Southwest Division
Naval Facilities Engineering Command
Contracts Department
1220 Pacific Highway, Building 127, Room 112
San Diego, CA 92132-5187

Contract No. N68711-92-D-4670

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

CLEAN II

FIELD SAMPLING PLAN GROUNDWATER MONITORING OF PERCHLORATE MARINE CORPS AIR STATION EL TORO, CALIFORNIA

CTO-0171/0020
August 1998

Prepared by:

BECHTEL NATIONAL, INC.
401 West A Street, Suite 1000
San Diego, CA 92101-7905

Signature: ______________ for   Date: 8/25/98
J. Patrick Wiegand, CTO Leader

Signature: ______________   Date: 8/25/98
Nars Ancog, U.S. Navy Quality Assurance Officer

SUMMARY

Sampling and analysis of groundwater for perchlorate will be conducted at 50 monitoring wells/ports at Marine Corps Air Station (MCAS) El Toro located in Orange County, California. This Field Sampling Plan (FSP) and the Quality Assurance Project Plan (QAPP) (BNI 1998a) constitute the fieldwork plans for groundwater monitoring of perchlorate as stipulated by United States Environmental Protection Agency guidelines.

This FSP provides an overview of field sampling procedures, laboratory analyses, and data-gathering methods to be used for groundwater monitoring of perchlorate. The field methods to be followed during the groundwater monitoring are based on previous groundwater monitoring at MCAS El Toro, comments from regulatory agencies, and available technologies. During the procurement, mobilization, and/or implementation phases, these field methods may change to incorporate revisions, innovative technologies, or other supplemental information. Additional information on verification and validation of analytical methods, as well as Comprehensive Long-Term Environmental Action Navy Program Standard Operating Procedures applicable to groundwater monitoring at MCAS El Toro, are found in the QAPP.

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ACRONYMS/ABBREVIATIONS

bgs	below ground surface
BNI	Bechtel National, Inc.
°C	degrees Celsius
CDM	CDM Federal Programs Corporation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy
CPT	cone penetrometer test
CTO	Contract Task Order
DBPE	double-blind performance evaluation
DHS	Department of Health Services
DMP	Data Management Plan
DO	dissolved oxygen
DON	Department of the Navy
DQO	data quality objective
DRMO	Defense Reutilization and Marketing Office
EC	electrical conductivity
EOD	explosive ordnance disposal
°F	degrees Fahrenheit
FFA	Federal Facilities Agreement
FID	flame ionization detector
FS	Feasibility Study
FSP	Field Sampling Plan
IDWMP	Investigation-Derived Waste Management Plan
IRP	Installation Restoration Program
IRWD	Irvine Ranch Water District
JEG	Jacobs Engineering Group, Inc.
JMM	James M. Montgomery Engineers, Inc.
µg/L	micrograms per liter
MCAS	Marine Corps Air Station
mg/L	milligrams per liter
MS	matrix spike
MSD	matrix spike duplicate
MSL	mean sea level

ACRONYMS/ABBREVIATIONS (continued)

NFA	no further action
NFESC	Naval Facilities Engineering Service Center
OCWD	Orange County Water District
ORP	oxidation-reduction potential
OU	operable unit
PID	photoionization detector
PPE	personal protective equipment
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
SOP	Standard Operating Procedure
SSHP	Site-Specific Safety and Health Plan Supplement
Station	Marine Corps Air Station El Toro
SWDIV	Southwest Division Naval Facilities Engineering Command
TCE	trichloroethene
TDS	total dissolved solids
U.S. EPA	United States Environmental Protection Agency
VOC	volatile organic compound
WSA	waste staging area

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SECTION 1

INTRODUCTION

Section 1
INTRODUCTION

Groundwater monitoring for perchlorate will be conducted at Marine Corps Air Station (MCAS) El Toro (Station), located in Orange County, California. This Field Sampling Plan (FSP) was prepared by Bechtel National, Inc. (BNI), on behalf of the United States (U.S.) Department of the Navy (DON), Southwest Division Naval Facilities Engineering Command (SWDIV), in accordance with Contract Task Order (CTO)-0171 issued under the Comprehensive Long-Term Environmental Action Navy (CLEAN) II Program, contract No. N68711-92-D-4670. This FSP and the accompanying Quality Assurance Project Plan (QAPP) (BNI 1998a) constitute the fieldwork plans that will guide implementation of the perchlorate sampling activities at MCAS El Toro.

1.1 PURPOSE

This FSP provides an overview of field sampling procedures and data gathering methods that will be used to conduct a single perchlorate groundwater sampling event. Preparation of an FSP is a requirement of the Federal Facilities Agreement (FFA) dated October 1990, between the DON, the U.S. Environmental Protection Agency (U.S. EPA) Region IX, the California Environmental Protection Agency, and the California Regional Water Quality Control Board Santa Ana Region.

1.2 OBJECTIVES

The objectives for groundwater monitoring of perchlorate at MCAS El Toro are to:

- determine the concentrations and distribution of perchlorate in the shallow groundwater unit and the principal aquifer at on-Station, downgradient off-Station, and background sampling locations; and
- provide data to evaluate whether MCAS El Toro is a probable source of perchlorate in groundwater or whether reported perchlorate concentrations reflect ambient groundwater quality.

The data collected during groundwater monitoring for perchlorate will be used to produce a brief groundwater monitoring report that summarizes the results of the field sampling program and presents recommendations for further action, if applicable, based on the data quality objectives (DQOs) outlined in the QAPP (BNI 1998a).

1.3 CONTENTS

The contents of this FSP focus on the field sampling and analytical procedures and types of information to be collected. This FSP consists of the following.

- Section 1, Introduction. This section summarizes the groundwater monitoring objectives and the structure of the FSP.
- Section 2, Site Description. This section summarizes Station history and physical setting.

- Section 3, Maps. This section presents maps identifying the locations of monitoring wells to be sampled.
- Section 4, Rationale for Groundwater Sampling. This section briefly summarizes the rationale for the groundwater sampling.
- Section 5, Request for Analyses. This section identifies the laboratory samples and analyses.
- Section 6, Field Methods and Procedures. This section describes the field methods and procedures that will be used to conduct the groundwater sampling activities.
- Section 7, Referenced Forms and Data Sheets. This section presents the forms that will be used to record data collected in the field during groundwater monitoring.
- Section 8, References. This section lists references cited in the text.

This FSP is one of five plans that have been prepared to facilitate groundwater sampling for perchlorate at MCAS El Toro. The other supporting plans are:

- QAPP. This document summarizes data measurement objectives, sample collection procedures, and data management procedures (BNI 1998a).
- Update to the Final Investigation-Derived Waste Management Plan (IDWMP) (BNI 1998b). This document, prepared under CTO-153 as an appendix to the MCAS El Toro Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Groundwater Monitoring Plan, is an update to the approved final IDWMP prepared by CDM Federal Programs Corporation (CDM) for previous groundwater monitoring at the Station (CDM 1995). The update to the IDWMP summarizes procedures for handling, storing, and disposing of waste materials generated during groundwater monitoring.
- Site-Specific Safety and Health Plan Supplement (SSHP) (BNI 1998c). This document was prepared under CTO-153 as an appendix to the MCAS El Toro CERCLA Groundwater Monitoring Plan.
- Update to the Final Amended Data Management Plan (DMP) (BNI 1998d). This document, prepared under CTO-153 as an appendix to the MCAS El Toro CERCLA Groundwater Monitoring Plan, is an update to the approved final amended DMP prepared by CDM for previous groundwater monitoring at the Station (CDM 1996a). The update to the DMP summarizes the procedures that will be used to manage data collected during groundwater monitoring.

SECTION 2

SITE DESCRIPTION

Section 2
SITE DESCRIPTION

This section summarizes the history and physical conditions at MCAS El Toro, including information pertaining to perchlorate in groundwater.

2.1 LOCATION

MCAS El Toro is situated in a semiurban agricultural area in southern California, approximately 8 miles southeast of Santa Ana and 12 miles northeast of Laguna Beach (maps are provided in Section 3). Land northwest of MCAS El Toro is used for agricultural purposes; land to the south and northeast is used primarily for commercial, light industrial, and residential purposes. The closest residential areas are the cities of Lake Forest, Irvine, and Laguna Hills.

2.2 HISTORY

The following subsections provide a summary of the history, recent base operations, and previous investigations at MCAS El Toro.

2.2.1 History of MCAS El Toro

MCAS El Toro was commissioned as a Marine Corps pilot fleet operation training facility in March 1943. In 1950, MCAS El Toro was selected for development as a master jet station and permanent center for Marine Corps aviation on the west coast to support the operations and combat readiness of Pacific Fleet Marine Forces. Since its commissioning, MCAS El Toro has been used for aviation activities of the United States Marine Corps and continues to provide materials and support for these activities.

2.2.2 Recent Base Operations

MCAS El Toro occupies 4,738 acres (BNI 1997a) comprising runways, aircraft maintenance and training facilities, ground support and construction equipment maintenance facilities, housing, shopping facilities, and other support facilities. As of 1995, approximately 6,600 marines and civilian personnel worked or resided at MCAS El Toro.

In March 1993, MCAS El Toro was placed on the proposed Base Closure and Realignment Act of 1990 list of military facilities considered for base closure and was formally selected for closure in September of that year. The Station is scheduled to close in July 1999. Some operations have already ceased, and various parts of the Station are no longer in use. Most of the aircraft squadrons have been transferred to other Marine Corps and Naval Air Stations. Some of the resulting vacated space temporarily houses helicopters that departed MCAS Tustin (BNI 1997a).

Currently, hazardous wastes are managed under Resource Conservation and Recovery Act (RCRA) requirements. Hazardous wastes are stored in containers at generator accumulation areas and are held for less than 90 days. The on-Station RCRA

Interim-Status Storage Facility holds these wastes until they are released for disposal. MCAS El Toro contracts with waste transporters as well as treatment, storage, and disposal facilities to transport, recycle, treat, and dispose of hazardous wastes. The contracts are established through either the Defense Reutilization and Marketing Office (DRMO) established in 1973 or through the Environmental Office at the Station.

Based on information presented in the various plans and reports prepared for MCAS El Toro (Base Closure Plan, Environmental Baseline Study, Remedial Investigation reports, and RCRA Assessment reports), only a few sites may be potential sources of perchlorates. Other than solid propellants in missile and possible jet-assisted take-off units used during World War II, which were stored on the Station, no explosives or solid propellant manufacturing occurred there. However, residual or damaged weapons containing perchlorates may have been disposed at MCAS El Toro.

Disposal of ordnance has been conducted at Site 1 (Explosive Ordnance Disposal [EOD] Range) since 1952. Military ordnance demolition/disposal has included small arms ammunition, hand grenades, land mines, cluster bombs, smoke bombs, rocket warheads, and rocket motor propellants. Civilian and commercial explosives, such as 2,4,6-trinitrotoluene, dynamite, and plastic or gelatinous explosives, are also disposed at the EOD Range. Ordnance such as small arms ammunition and rocket motor propellants are placed in slit trenches covered with steel plating, doused with fuel, and ignited. Metal slag remaining after a burn is collected, drummed, and transported to the DRMO yard for sale as scrap metal. Most of the other ordnance is placed in trenches or small pits and detonated. An estimated 30,000 tons of munitions and explosives have been disposed at this site. In addition, an estimated 300,000 gallons of petroleum fuels were used in burning the disposed materials (JEG 1993). According to Station personnel, their records show that various missiles with solid propellants were destroyed at this site. These missiles include the Dragon missiles; TOW missiles; LAAW rockets; AT4 antitank rockets; and rocket motors from 2.25-inch, 2.75-inch, and 5-inch rockets (Mullet, pers. com. 1994).

Because of their explosive nature and association with weapons, it is unlikely that significant quantities of perchlorate compounds would have been intentionally disposed in landfill Sites 2, 3, 5, and 17. However, small quantities from munitions may have been disposed in the landfills.

2.2.3 Previous Investigations

In 1985, trichloroethene (TCE) was identified in groundwater from an agricultural well located about 3,000 feet west of the Station during routine groundwater sampling performed by Orange County Water District (OCWD). Subsequent investigation by OCWD concluded that MCAS El Toro was the source of the groundwater contamination (Herndon and Reilly 1989). In 1990, the U.S. EPA placed MCAS El Toro on the National Priorities List and the DON agreed to conduct a remedial investigation

(RI)/feasibility study (FS) of 24 Installation Restoration Program (IRP) sites previously identified. For purposes of the RI, the 24 sites were divided into the following three OUs.

- OU-1 addresses the regional groundwater contamination associated with Site 18.
- OU-2 is divided into three subunits.
  - OU-2A addresses the volatile organic compound (VOC) source area (Site 24) and the major surface drainages (Site 25).
  - OU-2B addresses two on-Station landfills (Sites 2 and 17).
  - OU-2C also addresses two on-Station landfills (Sites 3 and 5).
- OU-3 is divided into two subunits.
  - OU-3A addresses 13 sites (Sites 4, 6, 8, 9, 10, 11, 12, 13, 15, 19, 20, 21, and 22).
  - OU-3B addresses four sites (Sites 1, 7, 14, and 16).

The RI/FS for each OU was designed to investigate soil and/or groundwater contamination resulting from historical Station operations and recommend remedial action at sites that pose an unacceptable risk to human health and the environment.

RIs have been completed for the OU-1 (JEG 1996), OU-2A (BNI 1997b), OU-2B (BNI 1997c,d) OU-2C (BNI 1997e,f), and OU-3A (BNI 1997g) sites, as well as OU-3B Site 16 (BNI 1997g). Based on these RIs, no further action (NFA) was recommended for OU-2A Site 25 and OU-3A Sites 4, 6, 9, 10, 13, 15, 19, 20, 21, and 22. An NFA Record of Decision closing these 11 sites was signed in September 1997 (SWDIV 1997). Further action was recommended for OU-1 Site 18; OU-2A Site 24; OU-2B Sites 2 and 17; OU-2C Sites 3 and 5; OU-3A Sites 8, 11, and 12; and OU-3B Site 16. Groundwater contamination was identified in association with four of these ten sites (Sites 2, 16, 18, and 24) and groundwater was identified as an area of potential concern at three other sites (landfill Sites 3, 5, and 17). With the exception of OU-3B Site 16, FSs have been completed for all ten of these IRP sites, but no decisions have yet been made as to which remedial action alternative will be implemented at any of these sites. Although groundwater contamination was not identified in association with six of the sites (Sites 3, 5, 8, 11, 12, and 17), the remedial alternatives evaluated in FSs completed for landfill Sites 3, 5, and 17 include recommendations for long-term groundwater monitoring.

As part of the OU-1, OU-2A, OU-2B, OU-2C, and OU-3A RI/FS conducted at MCAS El Toro between 1992 and 1997, a network of 131 on- and off-Station monitoring locations (single wells, cluster wells, and Westbay multiports) was installed and sampled to determine groundwater flow patterns and to address groundwater quality issues. Two rounds of groundwater sampling and analyses were performed as part of the CLEAN I program in 1992 and 1993. Sampling and analyses of selected wells at the Station were also conducted between 1995 and 1997 as part of the CLEAN II program. Since 1996, five rounds of groundwater sampling and analyses (rounds 3 through 7) have been performed at up to 182 on- and off-Station sampling locations (single wells, cluster wells, and Westbay multiports) as part of the MCAS El Toro groundwater monitoring program (CDM 1996b; 1997a,b,c; and 1998). This monitoring program provided groundwater quality and groundwater-elevation data in support of ongoing RI/FS activities at MCAS El Toro. Thirty-six of these sampling locations are also monitored by OCWD, which routinely collects data from up to 85 on- and off-Station monitoring and production well locations.

Perchlorate was first identified in groundwater near MCAS El Toro during sampling conducted by the OCWD in December 1997. OCWD collected groundwater samples from Westbay Multiport monitoring well sample ports 18_MCAS03-1, 18_MCAS03-2, and 18_MCAS03-3 located at depths of 89, 164, and 224 feet below ground surface (bgs) respectively (OCWD 1998). This monitoring well is located approximately 100 feet west of the west Station boundary. The samples were sent to the California Department of Health Services (DHS)-approved Montgomery Watson analytical laboratory and a split sample from 164 feet bgs was sent to the DHS-approved Weck Laboratories for analysis of perchlorate using U.S. EPA Method 300-M. The Montgomery Watson laboratory did not detect perchlorate in the 89-foot-bgs sample (detection limit of 4.0 micrograms per liter [μg/L]) but detected 7.6 μg/L in the 164-foot-bgs sample and 4.3 μg/L in the 224-foot-bgs sample. Weck Laboratory did not detect perchlorate in the sample from 164 feet bgs. These concentrations are all below the California provisional action level of 18 μg/L.

Between 26 January 1998 and 09 March 1998, groundwater samples were collected with a HydroPunch® sampling device attached to a cone penetrometer test (CPT) direct-push truck near the west corner of MCAS El Toro. While the primary objective of this sampling activity was to refine the extent of the TCE plume in this area of the Station, samples were also collected and submitted for analyses of perchlorate. Twenty-eight HydroPunch samples were collected for analyses of perchlorate at depths ranging from 123 to 209.5 feet bgs at seven locations in an area approximately 500 to 2,000 feet east of off-Station OCWD monitoring well 18_MCAS03. Perchlorate was reported in 27 of the 28 samples at concentrations ranging from 4 to 23 μg/L (detection limit 10 μg/L). All but one of the reported perchlorate concentrations were 12 μg/L or less.

2.3 SETTING

The following subsections describe the setting of MCAS El Toro in terms of weather and climate, topography and geography, land use and demographics, biological setting, geology, hydrogeology, and hydrology.

2.3.1 Weather and Climate

MCAS El Toro has a Mediterranean climate, characterized by cool, moist winters and warm, dry summers. Early morning fogs are typical in late spring and early summer. Annual precipitation averages 12.2 inches, and most of the rainfall occurs from November through April. Winter temperatures seldom drop below freezing. The mean low temperature is 37 degrees Fahrenheit (°F). Summer temperatures rarely exceed 100°F. Night temperatures are generally cool throughout the year. From March through October, the prevailing wind is from the west and averages 6 knots. From November through February, the prevailing wind is from the east and averages 4 knots. During the late fall and early winter, strong, dry, gusty offshore winds (known locally as Santa Ana winds) are common.

2.3.2 Topography and Geography

MCAS El Toro is situated on the southeastern margin of the Tustin Plain, a gently sloping surface of alluvial fan deposits derived mainly from the Santa Ana Mountains. The Tustin Plain, bounded on the north and east by the Santa Ana Mountains and on the south by the San Joaquin Hills, is at the southeast end of the Los Angeles Basin, a large sedimentary basin in the Peninsular Ranges Geologic Province. At the west corner of MCAS El Toro, the elevation is approximately 215 feet above mean sea level (MSL) and rises to approximately 800 feet above MSL at the east corner of the Station in the foothills of the Santa Ana Mountains. The land northwest of MCAS El Toro is relatively level.

2.3.3 Land Use and Demographics

MCAS El Toro encompasses 7.4 square miles (about 4,738 acres). Approximately 1,000 acres are designated for outleases because airfield safety clearances render them unsuitable for any other use. The outleased lands are at the corners of the Station and are used for agricultural purposes, including landscape nurseries, livestock grazing, and crop production. Crops grown on-Station include strawberries, winter celery, tomatoes, and avocados (MCAS El Toro 1991).

Land use on MCAS El Toro consists of a few general types. General Station land uses are described in the following four quadrants, as defined by the bisecting north-south and east-west runways.

- The northwest quadrant consists primarily of administrative services (including the MCAS El Toro headquarters, family and bachelor housing, and community support services).
- The northeast quadrant consists primarily of Marine Aircraft Group activities (including training, maintenance, supply and storage, and airfield operations), family housing, community services, and ordnance storage for areas isolated by topographic relief and distance from other developments (MCAS El Toro 1991).
- The southeast quadrant consists primarily of administrative services, maintenance facilities, ordnance storage, and the golf course.
- The southwest quadrant includes maintenance facilities, supply and storage facilities, and limited administrative services.

The locations of structures, principal roads, and runways are shown in Figure 3-2. A boundary fence surrounds MCAS El Toro, and access is presently limited to two gates are open 24 hours: the Main Gate (off Trabuco Road) and Gate No. 2 (off Irvine Boulevard).

2.3.4 Biological Setting

The Initial Assessment Study report describes the biological features and existing habitats of MCAS El Toro (Brown and Caldwell 1986). Ecological descriptions (based on reconnaissance surveys conducted in early May 1992 and September 1993) and a biological inventory conducted by the U.S. Fish and Wildlife Service list and describe MCAS El Toro habitats (JEG 1993). A habitat assessment of the Station's IRP sites was also conducted in support of the Phase II RIs in May 1995. Ninety percent of the native habitats at MCAS El Toro have been cleared for agriculture, housing, and Station operations. In the remaining 10 percent of the Station, three native habitats predominate: annual grassland (70 percent), coastal sage scrub, and riparian woodland (Brown and Caldwell 1986). Many wildlife species typically include multiple habitats within their home range.

2.3.5 Geology

This section summarizes background information on the geology of MCAS El Toro and the area surrounding the Station.

2.3.5.1 STRATIGRAPHY

MCAS El Toro is underlain primarily by Tertiary sedimentary rocks, which are overlain by Quaternary surficial deposits (Fife 1974). Most of the Station, comprising the Tustin Plain, lies on alluvial fan deposits derived mainly from the Santa Ana Mountains. These Holocene materials consist of isolated coarse-grained, stream-channel deposits contained within a matrix of fine-grained overbank deposits that range in thickness up to 300 feet (Herndon and Reilly 1989). The Holocene alluvial materials conformably overlie Pleistocene Age sediments predominantly composed of interlayered fine-grained lagoonal and near-shore marine deposits. These materials become increasingly mixed with beach sands, terrace, and stream-channel deposits in the eastern portion of the Tustin Plain and along the plain margins. Thus, the Quaternary deposits form a heterogeneous mixture of silts and clays with interbedded sands and fine gravels that range in thickness up to 500 feet in the western portion of the Tustin Plain (Singer 1973). The deeper Quaternary sediments may be equivalent to the lower Pleistocene San Pedro Formation, which consists of semiconsolidated silts, clays, and sands with interbedded limestone. These lagoonal and shallow marine deposits are considered to be a major water-bearing unit in the region (Brown and Caldwell 1986).

The Pleistocene deposits unconformably overlie older semiconsolidated marine sandstones, siltstones, and conglomerates of late Miocene to late Pliocene age; these units make up the Niguel, Fernando, and Capistrano Formations. These semiconsolidated sediments are considered bedrock near MCAS El Toro. The lower Pliocene Fernando Formation is the base of the water-bearing units at MCAS El Toro (Herndon and Reilly 1989). This formation probably interfingers with marine clayey and sandy siltstones of the Capistrano and Niguel Formations west of MCAS El Toro. Together, these formations range up to 1,500 feet in thickness (JMM 1988).

The foothills area in the northeast corner of MCAS El Toro is also characterized by Tertiary sedimentary rocks overlain by a thin cover of Quaternary alluvial and colluvial deposits. The bedrock consists of poorly to moderately consolidated siltstone and sandstone strata. The alluvial deposits are composed of heterogeneous mixtures of sand and gravel with lesser amounts of silt and clay. The alluvial deposits range in thickness from less than a foot along some ridge tops to more than 200 feet along the surface drainage channels incised into the bedrock strata. Along the washes, the alluvial deposits thicken in a downstream (southwesterly) direction.

2.3.5.2 STRUCTURAL GEOLOGY

MCAS El Toro is situated on the southeastern edge of the Tustin Plain in the so-called "Central Block" of the Los Angeles Basin, which is bound on the north by the Whittier Fault zone and on the south by the Newport-Inglewood Fault zone (JEG 1993). The Los Angeles Basin is characterized by a northwest-trending, doubly plunging synclinal trough, deeper than 30,000 feet. In the study area, several faults and folds are found on the flanks of the Los Angeles Basin syncline. Three northwest-trending faults (Shady Canyon, Pelican Hill, and Newport-Inglewood) are less than 10 miles southwest of MCAS El Toro. The Shady Canyon Fault is a normal fault with the west side down.

The Pelican Hill Fault, probably a branch of the Newport-Inglewood Fault, is a right-lateral strike-slip fault (Miller and Tan 1976). Of these faults, only the Newport-Inglewood Fault (also a right-lateral strike-slip fault) is considered active (Holocene movement). The Cristianitos Fault, a north-trending, high-angle, normal fault, is 3 miles east of MCAS El Toro. This fault appears to converge with a system of northwest-trending frontal faults along the southwest side of the Santa Ana Mountains (Fife 1974).

2.3.6 Hydrogeology

MCAS El Toro is situated within the Irvine Groundwater Subbasin, immediately southeast of the Main Orange County Groundwater Basin. From a regional standpoint, aquifer systems in the Irvine Subbasin have been described as a series of discontinuous lenses of clayey sands and gravels contained within an assemblage of sandy clay and silt (JEG 1996). Regionally, the lenticular nature of the sandy clays and silts that separate the more permeable sand and gravel lenses probably allows groundwater to flow between aquifer zones. The Irvine Subbasin groundwater system has been divided into a forebay area and a pressure area. The forebay area is situated along the margin of the basin where alluvial sediments abut or overlie the semiconsolidated bedrock strata of the foothills. Most of the regional recharge takes place in the forebay area. Groundwater recharge results from infiltration of precipitation, runoff from the surface drainages in the foothills areas, and applied irrigation water. Runoff from the foothills areas and applied irrigation water account for most of the annual basin recharge (JEG 1996). The pressure area is located in the central portion of the subbasin where the sediments are thicker. Productive aquifers in this area are present mainly in deeper zones that become increasingly confined with depth. Groundwater within the Irvine Subbasin generally flows in a westerly direction toward the Pacific Ocean. However, groundwater flow in the central and western portions of the subbasin are affected by local pumping depressions nested around several extraction well fields.

2.3.6.1 AQUIFER SYSTEMS

The uppermost subsurface sediments beneath the western half of MCAS El Toro and the off-Station area to west and northwest comprise the three main hydrogeologic units. These consist of a coarse-grained interval designated the shallow groundwater unit, a deeper coarse-grained interval designated the principal aquifer, and a fine-grained intermediate zone that appears to hydraulically separate the two aquifer zones. The principal aquifer zone is underlain by low-permeability semiconsolidated materials. The contact between the principal aquifer and these low-permeability materials is considered the base of the water-bearing zone in this area (Herndon and Reilly 1989). Near the eastern Station boundary and in the foothills area to the northeast, the intermediate zone pinches out or is not present and only a single aquifer zone has been identified (JEG 1996). The single aquifer zone in this part of the Station is also designated as the shallow groundwater unit. Groundwater in the shallow groundwater unit is typically present under unconfined "water table" conditions, while groundwater in the principal aquifer is typically present under confined conditions.

2.3.6.2 HORIZONTAL FLOW

Groundwater is first encountered in the shallow groundwater unit at depths ranging from about 10 feet bgs in Irvine near North Lake (about 2 miles west of MCAS El Toro) up to approximately 230 feet bgs in monitoring wells located along the margin of the Tustin Plain (near the southeastern Station boundary). The total saturated thickness of this first water-bearing unit throughout the Irvine Subbasin ranges from approximately 100 to 150 feet (JEG 1996). Groundwater elevations in the shallow groundwater unit range from about 90 feet MSL near North Lake to about 280 feet MSL along the southeastern Station boundary. The direction of groundwater flow in the shallow unit is generally toward the northwest at an average hydraulic gradient of approximately 0.007 feet per foot.

In the foothill area at the northeast corner of the Station, the depth to groundwater ranges from approximately 25 feet bgs in the alluvial deposits along Borrego Canyon Wash to approximately 110 feet bgs in bedrock along the north Station boundary. In the alluvial deposits along Borrego Canyon Wash and its tributaries, the thickness of the saturated alluvium is typically 40 feet or less, generally increasing in the downstream direction.

Groundwater elevations in the foothills area range from about 435 feet MSL near the margin of the Tustin Plain up to about 685 feet MSL in a monitoring well located adjacent to the northern Station boundary. Groundwater flow in the alluvial sediments and bedrock of the foothills area is generally toward the southwest at an average hydraulic gradient of approximately 0.027 feet per foot. At the edge of the foothills area, the bedrock surface beneath the shallow alluvium in the foothills dives steeply beneath the thicker basin fill alluvial deposits of the Tustin Plain. There, the hydraulic gradient increases dramatically as groundwater elevations decline from about 430 feet MSL to about 280 feet MSL as the shallow groundwater in the foothills transitions to the shallow groundwater unit in the Irvine Subbasin.

The intermediate zone separates the shallow groundwater unit from the deeper principal aquifer throughout most of the Irvine Subbasin. Based on lithologic, CPT, and geophysical logs, it has been determined that the intermediate zone consists of finer-grained alluvial sediments and ranges from approximately 70 to 140 feet thick (JEG 1996). Geotechnical analytical results indicate that the hydraulic conductivity of the intermediate zone is several orders of magnitude lower than the hydraulic conductivity of the two water-bearing zones it separates (BNI 1997b). Although the vertical thickness of this low-permeability layer suggests it would act as an aquitard between the shallow groundwater unit and the principal aquifer in much of the Irvine Subbasin, subsurface data also suggest that the intermediate zone is not a single areally extensive geologic unit (JEG 1996). The composition and hydrogeologic properties of the intermediate zone sediments commonly vary both laterally and vertically, so discontinuities in the intermediate zone are likely to exist throughout the Irvine Subbasin.

The principal aquifer is the main water-production zone in the Irvine area. The saturated thickness of the principal aquifer ranges from less than 50 feet in the eastern portion of the Irvine Subbasin to approximately 1,000 feet in the western portion (JEG 1996). Groundwater elevations in the principal aquifer under static (i.e., nonpumping) conditions range from approximately 10 feet MSL near the western end of the Irvine Subbasin to about 200 feet MSL along its eastern margin beneath MCAS El Toro. The direction of groundwater flow in the principal aquifer is generally towards the west and northwest. Beneath MCAS El Toro, the groundwater flow direction is generally toward the northwest. It becomes more westerly off-Station in the downgradient direction as a result of a large local groundwater depression created by withdrawals from several production wells located in the vicinity of North Lake. The hydraulic gradient ranges from about 0.007 feet per foot beneath MCAS El Toro to more than 0.02 feet per foot in the vicinity of downgradient off-Station production well 18_NLAKE.

Groundwater conditions within the principal aquifer vary locally throughout the year as a result of groundwater production at pumping centers situated throughout the Irvine Subbasin. Most of the groundwater production is concentrated in the western part of the Subbasin downgradient from MCAS El Toro. However, several wells that contribute a limited amount to the overall production from the Subbasin are located either on-Station or near the MCAS El Toro western boundary. In addition, the Irvine Desalter Project, which is partially designed but on hold at this time, has proposed additional extraction wells in the eastern Irvine Subbasin in the vicinity of MCAS El Toro. Several of the proposed well locations are just off-Station near the western corner of MCAS El Toro.

Groundwater withdrawals associated with the production wells are used primarily for irrigation purposes. During their annual periods of operation, typically about 6 months during the summer and fall (JEG 1996), drawdown resulting from groundwater withdrawals produces localized depressions in the regional potentiometric surface. While the groundwater flow direction remains west and northwesterly on a regional scale, localized changes in the hydraulic gradient induce groundwater flow toward the production wells at the center of these pumping depressions. Hydrographs of selected production wells in the Irvine Subbasin indicate that the potentiometric surface elevation may decline up to 250 feet at some well locations when they are in operation. Furthermore, declines in potentiometric surface elevations of up to 40 feet or more are observed on hydrographs of selected monitoring wells located up to one-half mile from the nearest operating production well.

2.3.6.3 VERTICAL FLOW

Vertical groundwater flow between the shallow groundwater unit and the principal aquifer can be characterized by comparing groundwater elevation measurements obtained from cluster wells and Westbay multiport wells that monitor conditions in the shallow groundwater unit and principal aquifer. Potentiometric elevations measured in the principal aquifer fluctuate over a much greater range than those measured in the shallow groundwater unit at the same location. The greater range of variation in the principal aquifer reflects groundwater withdrawals by the production wells that are typically screened over long intervals of this water-bearing zone. The absence of a similar response in the shallow groundwater unit suggests that throughout much of the basin, the low permeability of the fine-grained materials constituting the intermediate zone limits vertical flow between the shallow groundwater unit and the principal aquifer. However, the presence of TCE in the principal aquifer downgradient from MCAS El Toro indicates that some vertical flow occurs between the two water-bearing zones. The degree of hydraulic communication is largely controlled by the composition, continuity, and thickness of the fine-grained sediments constituting the intermediate zone at a particular location.

The potentiometric elevation data suggest that vertical groundwater flow throughout most of the basin is generally characterized by a slight downward gradient that becomes more pronounced when the principal aquifer production wells are in operation. A downward gradient is observed primarily in the off-Station area to the west of MCAS El Toro. A neutral or slight upward groundwater gradient between the two water-bearing zones may also develop locally when potentiometric elevations in the principal aquifer recover to static or near-static conditions during nonpumping periods and in areas remote from the production well. Upward gradients are observed most frequently in the northern half of the Subbasin remote from the production wells and beneath MCAS El Toro. The transition from the neutral or upward gradient (typically observed beneath the Station) to the downward gradient (typically observed off-Station to the west) occurs just west of the Station boundary. This is also the area where the VOC plume in the shallow groundwater unit migrates downward into the underlying principal aquifer.

2.3.6.4 AVERAGE LINEAR GROUNDWATER VELOCITIES

Aquifer test results presented in the draft final Interim OU-1 RI report (JEG 1996) for wells screened in the shallow groundwater unit at various on- and off-Station locations indicate that hydraulic conductivity values range from about 0.01 to 174 feet per day. In the foothills area at the northeast corner of the Station, aquifer test results presented in the Phase II RI report for OU-2B Site 2 suggest that hydraulic conductivities may range from about 0.06 to 1 feet per day in the saturated alluvial deposits and from 0.05 to 19 feet per day in bedrock (BNI 1997c). Based upon results reported for a variety of aquifer tests, the hydraulic conductivities of the saturated sediments constituting the principal aquifer range from 0.01 to 56.8 feet per day (JEG 1996).

2.3.6.5 WATER QUALITY

Groundwater quality in the shallow groundwater unit and the principal aquifer throughout much of the Irvine Subbasin is generally characterized by elevated concentrations of total dissolved solids (TDS) and nitrate. TDS concentrations in the shallow groundwater unit range from approximately 300 milligrams per liter (mg/L) to greater than 2,500 mg/L. Nitrate concentrations range from approximately 1 mg/L to greater than 200 mg/L. Although considerable variation in the areal distribution of TDS and nitrate concentrations is evident from groundwater monitoring data, concentrations generally increase in a downgradient direction. The high TDS concentrations in the shallow groundwater unit may be related to the cyclic downward leaching of salts by infiltrating water from precipitation and irrigation, as well as the loss of moisture through evaporation from the shallow water table and vadose zone in the western part of the Subbasin. The elevated nitrate concentrations are probably the result of agricultural practices and former unsewered development (Banks 1984).

Investigations conducted by OCWD (Herndon and Reilly 1989) to the west of MCAS El Toro suggest that the principal aquifer can be differentiated into two hydrochemical facies based upon differences in TDS and nitrate concentrations. The upper facies, present at depths ranging from approximately 200 to between 400 and 450 feet bgs, is characterized by lower TDS and nitrate concentrations. The lower facies, present at depths greater than 400 to 450 feet bgs, is characterized by higher TDS concentrations and low nitrate concentrations. Analytical results reported for sampling locations screened in the upper facies interval had TDS concentrations ranging from approximately 700 to 1,500 mg/L and nitrate concentrations ranging from less than 0.1 to about 60 mg/L. Analytical results for samples obtained from the lower facies interval had TDS concentrations ranging from about 350 mg/L to greater than 3,000 mg/L and nitrate concentrations generally ranging from less than 0.1 mg/L to about 10 mg/L.

Concern about the elevated TDS and nitrate concentrations in groundwater was the primary factor that led to initial planning for the Irvine Desalter Project by OCWD and the Irvine Ranch Water District (IRWD) in the mid-1980s. OCWD and IRWD initiated the Irvine Desalter Project program to contain TDS and nitrate plumes by extracting approximately 8,460 acre-feet of groundwater per year that would be treated to potable water quality standards and distributed by the IRWD (OCWD 1994). Since the identification of TCE in groundwater in 1985, OCWD has modified the Irvine Desalter Project to address VOC contamination in addition to the capture and treatment of TDS and nitrates (JEG 1996).

2.3.7 Surface Hydrology

Surface drainage near MCAS El Toro generally flows southwest, following the slope of the land perpendicular to the trend of the Santa Ana Mountains. Several washes originate in the hills northeast of MCAS El Toro and flow through or adjacent to the Station en route to San Diego Creek. Off-Station drainage from the hills and upgradient irrigated farmlands combines with Station runoff at MCAS El Toro (generated from the extensive paved surfaces) and flows into four main drainage channels: Borrego Canyon, Agua Chinon, Bee Canyon, and Marshburn Channel (Figure 3-2).

The southernmost wash is Borrego Canyon Wash, which flows along the southeast boundary of MCAS El Toro. The wash is unlined in the Santa Ana Mountains; downstream of Irvine Boulevard, it is lined. Borrego Canyon Wash crosses the south corner of the Station and joins Agua Chinon Wash about 1/4 mile from the Station boundary.

Both the Agua Chinon and the Bee Canyon Washes cross the central portion of MCAS El Toro and receive runoff mainly through storm sewers. These washes are contained in culverts through most of their pathways across the Station. Both washes are unlined along several hundred feet at the southwest edge of the Station and are lined again in a culvert beneath the Irvine Spectrum development adjacent to the southwest boundary of the Station. Surface water may infiltrate through the bottom of the unlined portions of the culverts. The lined culverts may also act as a source of infiltration to groundwater because the concrete lining is cracked in many places, as shown by vegetation growth. Agua Chinon Wash flows into San Diego Creek just east of the intersection of the San Diego and Laguna Beach Freeways, about 1 mile downstream of its confluence with Borrego Canyon Wash. Bee Canyon Wash flows into San Diego Creek just northeast of the same intersection, about 1,500 feet north of Agua Chinon Wash. Marshburn Channel is a lined drainage channel that runs along the northwest boundary of MCAS El Toro. The channel receives runoff from the western part of the Station and discharges into San Diego Creek about 3/4 mile northwest of Bee Canyon Wash.

Southwest of MCAS El Toro, the San Diego Creek flows through commercial and agricultural areas. Approximately 5 miles downstream from the Station, the creek runs through a recreational area that includes hiking and bicycle paths. The creek flows into Upper Newport Bay about 7 miles downstream from its intersection with the Marshburn Channel. Recreational uses of the bay include swimming and fishing. Upper Newport Bay is an ecological preserve used by migratory birds.

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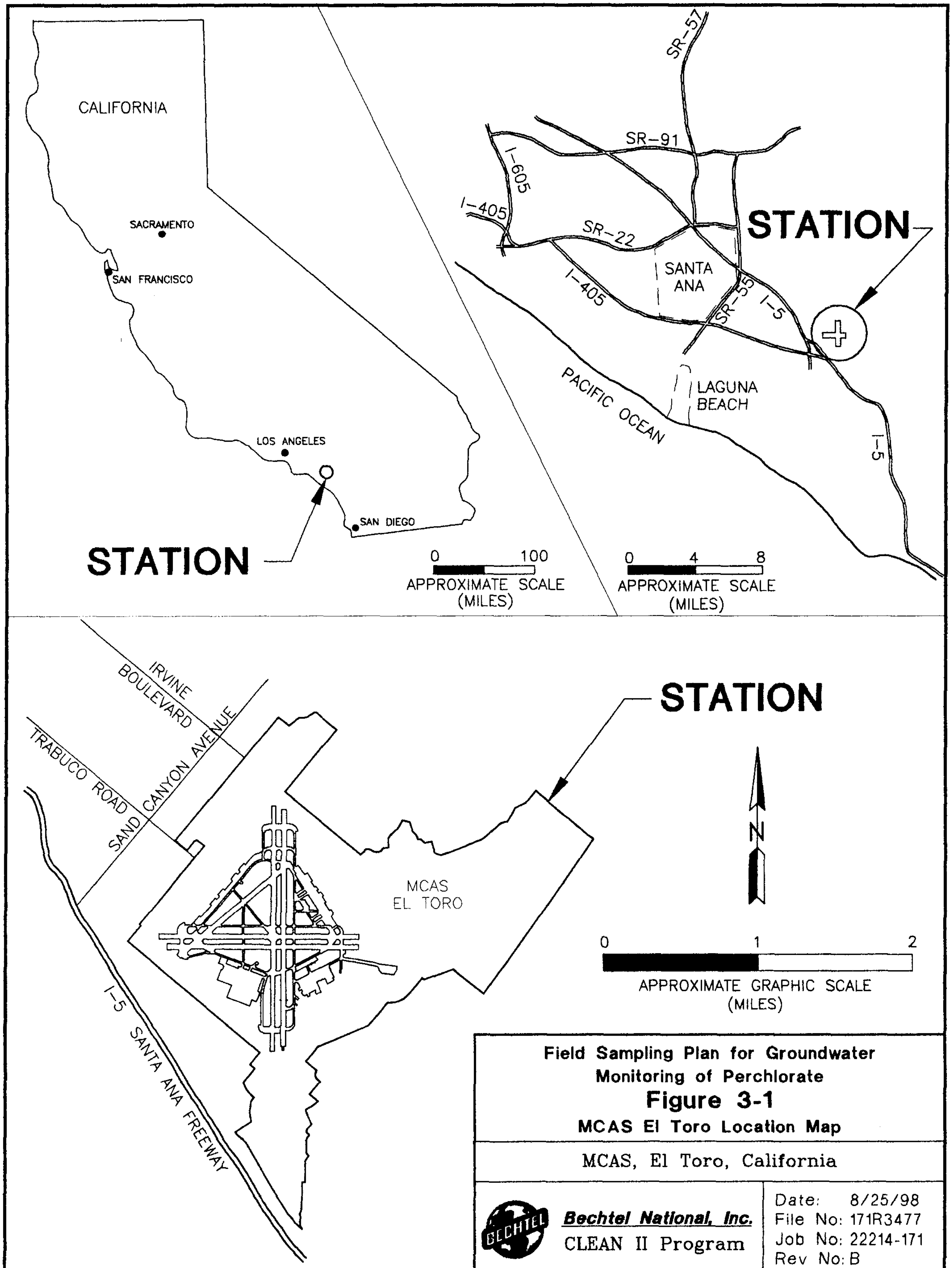
SECTION 3

MAPS

Section 3
MAPS

This section presents maps identifying the general location of MCAS El Toro and the locations of monitoring wells that will be sampled for perchlorate in accordance with the provisions of this FSP and the associated QAPP.

Figure 3-1 illustrates the general location of MCAS El Toro. Figure 3-2 identifies the groundwater monitoring well locations designated for perchlorate sampling and their relationship to the EOD Range (Site 1) and the four inactive landfills (Sites 2, 3, 5, and 17) that could be potential sources for perchlorate in groundwater. It also illustrates the well locations in relation to the VOC plumes in the shallow groundwater unit (Site 24) and principal aquifer (Site 18).



Field Sampling Plan for Groundwater Monitoring of Perchlorate

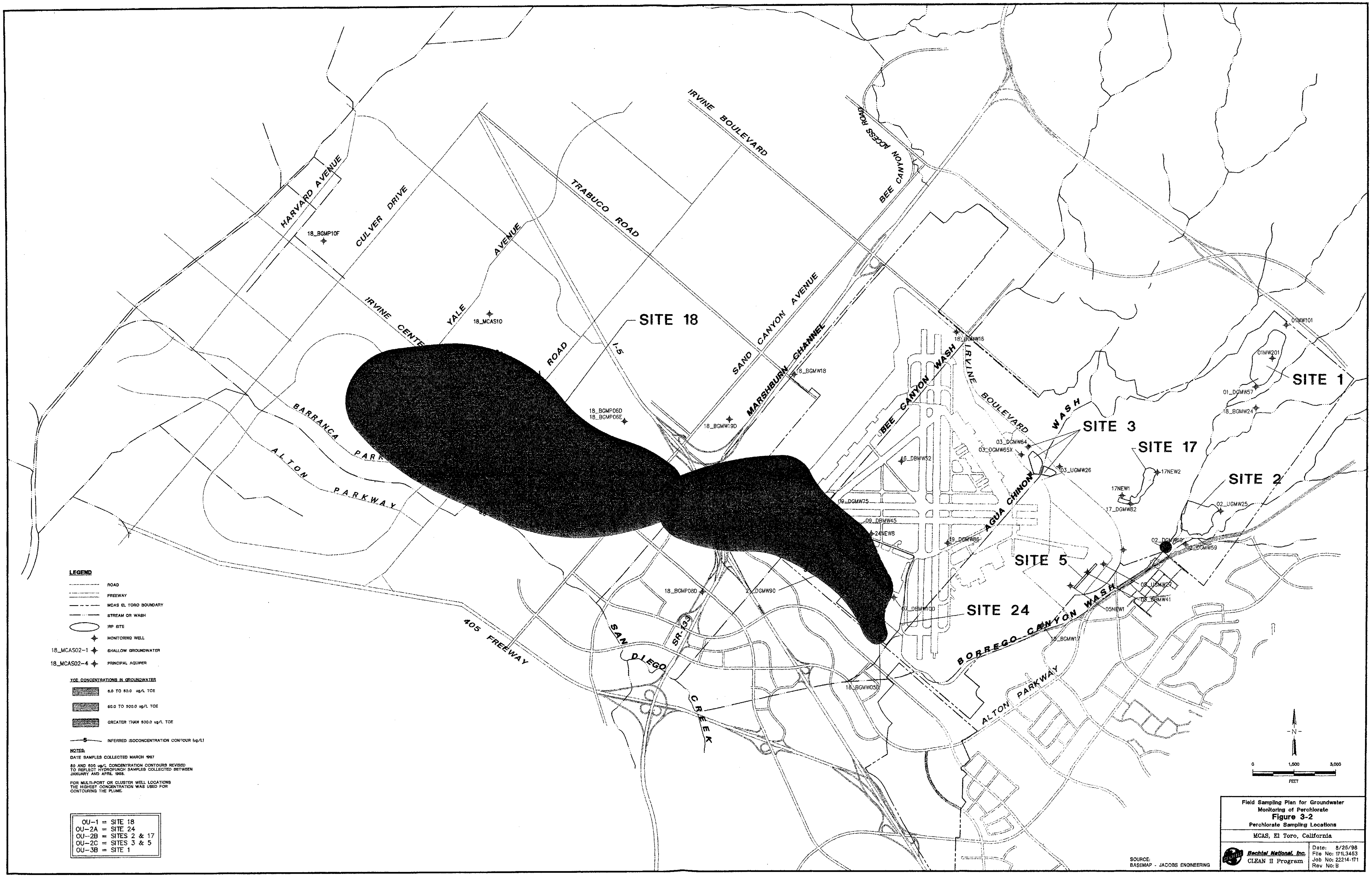
Figure 3-1

MCAS El Toro Location Map

MCAS, El Toro, California

Bechtel National, Inc.
CLEAN II Program

Date: 8/25/98
File No: 171R3477
Job No: 22214-171
Rev No: B


HARVARD AVENUE
CULVER DRIVE
YALE AVENUE
IRVINE CENTER ROAD
TRABUCO ROAD
IRVINE BOULEVARD
BEE CANYON ACCESS ROAD
SAND CANYON AVENUE
MARSHBURN CHANNEL
BEE CANYON WASH
I-5
BARRANCA PARKWAY
ALTON PARKWAY
405 FREEWAY
SAN DIEGO CREEK
SR-133
AGUA CHINON WASH
BORREGO CANYON WASH
SITE 18
SITE 24
SITE 5
SITE 3
SITE 17
SITE 2
SITE 1
18_BGMP10F
18_MCAS10
18_BGMP06D
18_BGMP06E
18_BGMW19D
18_BGMW18
18_BGMW16
18_BGMP08D
21_DGMW90
18_BGMW05D
16_DBMW52
09_DGMW75
09_DBMW45
24NEW8
19_DGMW86
07_DBMW100
03_DGMW64
03_DGMW65X
03_UGMW26
17NEW1
17NEW2
17_DGMW82
02_UGMW25
02_DGMW59
05_UGMW27
05_DBMW41
05NEW1
01MW101
01MW201
01_DGMW57
18_BGMW24
LEGEND
ROAD
FREEWAY
MCAS EL TORO BOUNDARY
STREAM OR WASH
IRP SITE
MONITORING WELL
18_MCAS02-1 SHALLOW GROUNDWATER
18_MCAS02-4 PRINCIPAL AQUIFER
TCE CONCENTRATIONS IN GROUNDWATER
5.0 TO 50.0 ug/L TCE
50.0 TO 500.0 ug/L TCE
GREATER THAN 500.0 ug/L TCE
5 INFERRED ISOCONCENTRATION CONTOUR (ug/L)
NOTES:
DATE SAMPLES COLLECTED MARCH 1997
50 AND 500 ug/L CONCENTRATION CONTOURS REVISED TO REFLECT HYDROPUNCH SAMPLES COLLECTED BETWEEN JANUARY AND APRIL 1998.
FOR MULTI-PORT OR CLUSTER WELL LOCATIONS THE HIGHEST CONCENTRATION WAS USED FOR CONTOURING THE PLUME.
OU-1 = SITE 18
OU-2A = SITE 24
OU-2B = SITES 2 & 17
OU-2C = SITES 3 & 5
OU-3B = SITE 1
N
0
1,500
3,000
FEET
SOURCE:
BASEMAP - JACOBS ENGINEERING
Field Sampling Plan for Groundwater Monitoring of Perchlorate
Figure 3-2
Perchlorate Sampling Locations
MCAS, El Toro, California
Bechtel National, Inc.
CLEAN II Program
Date: 8/25/98
File No: 171L3453
Job No: 22214-171
Rev No: B

SECTION 4

RATIONALE FOR GROUNDWATER SAMPLING

Section 4
RATIONALE FOR GROUNDWATER SAMPLING

The sampling locations, field investigations, and analytical method presented in this FSP are specific to the evaluation of perchlorate in groundwater at MCAS El Toro.

4.1 RATIONALE FOR LABORATORY ANALYSES

The laboratory analyses specified for the groundwater sampling locations identified in this FSP are based on the affected medium (groundwater) and the objectives of groundwater monitoring for perchlorate outlined in Section 2 of this FSP. Laboratory analyses of groundwater samples for perchlorate will be performed in accordance with procedures established by the California DHS Sanitation and Radiation Laboratory Branch, the CLEAN Program Technical Specification for Analytical Laboratory Services (BNI 1998e), and the Navy Installation Restoration Program Laboratory Quality Assurance Guide (NFESC 1996). The perchlorate analyses will be performed by a California state-certified laboratory that has successfully undergone Naval Facilities Engineering Service Center (NFESC) evaluation. The analytical method, shipment temperature, sample containers, and holding time associated with laboratory analyses of groundwater samples collected at MCAS El Toro are as follows:

- analytical method – Determination of Perchlorate by Ion Chromatography, Revision 0.0, June 3, 1997, Sanitation and Radiation Laboratory Branch, DHS, state of California;
- samples will be cooled and maintained at a temperature of 4°C; no other sample preservation methods are required;
- sample containers – 250-milliliter polyethylene bottles; and
- holding time – 14 days.

The results of this perchlorate sampling effort will be used to determine whether further sampling for perchlorate may be necessary during subsequent sampling events.

4.2 RATIONALE FOR SAMPLING LOCATIONS

The locations identified for groundwater sampling (Table 4-1 and Figure 3-2) of perchlorate were selected to meet the groundwater monitoring objectives presented in Section 2 of this FSP and the DQOs presented in Section 3 of the QAPP (BNI 1998a). The sampling locations include monitoring wells located:

- at Site 1, the EOD Range where rocket motors and missiles containing solid propellants are known to have been burned or destroyed;
- at the four on-Station landfills;
- adjacent to two former burn pits used for fire-fighter training exercises;
- near runways, taxiways, and aircraft parking areas;
- within the on- and off-Station VOC plumes; and
- at on- and off-Station background monitoring locations.

Table 4-1
Summary of Perchlorate Sampling Locations

Sampling Location*	Well Type	Well Completion Zone
01MW101	Single	Shallow
01MW201	Single	Shallow
01_DGMW57	Single	Shallow
02_UGMW25	Single	Shallow
02_DGMW59	Single	Shallow
02_DGMW60	Single	Shallow
03_UGMW26	Single	Shallow
03_DGMW64	Single	Shallow
03_DGMW65X	Single	Shallow
05_UGMW27	Single	Shallow
05_DBMW41	Single	Shallow
05NEW1	Single	Shallow
07_DBMW100	Single	Shallow
09_DBMW45	Single	Shallow
09_DGMW75	Single	Shallow
16_DBMW52	Single	Shallow
17NEW2	Single	Shallow
17NEW1	Single	Shallow
17_DGMW82	Single	Shallow
18_BGMP06D	Westbay Multiport	Shallow
18_BGMP06E	Westbay Multiport	Shallow
18_BGMP08D	Westbay Multiport	Shallow
18_BGMW05D	Single	Shallow
18_BGMW16	Single	Shallow
18_BGMW17	Single	Shallow
18_BGMW18	Single	Shallow
18_BGMW19D	Cluster	Shallow
18_BGMW24	Single	Shallow
18_BGMW101	Single	Shallow
18_DW135	Cluster	Shallow
18_MCAS01-1	Westbay Multiport	Shallow
18_MCAS01-3	Westbay Multiport	Shallow
18_MCAS01-5	Westbay Multiport	Principal
18_MCAS01-6	Westbay Multiport	Principal
18_MCAS02-1	Westbay Multiport	Shallow

(table continues)

Table 4-1 (continued)

Sampling Location	Well Type	Well Completion Zone
18_MCAS02-3	Westbay Multiport	Shallow
18_MCAS02-4	Westbay Multiport	Principal
18_MCAS03-1	Westbay Multiport	Shallow
18_MCAS03-2	Westbay Multiport	Shallow
18_MCAS03-3	Westbay Multiport	Shallow
18_MCAS03-4	Westbay Multiport	Principal
18_MCAS07-2	Westbay Multiport	Shallow
18_MCAS07-3	Westbay Multiport	Principal
18_MCAS07-4	Westbay Multiport	Principal
19_DGMW86	Single	Shallow
21_DGMW90	Single	Shallow
24NEW4	Single	Shallow
24NEW8	Single	Shallow
18_MCAS10	Single	Principal
18_BGMP10F	Westbay Multiport	Principal

Note:

* one groundwater sample from each of these sample locations will be collected and analyzed for perchlorate

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SECTION 5

REQUEST FOR ANALYSES

Section 5
REQUEST FOR ANALYSES

The request for analyses presented in this FSP focuses solely on perchlorate. The primary objective when requesting an analytical method is to assure that the analytical data obtained are precise, accurate, representative, complete, and comparable. The analytical data must meet the DQOs detailed in Section 3 of the QAPP (BNI 1998a). The data must also follow the guidelines established by NFESC.

5.1 CONTRACT LABORATORY/NFESC PROCEDURES AND ANALYSES

The CLEAN Program and NFESC set requirements for field investigations and sample analyses to control activities performed in the field and laboratories. The laboratory performing the analyses must be approved and must comply with quality control (QC) requirements of the CLEAN Program Technical Specification for Analytical Laboratory Services (BNI 1998e) and the Navy Installation Restoration Program Laboratory Quality Assurance Guide (NFESC 1996). Sample analysis and sampling procedures including equipment and preparation, containers, and shipping and handling are presented in detail in the QAPP (BNI 1998a).

5.2 DATA VALIDATION

Level IV QC requires review and approval of the laboratory Quality Assurance (QA) Plan and this FSP prior to conducting the sampling activities. Level IV QC procedures will be followed to generate deliverables in accordance with this FSP and the associated QAPP (BNI 1998a). In addition, Level IV data validation will be provided for 20 percent of the samples analyzed by the laboratory. Level IV data validation includes a thorough evaluation of raw data and calibration standards. Calculations check the quantified analytical data and the QC samples. The remaining 80 percent of the samples analyzed by the laboratory will undergo Level III data validation. Level III validation includes a limited evaluation of QC parameters and criteria (or limits). QA/QC requirements for field sampling and laboratory analyses are outlined in the NFESC requirements.

5.3 QUALITY CONTROL

The field and laboratory QC procedures will be implemented to evaluate the performance of the field and analytical procedures. Field QC samples will be used to monitor sample handling, packaging, and transport to the approved laboratory in the form of field duplicate samples, rinsates and equipment blanks, and source water blanks. Laboratory QC samples will be used to assure that the analytical procedures are accurate and precise and will include method blanks, surrogate/matrix spikes (MSs), matrix spike duplicates (MSDs), and double-blind performance evaluation (DBPE) samples. A further discussion of QC procedures is presented in the QAPP (BNI 1998a).

QC samples are used to:

- assess data quality in terms of precision and accuracy; and
- verify that sampling procedures (e.g., chain of custody, decontamination, packaging, and shipping) are not introducing outside variables into the sampling chain that could render the validity of samples questionable.

Such QC samples are regularly prepared in the field and laboratory so that all phases of the sampling and analysis process are monitored. The types of QC samples to be collected during groundwater monitoring for perchlorate are discussed below.

5.3.1 Field Duplicate Samples

Field duplicates are two samples of the same matrix, collected at the same location and time (to the extent possible), with an assumed level of overall groundwater homogeneity. The same sampling techniques and analytical methods will be performed on both samples. Analysis of field duplicates provides a quantitative measure of the precision of the overall sampling and analysis process as the sum of contributions from sample heterogeneity, the precision of the sampling process, and the analytical method(s). Laboratory duplicates will not be substituted for field duplicates. One duplicate sample will be taken for every ten groundwater samples collected for perchlorate analysis. Duplicate samples will be analyzed for perchlorate using the same analytical method as the associated regular sample. Duplicates will be submitted to the laboratory "blind" (no indication of the contents or the associated sample).

5.3.2 Rinsates and Equipment Blanks

To evaluate decontamination procedures, the sample teams will prepare equipment rinsate blanks by collecting samples of rinsate from the decontaminated sampling equipment and apparatus. These blanks will be collected by passing organic-free water through or over decontaminated sampling equipment and filling the rinsate sample bottles. One set of equipment rinsate blanks for perchlorate analysis will be prepared each day from one piece of decontaminated equipment.

5.3.3 Source Water Blanks

Source water blanks will be used to verify that the source of water used for equipment decontamination is not itself contaminated by perchlorate. Source water blanks will consist of collection of the source water used for the final rinse in the decontamination process. One source water blank will be prepared and submitted to the laboratory for perchlorate analysis each month that the field sampling activities are in progress.

5.3.4 Double-Blind Performance Evaluation Samples

DBPE samples will be submitted to monitor the laboratory's performance of the perchlorate analyses. The DBPE samples will consist of five unmarked spiked perchlorate samples prepared by U.S. EPA and provided to the field teams. The sealed DBPE samples will be transferred to the field team leader under chain-of-custody protocols to ensure sample integrity from preparation through analysis by the designated laboratory. The five DBPE samples will be spiked with perchlorate concentrations of 0, 5, 10, 20, and 50 μg/L, respectively.

The U.S. EPA will provide these spiked samples to the field team leader in the same sample containers used for collection of the groundwater samples so that they are indistinguishable from the other samples being submitted to the laboratory. For this same reason, the DBPE samples will be assigned dummy well identification numbers and will be labeled in the field consistent with the groundwater samples being collected. One DBPE sample will be submitted to the laboratory for every ten groundwater samples collected for perchlorate analysis. Based on the estimated 50 groundwater samples to be collected, approximately 5 DBPE samples will be submitted to the laboratory for analysis.

5.3.5 Laboratory Quality Control Checks

Laboratory checks will include the procedures detailed below.

- The reagents, gases, and standards required to analyze samples by a specified method will be of the highest quality available. Materials and procedures will be recorded in a logbook to document complete traceability to a certified reference standard and source such as the National Institute of Standards and Technology.
- Instruments will be calibrated according to the manufacturer's instructions and as required by the California DHS analytical method for perchlorate.
- Calibration of instruments will be documented in a bound logbook, and records will be maintained in accordance with Section 4.6 of the Laboratory Technical Specification (BNI 1998e).
- Continuing calibration standards will be analyzed and documented in a logbook for each analytical method during sample analysis as required by the method.
- The percent recovery and percent difference criteria for inorganics and organics continuing calibration shall be within the QC criteria of the requested method.
- Laboratory method blanks will be included in every preparation batch or analytical batch at a frequency of at least one per 20 samples.
- An analysis of one MS sample will be made for every 20 samples and will be fortified with representative compounds for each analytical method performed.

- An analysis of one MSD or matrix duplicate sample will be made for every 20 samples analyzed or one per batch, whichever is greater.

The term "matrix" refers to the use of the actual sample media collected in the field. Laboratory QC samples are derived from an aliquot (subset) of the field samples.

SECTION 6

FIELD METHODS AND PROCEDURES

Section 6
FIELD METHODS AND PROCEDURES

This section describes the field methods to be followed during groundwater monitoring for perchlorate at MCAS El Toro. These methods are based on previous groundwater monitoring experience at the Station, comments from regulatory agencies, available technologies, and CLEAN Program Standard Operating Procedures (SOPs) (BNI 1998f). During procurement, mobilization, and/or implementation, these field methods may change to incorporate revisions, innovative technologies, or other supplemental information. Therefore, the most current version of the update to the FSP should always be consulted.

The most recent versions of the SOPs and plans will be available on-site in the groundwater monitoring project field office library. The management organization and chain of command for the team assigned to implement groundwater monitoring at MCAS El Toro are described in Section 2 of the QAPP (BNI 1998a).

6.1 SITE PROTOCOL AND GENERAL RECORD KEEPING

Site protocol and general record-keeping procedures include requirements for field office administration, field logbooks, photographs, access to sensitive military areas, and radio protocol. These protocols and procedures are necessary for maintaining current and consistent documents for field activities.

6.1.1 Field Office Records

Forms and field logs for specific procedures for groundwater monitoring at MCAS El Toro are discussed below. Forms and records relating to site health and safety are located in the SSHP (BNI 1998c). These records will be maintained in the project on-site field office.

Forms and field logs will be completed in indelible ink and stored in locked file cabinets on-site. Forms will be assembled into bound notebooks. Completed records will be copied at least once a week and the duplicates stored outside MCAS El Toro at the Bechtel CLEAN Program office in San Diego, California. The CTO Leader will be responsible for maintaining and controlling forms and logs, except as noted below.

Sign-in forms will be initialed by the field staff in the project on-site field office every working day. Visitor sign-in logs will be available in the on-site field office. Visitors, including company and project staff not included on the staff sign-in forms, will be asked to sign the visitors log. Visitors to specific field sites will also be noted in the appropriate field logbooks.

Equipment rental and services records, including receipts for materials, will be the responsibility of the CTO Leader. Equipment sign-out and return sheets will also be the responsibility of the CTO Leader.

Other forms and records will be retained in the project on-site field office and will be the responsibility of the CTO Leader. These forms include the daily staff sign-in form, visitor sign-in form, field logbooks, and miscellaneous records of progress. Records will be sent weekly to the Bechtel CLEAN Program office in San Diego, California, for safekeeping. Records pertaining to sample custody, sample shipping, and receipt at the laboratory will be retained by the CTO Leader. Copies of these records will be transmitted to the Laboratory Services Supervisor (or at his direction to the laboratory coordinator for this CTO) following each shipment of samples to the laboratory.

6.1.2 Field Logbooks

Pertinent work and sampling information will be recorded in a logbook during each day of the field effort and will follow the guidelines described CLEAN Program SOP 17, Logbook Protocols. The field team leaders are responsible for completing the logbook and assuring its custody when the logbook is outside the field administration office.

Health and safety information, including measurement of parameters made strictly for personnel protection and personnel decontamination, and notes on potential health or safety problems will be recorded in a separate health and safety logbook.

Logbooks will be used by the field team leaders to document types of sampling and work. The logbooks record all field methods used at a given site, including groundwater sampling, waste handling, and decontamination of equipment.

Strict custody procedures will be maintained with the field logbooks. While being used in the field, the logbook will remain with the assigned field team leader.

Each logbook will contain sufficient information for the field activity to be reconstructed without relying on the memory of the field crew. Information consists of both typical information and any additional information necessary for reconstructing the field record.

Two types of logbooks will be used: sampling logbooks and health and safety logbooks. Sampling logbooks will be used for groundwater sampling.

When a new logbook is opened, it will be assigned a unique document control number, which will be written on the inside cover and on the top of page 1. Each page in the book will be prenumbered sequentially.

The record for the day will be kept sequentially, beginning below the information on the stamped portion of the page. Entries will be made in indelible ink. The entries for each page will be initialed and dated at the bottom of the page. At the end of the day, a line will be drawn through any blank space on the page, and the author will sign and date the bottom of the final page. All corrections will consist of lined-out deletions that are initialed.

At the end of the day, the entries for that day will be copied and placed in the field files in the field administration office. The logbook will be checked in and locked in a filing cabinet until needed for the next field day.

6.1.3 Standard Forms

Standard forms to be used by field staff include:

- Chain-of-Custody Record,
- Custody Seal,
- Water-Level Measurements in Wells,
- Well Purging Record,
- Well Sampling Record,
- Field Change Notice,
- Daily Field Reports, and
- Photograph Log.

6.1.4 Access to Sensitive Military Areas

Access to certain areas of MCAS El Toro is restricted. These areas are primarily along and on the flight line and Site 1, the EOD Range. Certain remote areas designated as sensitive habitat, such as in the vicinity of Site 2, are also restricted. The CTO Leader, working through the appropriate MCAS El Toro contact, will be responsible for obtaining access to these areas. The procedures for obtaining access to restricted areas vary depending on the area and the persons involved. Private vehicles must remain outside all restricted areas.

As soon as it is known that access to a restricted area will be required, the field team leader will notify the CTO Leader and provide the following information:

- the time and duration access will be needed;
- what equipment will be used; and
- how many people will be involved.

The CTO Leader will make the initial contacts for access and will provide the field team leader with the information and protocol for access. The field team leader will follow through with the steps needed to obtain and retain access during the work at the restricted site.

Information concerning access to and operations within restricted areas will be documented in the logbook. Names and telephone numbers of contacts, times, and discussions with contact persons will be recorded.

6.1.5 Radio Protocol

Each field team will have an outside communication device. This device will consist either of a cellular telephone or a two-way radio to allow for communication between the field teams and the project on-site field office. Radios used by field team members will have either one or two channels. Channel 1 will be used for communications between the on-site field office and a field team. Radios that are equipped with a second frequency (used to contact the MCAS El Toro flight control tower) cannot be taken off-Station. The smaller, single-channel radios or cellular telephones will be used for all off-Station work.

A military-frequency radio, obtained from the flight operations office, will be used to contact the tower prior to crossing an active runway. Radios checked out from a military unit for use in a restricted access area must be treated carefully and returned as soon as practical after use.

The radios are for professional use. Conversations will be kept at a professional level and to a minimum. The radio frequency is public and, in theory, anyone can listen. Any highly sensitive material will be communicated to the on-site field office from a telephone or in person.

Field teams will each have a radio or telephone as needed. Each day, one member of the team will sign out a radio, as needed. As soon as the team is at its first field location, the radio operator will check radio operation by calling the base. Calling involves first addressing the station called, then giving the assigned identification. When transmitting is finished, the term "over" (or literally "over to you") is used.

At the end of the day, the radio is to be turned off, placed on a charger, and signed back in at the project field office. The radio must be turned off when it is placed in the charger, or it will not be fully charged the following morning.

6.2 FIELD INSTRUMENTS

The following paragraphs describe field instrument calibration, measurement of water quality parameters, and screening instruments.

6.2.1 Field Instrument Calibration

Prior to field investigations, field instrumentation must be properly calibrated. A record of each calibration must be maintained in a field logbook. The most recent version of the CLEAN Program SOP 6, Instrument Calibration and Use, discusses the general procedures to be employed for the calibration and use of equipment commonly used for field measurements and sample screening. This procedure is complete when supplemented with the manufacturer's calibration and maintenance instructions for the specific instrument.

Most field measurement instruments used will involve the following steps:

- remove the instrument from its container, assemble as necessary, and calibrate for field use according to manufacturer's instructions;
- clean and decontaminate the instrument prior to first field use;
- clean and decontaminate the instrument subsequent to each measurement;

- perform calibration checks at specific time intervals daily or when there are changes in environmental conditions (as specified by the manufacturer);
- return the instrument to its storage location at the end of each day after cleaning and decontamination;
- perform factory maintenance and necessary calibration at the intervals specified by the manufacturer; and
- make necessary repairs.

Trained individuals will perform all maintenance and calibration according to the manufacturer's requirements. Though each instrument manufacturer has instrument-specific calibration, the following sections offer general procedures that apply to most common field instruments.

6.2.2 Field Measurement of Water Quality Parameters

CLEAN Program SOP 6 and manufacturer's instructions describe the calibration and operating procedures for instruments to be used for measuring the groundwater quality parameters pH, electrical conductivity (EC), temperature, dissolved oxygen (DO), oxidation-reduction potential (ORP), and turbidity. These measurements will be recorded in a field logbook. For instruments that incorporate data recording and storage capabilities, the electronically stored data will be downloaded to a computer located in the project on-site field office at the end of each day. However, use of instrument electronic data storage capabilities in no way replaces manual recording of data in the field logbooks. Instrument manuals should be consulted for proper calibration and operation of all field analytical instruments.

A QED MicroPurge™ Model FC4000 flow cell water quality monitoring system (or comparable unit such as the YSI Model 6000) that simultaneously measures pH, EC, temperature, DO, and ORP will be used for collection of field measurements. Although turbidity is not expected to represent a concern owing to the low-flow purging and sampling procedures that will be used to accomplish groundwater sampling, turbidity measurements will be collected using an Engineered Systems Model 800 turbidity meter (or comparable unit).

6.2.3 Field Screening Instruments

A number of field instruments are available for sample screening purposes such as detecting and/or measuring organic vapors, or measuring oxygen levels in confined spaces. Each of these field instruments usually requires daily calibration. These individual instruments will be calibrated according to the manufacturer's procedures. These include, but are not limited to, instruments equipped with flame ionization detectors (FIDs), photoionization detectors (PIDs), and lower explosive limit meters.

6.3 WATER-LEVEL MEASUREMENTS

Depth-to-water measurements (as specified in CLEAN Program SOP 7, Water and Free-Product Level Measurement in Wells) are used to construct potentiometric surface maps and ultimately to determine the direction and rate of groundwater movement and the movement of any related contaminants. The water-level measuring device must be sufficiently sensitive to obtain water-level measurements to the nearest 0.01 foot.

Before the water level is measured, a hand-held photoionization detector or organic vapor meter will be held at the top of the casing for wells without dedicated pumps or at the water level measurement port for wells equipped with dedicated pumps. If organic vapor is recorded at the top of the well, the breathing zone will be monitored during depth-to-water measurements.

For wells equipped with dedicated bubbler gauges, water-level measurements will be taken using a QED MicroPurge Model 6400 water-level meter. For wells that are not equipped with dedicated bubbler gauges for water-level measurements, a decontaminated electric well sounder will be lowered into the well and measured against the marked measurement reference point or the north side of the top of the casing. Water-level measurements taken in Westbay multiport wells will be taken using the proprietary Westbay transducer unit. Depth to water will be measured and recorded to the nearest 0.01 foot. The reference measurement point is the top of the sounding tube for wells with a permanently installed pump and the north side of the casing for wells without a sounding tube. The well will be closed and locked when readings are completed.

Depth-to-water measurements will be recorded in the field logbook. Depth-to-water measurements will also be recorded electronically for wells equipped with dedicated water-level probes. These data will be downloaded to a computer located in the project on-site field office at the end of each day. However, use of electronic data storage capabilities in no way replaces manual recording of data in the field logbooks. Documented information will be recorded on the Water-Level Measurement log.

6.4 GROUNDWATER PURGING AND SAMPLING

The procedure for groundwater monitoring well purging using an electric submersible pump is covered in CLEAN Program SOP 8, Groundwater Sampling, and the following subsections. At all wells equipped with dedicated gas-operated low-flow bladder pumps, low-flow purging and sampling will be performed in accordance with the provisions of Section 6.4.5. The procedures for groundwater monitoring of the Westbay multiport wells are described in Section 6.6. All field measurements, observations, and calculations will be recorded on the Well Purging Record in the field logbook.

6.4.1 Well Volume

For non-Westbay multiport wells not equipped with dedicated bladder pumps, the depth-to-water will be measured as described in Section 6.3 and the well volume will be calculated by multiplying the height of the water column in the well by the appropriate value presented below:

- 2-inch-diameter Schedule 80 polyvinyl chloride (PVC) casing = 0.16 gallons per foot;
- 4-inch-diameter Schedule 80 PVC casing = 0.66 gallons per foot;
- 5-inch-diameter Schedule 80 PVC casing = 0.93 gallons per foot; and
- 6-inch diameter steel casing = 1.5 gallons per foot.

6.4.2 Use of a Portable Pump

For non-Westbay multiport wells that are not equipped with dedicated bladder pumps, a 2-inch Grundfos® Redi-Flo2 or a 4-inch portable electric submersible well pump capable of purging and sampling will be used. The pump will be lowered into the well as slowly as possible and will be allowed to sit as long as possible before pumping starts to minimize turbidity and aeration within the well.

When purging shallow water table wells where the static water level is within the screened interval of the well, the pump intake should be located just below the static water level. The water should be removed slowly to avoid exposing the lower portion of the well screen. Water will enter through the screened interval and move upward toward the pump, flushing all stagnant water from within the well.

When purging wells where the static water level is above the top of the screened interval, the pump should initially be located just below the static water level, but may need to be gradually lowered in the well during the purging process if the water level is drawn down and approaches the pump intake. To avoid altering the water quality by aerating the formation, the water level should not be drawn down below the top of the screened interval.

6.4.3 Purging Using a Portable Pump

Before the groundwater is sampled using a portable pump, each well will be purged to bring formation water into the well. After installation of the portable pump, in accordance with CLEAN Program SOP 8, Groundwater Sampling, and Section 6.4.2, a decontaminated discharge line equipped with a sampling tee will be connected to the pump discharge piping. The generator and pump controller will be attached to the pump electrical connection. Adequate storage for discharged groundwater will be set in place. After the pump is started, the pumping rate shall be adjusted to allow continuous operation at a constant rate until the required volume of purgewater has been removed from the well. The sampling side of the tee will remain closed until just before the sample is collected. Purgewater will be discharged through the larger discharge valve on the sampling tee.

During purging, water-level measurements must be taken regularly to document the amount of drawdown observed and to allow the sampler to control the pumping rate to minimize drawdown in the well and assure that the well is not dewatered. If no drawdown is observed during pumping, it may be assumed that the pumping rate is less than the recharge capacity of the formation and that stagnant casing water is not being pulled downward into the pump intake.

The field parameters, pH, temperature, EC, DO, ORP, and turbidity of the initial groundwater purged from the well shall be measured and recorded on the Well Purging Record in the field logbook. Testing of these parameters shall continue until measurements of pH are within 0.5 of the previous measured values and measurements of temperature, EC, DO, ORP, and turbidity have stabilized within 10 percent of previously measured values.

Purging shall be considered complete when the field parameters have stabilized and a minimum of three well volumes have been removed from the well. A well in which the static water level is slow to recover shall be purged twice, allowing 80 percent of the static water level to recover between purging rounds. If more than 2 hours are required for the well to recover from the first purging effort, the well shall be purged to dryness again. A sample shall be collected as soon as the well has recovered sufficiently to meet sample volume requirements parameter by parameter, regardless of the volume of water purged.

The volume of water removed from the well during purging will be calculated by determining the pumping rate in accordance with the procedures outlined in Section 6.5 or by directly measuring the total volume of water pumped from the well. Purged water will be discharged into a truck-mounted tank or into 55-gallon drums. The purged water will be transported to the MCAS El Toro waste staging area (WSA) located at Site 3 for storage and treatment.

6.4.4 Sampling

Groundwater samples for laboratory analysis will be collected according to the provisions of CLEAN Program SOP 8, Groundwater Sampling. After purging in accordance with the provisions of Section 6.4.3 or 6.4.5 (as appropriate) has been completed, groundwater samples will be collected from the sampling side of the tee. The valve to the sampling side will be slightly opened while the purge side continues to discharge. Section 4.1 discusses the groundwater samples and sampling requirements, and Table 4-1 summarizes the sampling locations. One groundwater sample will be collected from each sampling location.

Once sampling is complete, the pumping unit will be shut down and all equipment will be disconnected if the pump is permanently installed. All equipment to be reused will be decontaminated in accordance with Section 6.7. If a temporary pump is used, it will be removed from the well and decontaminated with the other sampling equipment. All field measurements, observations, and calculations will be recorded on the Well Sampling Record in the field logbook.

6.4.5 Low-Flow Well Purging

Low-flow purging and sampling will be conducted at all wells equipped with dedicated gas-operated bladder pumps. The objective of low-flow purging is to minimize drawdown in the well and limit the mixing of water within the screened interval with overlying stagnant water in the well casing. This is accomplished by removing water from the monitoring well screened interval at a rate that is comparable to the ambient groundwater-flow rate in the aquifer. Low-flow purging allows for collection of representative groundwater samples with minimal disturbance and low turbidity.

Upon arrival at each well location, the equipment required to operate and monitor the well will be laid out on plastic sheeting adjacent to the wellhead. When the outer protective casing, lockbox, or traffic box at each monitoring location is opened to provide access to the well, a handheld PID or FID will be held at the top of the casing to monitor for organic vapors. If organic vapor is measured at the top of the well, the breathing zone will be monitored during purging and sampling of the well. All measurements will be recorded on an air sampling/monitoring data sheet.

The MicroPurge water-level meter will then be connected to the water-level sounding tube on the well cap. The water-level meter will continuously collect water-level data throughout purging and sampling of each well. The MicroPurge pneumatic pump controller will be connected to a portable air compressor unit (or compressed air cylinder) and then to the air-line fitting on the well cap. The pump controller will have been programmed with the correct pump fill/discharge time cycle for each well prior to leaving the project on-site field office. The dedicated discharge tube will then be connected to the discharge fitting on the well and to the inlet on the MicroPurge flow cell that will be used to record field monitoring parameters during purging. Adequate storage for discharged groundwater will be set in place. Because low-flow purging requires only a small volume (typically several gallons) of discharged water, a 5-gallon plastic bucket should be sufficient for this purpose.

Before purging begins, an initial water-level measurement will be taken and recorded on the Well Purging Record in the field logbook. When the pump is started, continuous water-level monitoring will be conducted. Water-level measurements will be recorded on the Well Purging Record at 5-minute intervals throughout purging, just prior to sample collection, and immediately after sampling is complete. A pumping rate of between 100 and 500 milliliters per minute will be maintained during purging. The rate shall be recorded on the Well Purging Record at 5-minute intervals during purging. The purge rate will be specific to each well and will be selected to assure that little or no drawdown or mixing of stagnant and formation water occurs. The purge rate should be selected to achieve drawdown in the well of 0.3 feet or less. However, if the minimal drawdown that can be achieved even at a minimum purge rate of 100 milliliters per minute exceeds

0.3 feet but remains stable, purging should continue until the field monitoring parameters have stabilized. If the formation recharge rate to the well is lower than the minimum purging rate capabilities of the dedicated bladder pump and the well is essentially dewatered during purging, the well will be sampled as soon as the water level has recovered sufficiently to meet sample volume requirements on a parameter-by-parameter basis, even if the indicator parameters have not stabilized. If adjustments to the purge rate are required to maintain a stable drawdown, these adjustments should also be recorded on the Well Purging Record in the field logbook.

During purging, field monitoring parameters (pH, temperature, EC, DO, ORP, and turbidity) shall be measured and recorded at 5-minute intervals on the Well Purging Record in the field logbook. All measurements except turbidity will be taken using the MicroPurge flow cell. Testing of the field monitoring parameters shall continue until measurements of pH are within 0.5 of the two previous measured values, and measurements of temperature, EC, DO, ORP, and turbidity have stabilized within 10 percent of the two previously measured values for each parameter. Purging shall be considered complete when the field parameters have stabilized and the total volume of purged water is greater than one pump system volume (internal volume of pump bladder and discharge tubing). When these conditions have been met, the pumping rate will be reduced to 100 mL/min and the required samples will be collected in accordance with Section 6.4.4.

The purged water will be placed in a truck-mounted tank or a 55-gallon drum. The purged water will be transported to the WSA located at Site 3 for storage and treatment.

Depth-to-water and field monitoring parameter measurements recorded electronically during purging and sampling of each well will be downloaded to a computer located in the project on-site field office at the end of each day. However, use of electronic data storage capabilities in no way replaces manual recording of data in the field logbooks.

6.5 ESTIMATING GROUNDWATER DISCHARGE

The rate of groundwater discharge may need to be calculated during purging before collecting a groundwater sample. A 5-gallon bucket will be used to measure the discharge. If the bucket is not calibrated to exactly 5 gallons, a gallon-measuring pitcher will be used to fill the bucket to 5 gallons. A line will be marked on the outside of the bucket at the five-gallon level. A 1-liter beaker or plastic bottle can be used to measure low flows during purging using the dedicated bladder pumps.

The person directing the discharge into the container will instruct the watch reader when to start reading the second hand (or to start the stopwatch). When the water reaches the predetermined mark on the container, the person will tell the watch reader to stop.

If water is discharged into a container too small for the flow, it will splash and the final calculation will be too low. A large container may be used, if needed, and the water may be allowed to flow into it for a longer period of time.

The information recorded in the field logbook will include the well identification, reason for making the measurement, container size, and number of seconds required to fill the container.

6.6 COLLECTING DATA FROM MULTIPORT WELLS

Multiport well inserts were installed in selected on- and off-Station wells by Westbay Instruments, Inc., during the Phase I RI. These wells consist of a single, steel casing string equipped with multiple 10-foot screened intervals. The multiport inserts are a continuous assembly installed inside the steel well casing. The individual screened intervals are isolated by inflatable packer assemblies installed in the multiport insert. These packers prevent hydraulic communication and potential cross-contamination between the screened intervals in the well. Owing to their specialized construction, these wells require special equipment to determine the groundwater potentiometric surface elevation at a port or to obtain a groundwater quality sample from a port. The procedures for the mechanical portion of these activities are included in the manufacturer's instructions and are not repeated here. A copy of the instructions will be maintained in the project on-site field office. The field team members will be trained and certified by Westbay prior to taking groundwater potentiometric surface measurements and collecting groundwater samples from these wells.

Groundwater potentiometric surface-pressure measurements will be taken from the pressure port for each screened interval during quarterly water-level measurement rounds and prior to collection of any groundwater samples. Because the Westbay sampling system is closed to the atmosphere, the groundwater collected from the sampling port should be representative of the aquifer. Thus, purging prior to sampling is unnecessary. The manufacturer's instructions pertaining to sampling will be followed.

A sampling cable holding the Westbay sample container will be lowered and connected to the port to be sampled. The port will be opened and the container will be allowed to fill. The container will be brought back to the surface and emptied into the appropriate sample container(s). The cable and sampling container will be repeatedly lowered, filled, and raised until a sufficient volume of groundwater has been collected to satisfy the sampling requirements for each monitoring round. Sampling will conducted in accordance with the procedures outlined in Section 6.4.4. Upon completion of sample collection at a given port, the equipment will be decontaminated using the wash-and-rinse method outlined in Section 6.7.2.

This procedure will be repeated for each sampling port of each Westbay well. Westbay multiport well potentiometric surface measurements and groundwater sampling will be documented in the field logbook. The following information will be recorded in the logbook:

- well identification,
- well condition,

- pressure port identification and pressure reading,
- calculation of the potentiometric surface elevation for the applicable port,
- sample identification and related sampling information,
- QC samples if applicable,
- documentation of equipment decontamination, and
- any other pertinent observations.

6.7 DECONTAMINATION

This section describes decontamination of all material that is reused during the Phase II field investigation. It does not include personnel decontamination, which is described in the SSHP (BNI 1998c).

Decontamination is the process of neutralizing, washing, rinsing, and removing contaminants from the exposed surfaces of equipment to minimize the potential for contamination migration or cross-contamination. All equipment will be decontaminated before commencing each sampling event and before leaving each well after sampling at that location is completed.

At MCAS El Toro, the WSA has two concrete-lined decontamination areas with containment sumps for decontamination wastes. Any decontamination project that requires a large amount of wash and rinse water will be done on one of these pads, including all steam cleaning of vehicles and equipment (Section 6.7.1). This will facilitate the collection and treatment of decontamination solutions.

Small sampling equipment that is submersible can be washed at the sampling location. If needed, the WSA can be used as an alternative decontamination location for small equipment. The equipment will be hand-washed, following the procedure outlined in Section 6.7.2. The wipe method (Section 6.7.3) is used primarily for decontaminating instruments that cannot be submerged or drenched. All waste products developed away from the two main decontamination areas must be contained, labeled, and transported to the concrete decontamination area or the waste-handling facility.

6.7.1 Steam Cleaning Method

Vehicles and other large equipment used for groundwater sampling will be cleaned with a steam cleaner or high-pressure hot water cleaner. Pump-pulling units will be cleaned before they are moved to the sampling location.

At the sampling location, loose dirt will be brushed from the vehicle before the vehicle is moved from the plastic sheeting. Special attention will be given to the wheels so that contaminated soil will not drop off between the sampling location and the decontamination pad. This removed material will be placed in the solid waste container at the sampling location.

The vehicle and ancillary equipment will be moved to the decontamination pad. The cleaning procedure to be followed at the decontamination pad is presented below.

- Wet down the vehicle or other items with high-pressure hot water or steam.
- Turn on the soap dispenser and wash the vehicle or other items completely, with special attention to areas around the wheels and the areas that have been or will be near the drilling and sampling equipment.
- Turn off the soap dispenser and rinse the vehicle or other items completely.
- Rinse off the decontamination pad.
- Remove the vehicle or other item to the side of the pad to air dry.

Equipment, such as pumps, short pieces of pipe, and bailers will be taken to the decontamination pad. Decontamination will be conducted there in the following manner.

- Rinse the items with a steam cleaner or high-pressure hot water cleaner to remove as much particulate as possible.
- Place the pump or other items in a 55-gallon drum containing an Alconox® soap solution. Where possible, operate the pump to flush solution through it. Agitate nonpowered items to run the solution through the interior portions.
- Remove the items from the Alconox solution, and double-rinse by placing the equipment in a 55-gallon drum of clean potable water, followed by a second submersion in a second drum of clean potable water.
- Place the item in a clean area of the decontamination pad to air dry.

All decontamination procedures will be documented in the field logbook. The information recorded will include date and time of operation, sampling location at which the items became contaminated, method of decontamination, name of person completing and witnessing the decontamination procedure, and items decontaminated (identified by license, rig number, or serial number).

6.7.2 Wash and Rinse Method

Groundwater sampling equipment will be decontaminated before and after use at each well. This equipment includes various pump installation equipment, portable pumps, bailers, and downhole piping.

Groundwater sampling equipment that is cleaned and reused in the field without returning to the decontamination pad will be decontaminated using the procedure specified below.

- Scrub the equipment clean with Alconox or an equivalent soap solution (i.e., low-phosphate detergent) and a stiff long-bristle scrub brush. Containerize all waste solution.
- Rinse the equipment over a rinsate tub with clean potable water.

- Spray rinse the equipment with distilled water twice and allow it to drain and air dry.
- Place the equipment on a clean sheet of plastic and cover with another sheet if it is not to be used immediately.

All drummed or otherwise containerized wastes from field decontamination must be appropriately labeled for transport to the waste staging area. Incidental rinsate may be placed in containers for solid or liquid waste. If Baker tanks or roll-off bins are not available at a site, designated 55-gallons drums may be used for field rinsate collection. Any decontamination project that requires a large amount of wash and rinse water should be moved to one of the two decontamination sites to facilitate the collection and treatment of wash and rinse water.

All decontamination procedures will be documented in the field logbook. The information recorded will include date and time of operations, sampling location at which the items became contaminated, method of decontamination, person completing and witnessing the decontamination procedure, and items decontaminated.

6.7.3 Wipe Method

The wipe method of decontamination will be used at the sampling location for cleaning items that will be washed and rinsed in the field. These items include such things as steel tapes, electric sounders, transducers, and geophysical and video logging equipment.

The steel tape, electric sounder, or geophysical cable (and attachments) will be wiped with disposable soap-impregnated cloth and rinsed with potable water as it is being pulled from each well. The equipment will then be rinsed with deionized water and allowed to air dry.

Soap-pad wipes may be disposed with personal protective equipment in the 55-gallon drum at the site. Rinse water should be placed with development water. During depth-to-water measuring, a liquid waste-disposal drum should be carried in the vehicle.

Decontamination of nondedicated water-level measuring equipment used during depth-to-water measurements will be documented in the field logbook. The information will include date and time, sampling location at which the items became contaminated, method of decontamination, name of person completing and witnessing the decontamination procedure, and the items decontaminated.

6.8 WASTE HANDLING

The field sampling team will be responsible for the waste generated at its sampling locations until the sealed container is ready to be transported to the WSA at Site 3.

The update to the Final IDWMP (BNI 1998b) describes waste management. Arrangement for transportation of waste from each sampling location to the waste storage area will be the responsibility of the CTO Leader, in accordance with the update to the Final IDWMP.

6.8.1 Groundwater

Groundwater produced during groundwater purging and sampling will be stored in 55-gallon drums or in a truck-mounted polypropylene tank. All storage containers will be water-tight, lockable containers. Once filled, all storage containers will be labeled unless they are immediately transported to the WSA and emptied into a Baker tank at that location. The labels will be completed with indelible ink and will include information identifying the monitoring well(s), the depths from which the waste was produced, the date the container was first used, the date the container was last filled, the samplers' names, and the initials of the person recording the information. The same information will be documented in the field logbook and will include the amount of groundwater produced from a well during a specific procedure.

The field sampling team will be responsible for the groundwater waste generated at that location until it is transferred to a Baker tank located at the WSA. Groundwater produced during purging and sampling will be stored and treated at the WSA treatment system (granular-activated carbon).

6.8.2 PPE, Excess Samples, and Miscellaneous Trash

Disposable PPE, including Tyvek® coveralls, gloves, booties, duct tape, and plastic sheeting that comes in contact with samples, will be disposed in a 55-gallon drum provided for the disposal of PPE. It is important to keep PPE and miscellaneous trash separated. PPE must be treated as potentially hazardous material until proven otherwise. Miscellaneous trash collection and disposal is a normal housekeeping process that should not be mixed with the more complex and costly PPE disposal procedures. Virtually all procedures during groundwater monitoring will generate both PPE and nonhazardous miscellaneous trash.

A 55-gallon drum for PPE disposal will be placed in a designated, central location at the WSA. All disposable PPE will be placed in the drum immediately after use. The lid will be left on the drum when it is not being filled. When the drum is full, it will be disposed by authorized MCAS El Toro personnel. The PPE waste drum will be labeled in indelible ink to indicate the site, date, and contents (PPE) after it is set in place and before its use. The identification information will be recorded in the field logbook.

PPE generated at sampling locations may be placed in heavy-duty trash bags with ties, provided the waste material is labeled at the end of each day, transported to the waste storage area, and placed in the waste PPE drum. Miscellaneous trash that does not come into contact with samples or PPE will be placed in heavy-duty trash bags that are left in the vehicle transporting the field team. At the end of each day, this trash will be placed in the waste dumpster at the on-site field office.

6.9 SAMPLE HANDLING, PACKAGING, AND SHIPPING

This section describes the sample containers, sample identification system, procedures for sample handling, chain-of-custody procedures, and shipping procedures. Although some of the information is duplicated in the QAPP (BNI 1998a), this section emphasizes specific procedures to be followed by the field staff.

6.9.1 Sample Containers

The analytical laboratory shall provide the containers and coolers to be used for groundwater sample collection and shipment to the laboratory. Sample containers will be shipped from the laboratory to the on-site field office in sealed boxes and will be certified as having been decontaminated prior to being shipped.

Before leaving for the field, the field team leaders will obtain the proper containers and forms. The sample labels will be partially completed before the field activity begins. The containers will be left closed until needed for the sample. The type and size of containers used for perchlorate samples will consist of 250-milliliter polyethylene bottles.

After a sample is collected, the sample container will be sealed, the label and chain-of-custody form will be completed in indelible ink, and a custody seal will be placed so that the lid cannot be opened without breaking the seal.

Certificates of cleanliness, including bottle lot numbers, will be cross-referenced to provide ample identification in the field logbooks.

6.9.2 Sample Labeling and Numbering

Sample numbers will be assigned on the basis of a code system that provides blind samples to the laboratory with no duplication of numbers. The sample number consists of a nine-digit numeric label. The following is a summary of codes placed in each digit:

First through third digits	Numeric value identifying the CTO under which groundwater sampling is being conducted.
Fourth through seventh digits	Sequential sample number (0001 through 9999).
Eighth and ninth digits	Container number (01 through 99).

An example of this system of sample numbers would be:

171000101

where:

171 = the CTO number
0001 = sequential sample number
01 = sample container number

Sample labels convey information unique to each sample container. The sample labels also relay specific information about sample conditions at the time of sampling. Each sample label will have the project, site, and job number. Sample labels will also contain the name or initials of the sampler, sample identification number, analysis required, sample preservation, date of sampling, and local standard time of sample collection using a 24-hour clock notation.

The information recorded on the sample labels will also be recorded in the field logbook, chain-of-custody record, and water-sampling record. Additional information to be recorded in the field logbook includes sample location, sample matrix, sample appearance, volume of sample collected, field measurements (if applicable), type of sampling equipment used, type and number of sample containers used per sampling site, designation of QC samples (rinsates, splits, or duplicates), significant events, and observations. At the end of the day's logbook narrative, the field sampler will sign and date the sample collection information.

6.9.3 Sample Custody

The field sampler is personally responsible for the care and custody of the samples until they are transferred and/or shipped to an analytical laboratory or storage facility in accordance with the CLEAN Program SOP 10, Sample Custody, Transfer, and Shipment. The samples must be traceable from the time they are collected until they are accepted by the laboratory.

A sample is in the custody of the field sampler, shipping agent, or analytical laboratory employee if:

- it is in his/her possession;
- it is in his/her view, after being in his/her possession;
- it was in his/her possession and then placed under lock and key; or
- it is maintained in a designated secure area.

The field sampler shall fill out a chain-of-custody record as each sample is collected. The purpose of the chain-of-custody record is to physically trace sample possession from the time of collection to its ultimate disposition. The chain-of-custody record must move with the samples. When transferring samples, the individuals relinquishing and receiving them sign, date, and note the time on the record. The time of relinquishment and receipt will be identical to avoid breaking the chain of custody. Notation of the bill of lading number, name of the shipping company, and signature of the shipping company agent on that bill of lading serves to keep the chain of custody intact during shipping. Any blank space will be lined out and initialed by the field team leaders or other person relinquishing custody to the laboratory. The following information should be recorded in both the field logbook and on the chain-of-custody form:

- project name and site of sample collection;
- job number;
- names of field samplers;
- sample identification number;
- date of sampling;
- local standard time of sample collection using 24-hour notation;
- sample matrix;
- analyses requested;
- preservation of sample containers (if applicable);
- means of transmittal to the analytical laboratory or storage facility (including carrier and airbill number, if applicable); and
- any general comments, instructions to the analytical laboratory, or unusual circumstances including possible splits of particular samples with an owner, operator, or government agency, instructions to spike a sample, or problems encountered during an attempt to transfer a sample, etc.

The COMMENTS/INSTRUCTIONS section of the chain-of-custody form shall be used to record instructions to the analytical laboratory. The REMARKS section of the chain-of-custody form shall be used to record any additional unique information regarding particular samples.

Whenever samples are split with another party, the field sampler will note the split in the REMARKS section of the chain-of-custody form. The note will indicate with whom the samples were split and will be signed by both the sampler and the recipient. If a representative is unavailable or refuses to sign, the sampler will note this in the REMARKS section of the chain-of-custody form.

Any errors made on the sample label, in the field notebook, or on the chain-of-custody form shall be corrected by the method outlined in the CLEAN Program SOP 10, Sample Custody, Transfer, and Shipment. The procedure consists of drawing a single line through the error and recording the correct information. This correction will then be initialed by the individual making the correction. Any sample labels or custody seals found with an error will be replaced by corrected labels or seals. All error corrections will be recorded in the field logbook.

Custody seals are to be used on each sample to show that the sample was not disturbed during transportation. When a sample has been collected, labeled, logged into the field logbook, and entered on the chain-of-custody form, a signed and dated custody seal shall be affixed to the container in such a way that it is necessary to break the seal in order to open the sample container. Two or more custody seals shall be affixed to the outside of the shipping container or cooler before it is shipped by an overnight carrier.

6.9.4 Sample Handling in the Field

This section describes the way samples are to be handled in the field from the time they are collected until they are shipped by the field team leaders. The information duplicates some information in the QAPP (BNI 1998a).

The field sampler that collects the sample is responsible for the proper storage and preservation of sample until it arrives at the analytical laboratory or storage facility. Once a sample is collected, labeled, and custody sealed, it will be placed in a cooler for storage pending shipment.

The field sampler who either delivers or arranges for the delivery of samples is responsible for assuring that sufficient ice is present in the shipment container to maintain a temperature of 4°C ± 2° during shipment. The temperature of the cooler will be taken before shipment. Temperature and time of measurement will be entered into the field logbook.

All samples are to be handled by as few people as possible. If one person collects the samples and another delivers them to the laboratory, the chain-of-custody record must document the change of possession by the appropriate dated signatures. The chain-of-custody record for a given group of samples will be kept with those samples and the cooler at all times. Field notebooks, labels, and the chain-of-custody record will be completed in a timely manner.

6.9.5 Sample Packaging and Shipping

The final responsibilities of the field sampling team will be to ensure that each sample is properly packaged and shipped to the appropriate laboratory and that a record of the shipment is available. Samples to be sent to the laboratory will be packaged and released to the transporting agent as described below.

Individual sample containers will be sealed with a custody seal as described in Section 6.9.3, labeled as described Section 6.9.2, and placed in a cooler at the sample collection location. Coolers will be placed in the shade during the day with adequate ice to lower the temperature of samples to 4°C ± 2°.

Samples held overnight prior to shipping will be placed in a locked refrigerator or a locked and custody-sealed cooler in a locked building under the custody of the last person signed on the accompanying custody form. The temperature will be checked and recorded when the cooler is first opened.

Before shipment, each container within a cooler will be packaged and sealed in a plastic bag. Aqueous samples shall be packed individually in bubble wrap. All glass bottles and jars shall always first be wrapped in a protective layer of material before being sealed in a plastic bag. A sample rack is acceptable if the samples are being delivered to, or picked up by, representatives of the analytical laboratory at the end of each day. When samples are packed in shipping containers, cardboard separators may be placed between sample containers at the discretion of the field sampler. The use of shock-absorbent materials may also be necessary to prevent movement of sample containers during transport. The QAPP provides additional information on the process for groundwater samples (BNI 1998a).

Coolers used for shipment will be drained, dried, and lined with a plastic bag and approximately 3 inches of Styrofoam™ "peanuts" or other packing and cushioning material. For samples believed to contain medium concentrations of hazardous constituents, the use of shipment cans and vermiculite may be required for safe transportation. The chain-of-custody and other necessary documentation shall be placed in a sealable plastic bag and taped to the inside of the cooler lid. The cooler lid will be closed and taped shut with strapping tape. A mailing label or bill of lading with the address of the laboratory and the name of the shipper will be placed on top of the container. At least two signed custody seals will be affixed over lid openings (front and back of cooler under strapping tape).

When samples are transferred by land or air through a commercial shipping courier, the field sampler shall complete an airbill, provided by the carrier, for the shipment of the samples. The name of the overnight carrier and the airbill number shall be recorded in the RECEIVED BY and AIRBILL NO. blocks of the chain-of-custody form, respectively. This information with the date and time of sample pickup shall be recorded in the field logbook. The bottom two copies of the signed chain-of-custody form will be kept for field records, and the top parts of the chain-of-custody form shall accompany the samples as stated above. When the samples are relinquished to the carrier, the bottom copy of the airbill will be returned to the relinquishing party and should be retained for field records.

When samples are shipped to the laboratory by land through a noncommercial shipping courier or by the field samplers or other similar responsible party, the field sampler is responsible for transfer of the samples to the delivering party. Both parties (the relinquisher and receiver of the samples) must sign, date, and note the time of transfer on the chain-of-custody form. Again, the bottom two copies of the signed chain-of-custody form will be kept for field records and the top parts of the chain-of-custody form shall accompany the samples as stated above.

As outlined in the CLEAN Program SOP 10, the field sampler shall be aware of all regulations concerning the shipment of environmental samples prior to the field-sampling event. The field sampler shall also be aware of the shipping agent's limitations.

Upon sample arrival at the analytical laboratory, the designated sample custodian shall take custody of all samples and inspect all sample labels and custody forms to assure consistent information. The custodian shall also inspect all samples for signs of damage or tampering. Any discrepancies shall be documented and noted on the chain-of-custody form. The custodian shall then sign and date the chain-of-custody form for receipt. Each sample will receive a unique laboratory identification number and will be distributed to the appropriate areas for analysis or to secured storage areas. All sampler transfers within the laboratory shall be recorded.

Laboratory analysts shall be responsible for the care and custody of samples from the time they are received for analysis until the samples are exhausted or returned to the laboratory sample custodian for disposal. The laboratory shall retain all written records of laboratory handling and analysis as part of a permanent laboratory file.

Samples that are collected and archived for future chemical or physical analysis shall be documented and treated in the same manner as described above. The field sampler must check the ARCHIVE box on the chain-of-custody form to designate samples to be archived.

6.9.6 Sample Preservation

No preservatives will be introduced into the sample containers (polyethylene bottles). The analytical method "Determination of Perchlorate by Ion Chromatography" does not require any sample preservative.

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SECTION 7

REFERENCED FORMS AND DATA SHEETS

Section 7
REFERENCED FORMS AND DATA SHEETS

This section includes selected standard forms that will be used for groundwater monitoring at MCAS El Toro. The format and contents of the forms may change before or during groundwater monitoring to address specific needs or requirements that have not yet been identified. Therefore, these forms are for reference but may not represent the final version that will be used. These forms include:

- Daily Field Report,
- Photograph Log,
- Water-Level Measurements in Wells,
- Well Purging Record,
- Well Sampling Record, and
- Chain-of-Custody Record.

DAILY FIELD REPORT

CLEAN II

DATE: ______________ Page ______ of ______

JOB NO. 22214 - 171 FACILITY: MCAS EL TORO, CA

SITE: ______________________________

RECORDED BY: ______________________________

FIELD TEAM MEMBERS: ______________________________

SUBCONTRACTOR:	WEATHER CONDITIONS:

EQUIPMENT	HOURS WORKED	WORK PERFORMED

FIELD ACTIVITIES/COMMENTS:

DATA TRANSMITTED WITH THIS REPORT:

CLEAN II

PHOTOGRAPH LOG

FACILITY: MCAS EL TORO, CA

JOB NO: 22214-171

CTO NO: 171

SITE	ROLL #	PHOTO #	DATE	TIME	DESCRIPTION / ACTIVITY	DIRECTION FACING	INITIALS

WATER LEVEL MEASUREMENTS IN WELLS

WL-171-001

Water-Level Measurement Log	Project: Job Number: 22214-171	Sheet No.
Facility MCAS, El Toro, CA	Site:	Monitored By: Checked By:

Well ID Number	Date/ Time	Instrument Serial Number	Calibrated By	Reference Point Elevation (feet)	Depth To Water (feet)	Water Level Elevation (feet)	Remarks

Bechtel

PROJECT CLEAN II		WELL NO.
JOB NO. 22214-171	SITE MCAS El Toro	PREPARED BY

WELL PURGING RECORD

	PURGE METHOD	SAMPLING METHOD
BLADDER PUMP		
SUB. PUMP		
BAILER		
OTHER:		

PURGING CRITERIA:

CHECKED BY

REMARKS

BOREHOLE DIAMETER:
CASING DIAMETER (ID):
REFERENCE POINT:
DEPTH TO:
WATER LEVEL:
TOP OF FILTER PACK:
TOP OF SCREEN:
BOTTOM OF SCREEN:
BOREHOLE DEPTH:

PURGING DATE:
DATE / TIME OF SAMPLING:.
WEATHER:
TEMPERATURE:
BOREHOLE VOLUME:
SUBCONTRACTOR:
ANALYSES:.
SAMPLES CONTAINERS:
LABORATORY:
DATE SHIPPED:
VIA:
HANDLING PROCEDURES:

PURGING DATA			TOTAL WATER REMOVED		FIELD PARAMETERS						COMMENTS
Time Begin (hours)	Time Finish (hours)	Water Removed (gallons)	Volume (gallons)	Well Volumes	pH	Temp. (^{o}F)	Conductivity (μmhos)	Disolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU/Visual)	

WS-171-010

WATER SAMPLING RECORD

JOB NO.
22214-171

STATION ID	STATION TYPE	FACILITY
SAMPLE DATE START: END:	IDW LOGBOOK(S)/PAGES	DATA LOGBOOK(S)/PAGES

SAMPLE ID	SAMPLE TYPE	MATRIX	SAMPLING METHOD
TRIP BLANK ID	EQUIP. RINSATE ID	FIELD BLANK ID	SOURCE BLANK ID
LAB DELIVERY ORDER	REMARKS: ______		

USE FOR QC SAMPLES ONLY	THIS QC SAMPLE ID:	TYPE OF QC SAMPLE (Check one)
	REFERENCE SAMPLE ID:	Equip. Rinsate _ Duplicate _ Field Blank _ Source Blank _

ALL SAMPLES ARE ICED TO 4° C **Initial Here** ______

CONTAINER. NO.	TYPE	ANALYSIS	PRESERV.	FILTER (F or U)	COC NO.	DATE	TIME	COMMENTS

DATA RECORDED BY		CHECKED AND REVIEWED BY	
SIGNATURE	DATE	SIGNATURE	DATE

CLEAN II

CHAIN-OF-CUSTODY RECORD

16379

Site Name:	Sampler(s):
CTO Number:	Signature(s):
Site Contact/Supervisor:	

Analytical Laboratory Name:

Analytical Laboratory Address:

Field Logbook/Page Number:

Pay Items/ Analyses Required

Preservation (4°C)

TAT (in days)

2	7	14	30

Sample ID No. (7 digit)	Date/Time Collected	Station Description	Sample Matrix	Number of Containers	Archive (Container No.)	Container Nos. (2 digit)											Remarks (e.g., MS, MSD)

Relinquished By/Company	Received By/Company	Date	Time	Reason for Transfer

Comments/Instructions:

Method of Shipment:	Total No. of Containers:
Airbill No.:	
Cooler Temp.:	Total No. of Coolers Shipped:
Lab SDG:	

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SECTION 8

REFERENCES

Section 8
REFERENCES

Banks, H.O. 1984. Groundwater Management, Irvine Area, Orange County, California. Prepared for the Orange County Water District. September.

Bechtel National, Inc. 1997a. Base Realignment and Closure Cleanup Plan (BCP) for Marine Corps Air Station El Toro, California. March.

———. 1997b. Draft Final Phase II Remedial Investigation Report for Operable Unit 2A – Site 24. Marine Corps Air Station El Toro, California. March.

———. 1997c. Draft Final Phase II Remedial Investigation Report for Operable Unit 2B – Site 2. Marine Air Station El Toro, California. April.

———. 1997d. Draft Final Phase II Remedial Investigation Report for Operable Unit 2B – Site 17. Marine Corps Air Station El Toro, California. April.

———. 1997e. Draft Final Phase II Remedial Investigation Report for Operable Unit 2C – Site 3. Marine Corps Air Station El Toro, California. April.

———. 1997f. Draft Final Phase II Remedial Investigation Report for Operable Unit 2C – Site 5. Marine Corps Air Station El Toro, California. April.

———. 1997g. Draft Final Phase II Remedial Investigation Report for Operable Unit 3A Sites. Marine Corps Air Station El Toro, California. June.

———. 1998a. Quality Assurance Project Plan for Groundwater Monitoring of Perchlorate, MCAS El Toro, California. September.

———. 1998b. Update to the Final Investigation-Derived Waste Management Plan for Groundwater Monitoring, MCAS El Toro, California. July.

———. 1998c. Site-Specific Safety and Health Plan Supplement, MCAS El Toro, California. July.

———. 1998d. Update to the Final Amended Data Management Plan for Groundwater Monitoring, MCAS El Toro, California. July.

———. 1998e. CLEAN Program Technical Specifications for Analytical Laboratory Services, Contract Technical Specifications, 22214-TS-002, Revision 5. 25 March (or latest revision in effect at the time of analysis).

———. 1998f. CLEAN Program Procedures Manual, Volume 5: Technical Standard Operating Procedures.

BNI. *See* Bechtel National, Inc.

Brown and Caldwell. 1986. Initial Assessment Study of Marine Corps Air Station El Toro, California. CLE-C01-01F018-A2-016. May.

CDM. *See* CDM Federal Programs Corporation.

CDM Federal Programs Corporation. 1995. Final Investigation-Derived Waste Management Plan for Groundwater Monitoring. Marine Corps Air Station El Toro, California. November.

———. 1996a. Final Amended Data Management Plan for Groundwater Monitoring. Marine Corps Air Station El Toro, California. October.

———. 1996b. Final Quarterly Groundwater Monitoring Report, January-February 1996 Sampling Round. Marine Corps Air Station El Toro, California. June.

———. 1997a. Groundwater Monitoring Report, November-December 1996 Sampling Round. Marine Corps Air Station El Toro, California. February.

———. 1997b. Groundwater Monitoring Report, March 1997 Sampling Round. Marine Corps Air Station El Toro, California. June.

———. 1997c. Groundwater Monitoring Report, July 1997 Sampling Round. Marine Corps Air Station El Toro, California. October.

———. 1998. Draft Groundwater Monitoring Report, October 1997 Sampling Round. Marine Corps Air Station El Toro, California. January.

Fife, D.L. 1974. Geology of the South Half of the El Toro Quadrangle, Orange County, California. California Division of Mines and Geology.

Herndon, R.L., and J.F. Reilly. 1989. Phase I Report - Investigation of Trichloroethylene Contamination in the Vicinity of Marine Corps Air Station El Toro. Prepared for the Orange County Water District. March.

Jacobs Engineering Group, Inc. 1993. Marine Corps Air Station El Toro: Installation Restoration Program Phase I Remedial Investigation Draft Technical Memorandum.

———. 1996. Draft Final Interim Operable Unit 1 Remedial Investigation/Feasibility Study Report. August.

James M. Montgomery Engineers, Inc. 1988. MCAS El Toro and Tustin Site Inspection Plan of Action. August.

JEG. *See* Jacobs Engineering Group, Inc.

JMM. *See* James M. Montgomery Engineers, Inc.

Marine Corps Air Station El Toro. 1991. The Environmental Cleanup of Marine Corps Air Station El Toro. Facilities Management Department, U.S. Marine Corps Air Station El Toro, Santa Ana, California.

MCAS El Toro. *See* Marine Corps Air Station El Toro.

Miller and Tan. 1976. Geology and Engineering Geology Aspects of the South Half of the Tustin Quadrangle, Orange County, California. California Division of Mines and Geology, Special Report 126.

Mullet. 1994. Facsimile transmittal from Gunnery Sergeant Mullet of the U.S. Marine Corps Explosive Ordnance Disposal, Section SOMS/EDO at MCAS El Toro, on 27 September 1994.

Naval Facilities Engineering Service Center. 1996. Navy Installation Restoration Program Laboratory Quality Assurance Guide. Interim Guidance Document. February.

NFESC. *See* Naval Facilities Engineering Service Center.

OCWD. *See* Orange County Water District.

Orange County Water District. 1994. The Irvine Desalter Project. Preliminary Design Report. March.

———. 1998. Inter-Office Memorandum on the Subject of Perchlorate Sampling, from Pat Tennant to Nira Yamachiki, dated 15 January 1998.

Singer, J.A. 1973. Geohydrology and Artificial-Recharge Potential of the Irvine Area, Orange County, California. U.S. Department of the Interior Geological Survey, Water Resources Division.

Southwest Division Naval Facilities Engineering Command. 1997. Draft Final Record of Decision, Operable Units 2A and 3A No Further Action Sites. Marine Corps Air Station El Toro, California. September.

SWDIV. *See* Southwest Division Naval Facilities Engineering Command.

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