cover will occur at sampling locations.

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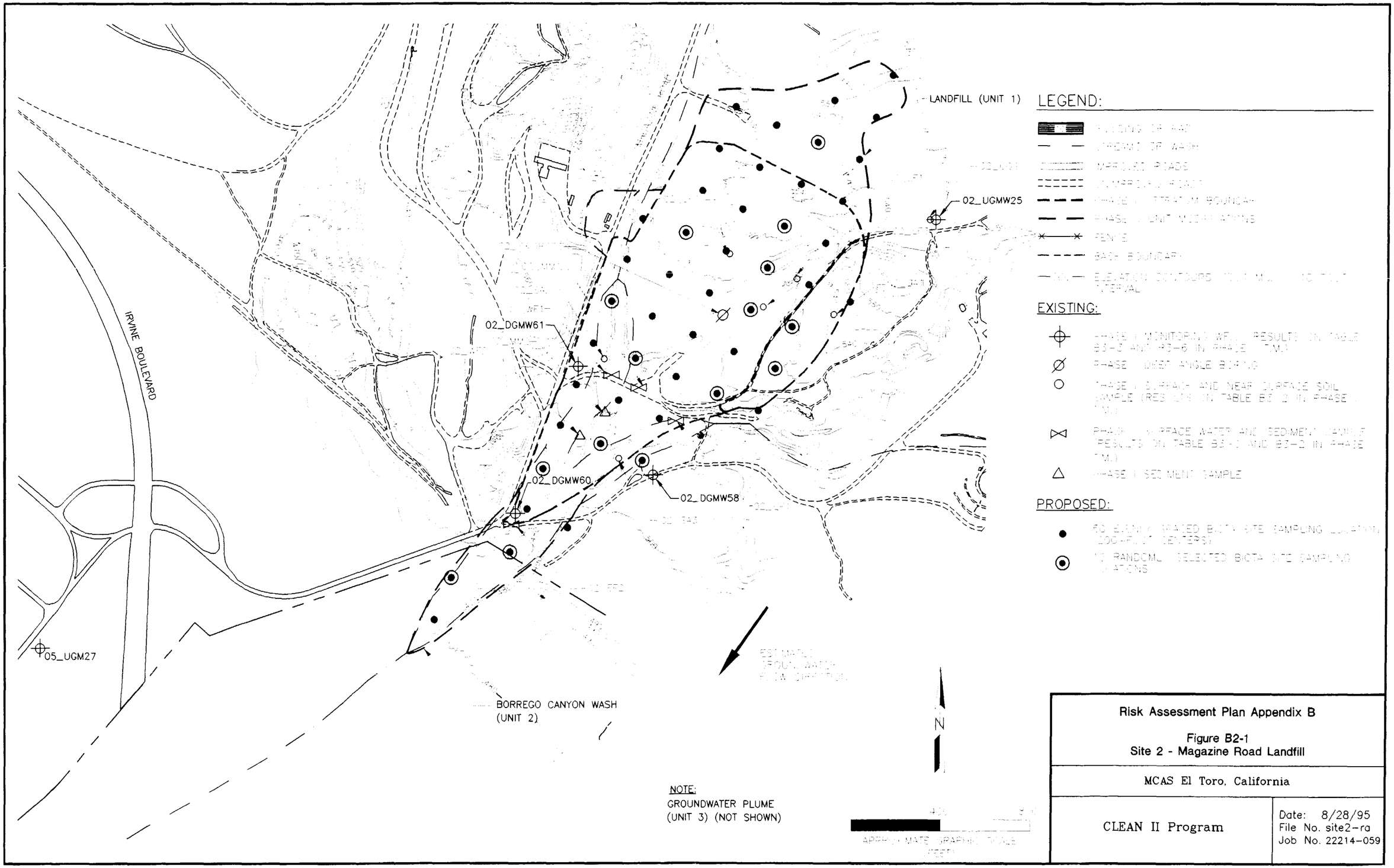

Risk Assessment Plan Appendix B

Figure B2-1
Site 2 - Magazine Road Landfill

MCAS El Toro, California

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File No. site2-ra
Job No. 22214-059

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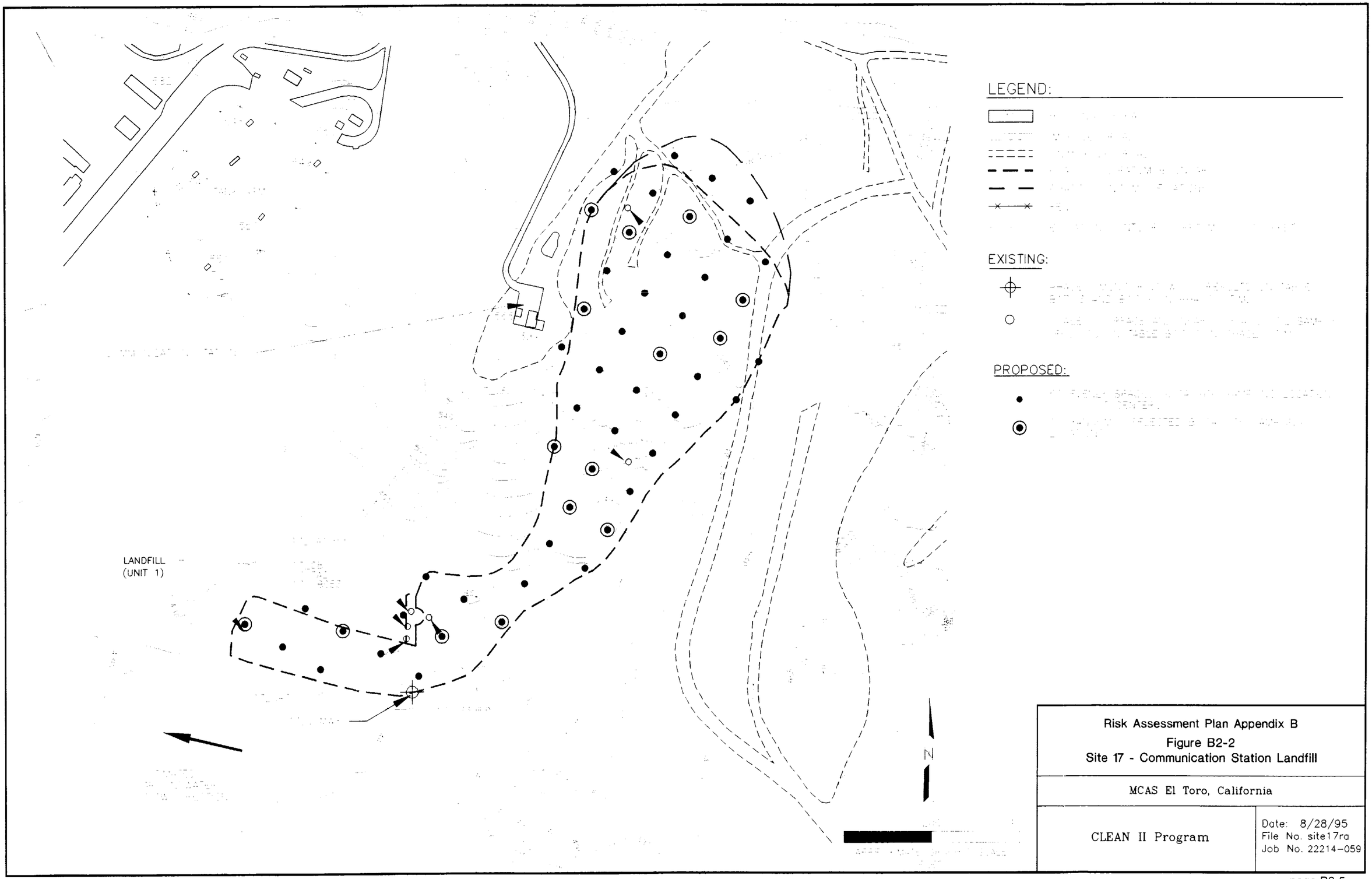

Risk Assessment Plan Appendix B
Figure B2-2
Site 17 - Communication Station Landfill

MCAS El Toro, California

CLEAN II Program

Date: 8/28/95
File No. site17ra
Job No. 22214-059

Section 3
SAMPLING PROCEDURES

Three sets of samples may be collected at each sampling location, including soil, small mammal, and plant material. The following sections discuss these sampling procedures.

3.1 SHALLOW SOIL SAMPLES

At the 15 randomly selected locations at each site, soil samples will be collected from a depth of 1 to 2 feet below ground surface using procedures discussed in Section 6 of the Field Sampling Plan (BNI 1995a). In general, a hand auger will be used to advance the boring to the selected depth. A handheld hammer sampler will be used to drive a stainless steel tube sampler to the desired depth. The collected soil will be described according to the Unified Soil Classification System and will be field-screened for volatile organic compounds with a photoionization detector. The soil sample tube will then be capped and prepared for submittal to the analytical laboratory.

3.2 SMALL MAMMAL SAMPLES

Small burrowing mammals are the most appropriate vertebrate receptors because of their contact with soil, small home ranges, and are a basic diet of higher trophic level predators. A Sherman live trap, or equivalent, will be used because they are inexpensive, easily transported and set, and can be thoroughly cleaned when removed from the trapping site. These traps will be baited with rolled oats placed inside the trap. The traps will be protected from direct sunlight and rain by placing a piece of plywood over it. A bedding material will line the trap.

Once set, the traps will be checked for captured animals in early morning and before sunset. Adult animals with body weights greater than 15 grams will be retained and a specialist in small mammal identification will speciate the captured animals. Special-status species will be released. Enough adult small mammals (preferably deer mouse) will be collected from each site to provide sufficient sample quantity (Section 4 of this Appendix). The retained animals will be euthanized in a manner to avoid pain.

All small mammals caught will be identified, sexed, and weighed in the field. Mammalian samples will be placed separately and double-bagged in clean Whirl-Pak bags and labeled. The label will be marked directly on the sample bag using an inedible marker. Samples will be chilled by placing in a cooler with blue ice and shipped by overnight delivery to the laboratory.

The sample label and chain-of-custody record will be completed. The field activity logbook will be used to record field activity, site condition, sample condition, and any deviation in the sampling protocol.

Prior to chemical analyses at the analytical laboratory, each whole specimen will be homogenized in a Warring blender to obtain a uniform, whole body tissue sample. A sample of the homogenate will be used for analysis. This analysis will provide quantitative results which will be used to simulate chemical exposure that might occur if higher-trophic level organisms consume the small mammals.

3.3 VEGETATION SAMPLES

Vegetation is the dominant biological component of a terrestrial ecosystem. Depending on species, soil characteristics, and environmental stresses, 40 to 85 percent of the plant mass may reside below the ground and in contact with contaminants in the soil.

To collect the vegetation samples, the vegetation community will be described at each randomly selected sampling location in an area of approximately 10- to 20-foot radius. The relative percentages of different plant species will be estimated and conditions of the plant community will be described.

Samples of vegetation will only be collected where California sagebrush is present. California sagebrush is one of the dominant plant species in the coastal sage scrub habitat and the concern will be to represent vegetation in this plant community. Samples of this plant will be collected from shoots, leaves, and seeds of mature plants within a 10-foot radius circle of the sample location with a clean, decontaminated, handheld stainless steel clipper. Shoots, leaves, and seeds constitute the preferred diet of insects and small mammals.

Clippings will be placed in new Whirl-Pak bags and labeled. All samples will be placed on blue ice. The sample label and chain-of-custody record will be completed. The field logbook will be used to record field activities, site condition, sample condition, and any deviation form the field protocol.

Prior to chemical analyses at the analytical laboratory, each sample will be homogenized in a Warring blender to obtain a uniform sample. A sample of the homogenate will be used for analysis. This analysis will provide quantitative results which will be used to simulate chemical exposure that might occur if higher-trophic level organisms consume insects and small mammals that may be feeding on this plants.

Section 4
REQUEST FOR ANALYSIS

Based on information in the data quality objectives for Sites 2 and 17 (BNI 1995b), the biota samples will be analyzed for:

- semivolatile organic compounds by United States Environmental Protection Agency (U.S. EPA) Method 8270 which requires 20 grams of tissue,
- pesticides by U.S. EPA Method 8080, which requires 20 grams of tissue, and
- metals by the U.S. EPA Method 200 series, which requires 10 grams of tissue.

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Section 5
PERMITS

Because the ecological field investigation will be conducted in a wildlife conservation area, all applicable local, state, and federal wildlife permits regulating taking of wildlife must be applied for before sampling. However, special-status wildlife species may be trapped but would be released at the sample location.

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Section 6
HEALTH AND SAFETY PRECAUTIONS

Many mammalian diseases are transmissible to humans. Every small mammal sample will therefore be treated as a potential health threat. All field personnel must wear leather gloves while handling mammals.

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Section 7
SAMPLE LABELING AND SHIPPING

Each sample will be identified with a unique sample number as discussed in Section 6 of the Field Sampling Plan (BNI 1995a). The chain-of-custody procedures as discussed in Section 6 of the Field Sampling Plan (BNI 1995a) will be followed. In addition to sample packaging and shipping as discussed in Section 6 of the Field Sampling Plan (BNI 1995a), the containers with wildlife specimens must bear the name and address of the shipper and consignee with a accurate statement of containers marked on the outside of the container as required by U.S. Fish and Wildlife regulations (50 *Code of Federal Regulations* 14). A packing list that includes the names and address of the cosignee and shipper and an accurate statement of types and quantities of each species contained in the shipment, should be secured on the outside of the container.

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Section 8
REFERENCES

Bechtel National, Inc. 1995a. Final Field Sampling Plan, Phase II Remedial Investigation and Feasibility Study, MCAS El Toro.

——— 1995b. Final Work Plan, Phase II Remedial Investigation and Feasibility Study, MCAS El Toro.

BNI. See Bechtel National, Inc.

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