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FINAL

REMEDIAL DESIGN/WORK PLAN

Revision 0
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ENHANCED IN SITU BIOREMEDIATION
INSTALLATION RESTORATION PROGRAM SITE 40
(CONCRETE PIT/GRAVEL AREA)
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

DCN: FWSD-RAC-05-0380

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EXECUTIVE SUMMARY

This design package defines the technical and functional requirements for remediation of groundwater contaminated with chlorinated volatile organic compounds (CVOCs) at Installation Restoration Program (IRP) Site 40 (Concrete Pit/Gravel Area), Naval Weapons Station (NAVWPNSTA) Seal Beach, California (Figures 1-1 and 1-2). Tetra Tech FW, Inc. (TtFW) prepared this document for Southwest Division, Naval Facilities Engineering Command (NFECSW) under Contract Task Order 0090 of the Remedial Action Contract (RAC) Program, Contract No. N68711-98-D-5713. The Department of the Navy (DON) directs this remedial action in accordance with requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

The DON has determined upon review of the site's operational history and site-specific groundwater investigation data that this site contains elevated concentrations of CVOCs, including tetrachloroethene (PCE) and trichloroethene (TCE) in groundwater, and thus requires a response action. The decision regarding the response action is documented in the Record of Decision (ROD) (DON, 2004).

NAVWPNSTA Seal Beach is located in the city of Seal Beach, California. Surrounding municipalities include Los Alamitos to the north, Westminster to the east, Huntington Beach to the southeast, and Long Beach to the west. The Pacific Ocean borders NAVWPNSTA Seal Beach to the south (Figure 1-1).

IRP Site 40 includes a concrete pit located in the Locomotive Shop (Building 240) and a gravel area located north of and adjacent to the building. During previous investigations, a CVOC plume consisting primarily of TCE and PCE was identified in groundwater. The areal extent of the CVOC plume in groundwater is approximately 400 feet by 250 feet, and contamination extends vertically from the groundwater table to approximately 66 feet below ground surface. The highest PCE concentrations in groundwater were reported at 3,940 micrograms per liter (µg/L) in a relatively shallow, localized source area, with much lower concentrations observed throughout the majority of the plume. TCE and trans-1,2-dichloroethene (trans-1,2-DCE) were detected in groundwater in maximum concentrations of 273 µg/L and 7.09 µg/L, respectively [Bechtel National, Inc. (BNI), 1999]. Vinyl chloride (VC) and cis-1,2-dichloroethene (cis-1,2-DCE) were detected in groundwater in maximum concentrations of 1,500 µg/L and 1 µg/L, respectively, during the pilot test study [Bechtel Environmental, Inc. (BEI), 2002]. The total mass of dissolved CVOCs at IRP Site 40 is approximately 6 pounds.

Although CVOCs have been reported in the groundwater beneath the site, no complete exposure pathway exists between the groundwater and potential ecological receptors. In addition, the impacted groundwater underlying IRP Site 40 does not presently serve as a source of water for

any of the beneficial uses designated in the *Water Quality Control Plan, Santa Ana River Basin* (Basin Plan) [Regional Water Quality Control Board (RWQCB), 1995]. However, during an extended removal site evaluation (BNI, 1999), a screening level human-health risk assessment indicated that cumulative human health risks from underlying groundwater exceeded the NCP-defined generally acceptable range. It was therefore recommended that the DON would conduct a Remedial Investigation/Feasibility Study to evaluate and select a remedy that would mitigate the risks to human health. As a result, the DON has initiated the remedial action described herein for the impacted groundwater at IRP Site 40 to reduce any potential threats to human health and the surrounding environment.

In addition to characterizing the nature and extent of contamination and associated risks at IRP Site 40, the DON has documented the occurrence of natural, biodegradation processes, which contribute to natural attenuation of CVOCs. Groundwater modeling has shown that the plume is relatively slow moving and is expected to attenuate naturally over time, which will eventually reduce CVOC impacts at IRP Site 40. However, the DON intends to conduct a remedial action for IRP Site 40 in order to enhance the natural processes, and thereby accelerate the cleanup timeframe.

The following Remedial Action Objectives (RAOs) were developed for IRP Site 40 groundwater cleanup:

- Consistent with U.S. Environmental Protection Agency (EPA), State Water Resources Control Board (SWRCB), California Environmental Protection Agency (Cal/EPA), and RWQCB, Santa Ana Region, policies and regulations, protect existing beneficial uses of the shallow aquifer underlying NAVWPNSTA Seal Beach to the extent practicable, while preventing or minimizing volatile organic compound (VOC) migration beyond the current NAVWPNSTA Seal Beach boundaries at concentrations exceeding site remediation goals.
- Protect human health by preventing extraction of VOC-impacted shallow groundwater for domestic use until site remediation goals are achieved.

Two CVOCs, PCE and TCE, were identified as the primary chemicals of concern (COCs) for IRP Site 40 groundwater. However, since the biological degradation of PCE and TCE will result in the formation of 1,2-dichloroethene (1,2-DCE) and VC, these chemicals are also considered to be COCs. The target cleanup levels for IRP Site 40 groundwater are as follows:

Analyte CVOCs	Performance Criteria (µg/L)
cis-1,2-Dichloroethene	6
trans-1,2-Dichloroethene	10
Trichloroethene	5
Tetrachloroethene	5
Vinyl chloride	0.5

The selected remedy for groundwater at IRP Site 40 is enhanced in situ bioremediation (ISB), monitored natural attenuation, (MNA), and land-use controls (LUCs). Enhanced ISB will consist of biostimulation and bioaugmentation activities. Sodium lactate will be strategically injected into the groundwater at locations designed to provide coverage of areas containing PCE and TCE to stimulate the growth of indigenous microorganisms capable of biologically degrading CVOCs via reductive dechlorination. Based on the results of extensive pilot testing conducted at the site, it is expected that indigenous microorganisms will be capable of reducing the PCE and TCE to 1,2-DCE; however, complete dechlorination to innocuous end products (ethene, ethane, carbon dioxide) will require bioaugmentation using dechlorinating microorganisms not found at the site.

Active remediation will be conducted within the areas of highest PCE concentrations through injection of sodium lactate, while employing MNA throughout the remaining portion of the plume. MNA will be implemented throughout the duration of the remediation at the site in order to confirm that natural attenuation processes are occurring and that the plume is stable and/or shrinking.

A total of nine wells are proposed for conducting performance monitoring during the enhanced ISB phase. These wells will be located within the active treatment areas. Performance monitoring during the active remediation will consist of field testing and laboratory analysis of groundwater, and groundwater level measurements. Field testing will be conducted biweekly during the active remediation period. Field testing frequency will be reduced to monthly or modified as necessary after the first 6 months. After the first year, field tests will be conducted on a quarterly basis. Field testing will include testing for nitrate, sulfate, ferrous iron, carbon dioxide, alkalinity, chemical oxygen demand (COD), pH, temperature, conductivity, oxidation/reduction potential (ORP) and dissolved oxygen (DO).

During the ISB performance monitoring period, groundwater samples will be collected for laboratory analysis. The sampling frequency will be on monthly basis for the first 3 months and quarterly for the remainder of the first year. Samples will be analyzed for VOCs, general chemistry and natural attenuation screening parameters, and metals. During the course of the performance monitoring period, analytical parameters may be refined based on review of the results to incorporate only data that yield useful information in monitoring the ISB.

MNA will complete remediation once quarterly performance monitoring results indicate that contaminant removal has become relatively constant indicating that active remediation has reached a low level of economic or technical efficiency and is no longer effective. If the proposed performance monitoring well(s) within the active remediation area, indicates that CVOC concentrations have reached asymptotic levels for two consecutive quarters, and if the CVOCs concentrations are less than 10 times their respective target cleanup goal (TCG) levels, the well(s) will be switched to and monitored for MNA. Otherwise, the enhanced ISB and performance monitoring will continue to be conducted on a quarterly basis, and until the above criteria or the TCGs are met.

MNA will be conducted with the commencement of the remediation activities for the areas within the plume boundaries but outside the active treatment areas. For these areas, select existing wells located along the limits of the plume and outside the active treatment areas will be used for monitoring natural attenuation. MNA will be conducted on a quarterly basis for the first year and semiannually for up to an additional 2 years. If at any time during the remediation the concentrations of the CVOC in any well(s) are less than their respective TCGs for 1 year, the well(s) will be monitored on an annual basis for only CVOCs to confirm that there are no rebounds in the CVOCs concentrations.

The parameters proposed for field testing and laboratory analysis for the MNA are similar to those proposed for the ISB performance monitoring. The field and laboratory testing parameters for the MNA may be modified following assessment of the ISB phase.

If all MNA and ISB monitoring wells reach TCGs for at least 1 year or have been monitored for MNA for 3 years, a long-term monitoring (LTM) program for the entire site will begin. The LTM program is intended to confirm that TCGs are continuing to be met and that there is no recurrence of the contaminants in the groundwater at the site, and to assess the effectiveness of the remedial action. During the LTM program, groundwater level measurements will be conducted and groundwater samples will be collected and analyzed for VOCs. Groundwater monitoring and sampling will be conducted on an annual basis for 5 years. Proposed groundwater monitoring wells for the LTM program will consist of existing monitoring wells located upgradient and downgradient of the plume, and select wells (proposed performance monitoring and injection wells) located within the enhanced ISB treatment areas. The proposed LTM wells consist of shallow interval and middle interval wells. The exact number and locations of the wells proposed for the LTM program may be modified based on the review and evaluation of data collected during the MNA phase. Any changes to the number of wells or well locations will be communicated and negotiated with the RWQCB and the DTSC prior to the implementation of the LTM program. If additional monitoring points are required for implementing the LTM program, efforts will first be made to use the available wells at the site, in lieu of drilling and installing additional new wells.

Site remedial activities will contain the following major components:

- A geophysical survey to assist in locating and marking any underground utilities or features and to provide utility clearance.
- Construction of a network of groundwater monitoring wells and lactate injection wells.
- Construction, operation, and maintenance of a sodium lactate injection system to accelerate natural biodegradation of CVOCs in groundwater.
- Injection of a commercially available *Dehalococcoides ethenogenes* (DHE) culture, and distribution of DHE-laden groundwater.

- Comprehensive performance monitoring throughout the ISB process in order to adjust and optimize the lactate dosing strategy.
- Health and safety monitoring in order to ensure a safe working environment for people working at or in the vicinity of the site
- Monitoring of contaminant concentrations and natural attenuation parameters until remediation goals are achieved.
- Confirmatory groundwater sampling at the end of remediation to confirm that VOC concentrations meet the target cleanup levels.

In order to document and analyze enhanced ISB system operation and subsequent enhanced and/or natural attenuation, semiannual monitoring and remediation status reports will be prepared and submitted to the Department of Toxic Substances Control (DTSC) and RWQCB. The reports will summarize field events including injection and monitoring details, present the data collected for the current monitoring event, make comparisons with data from past events and assess trends and make recommendations for future site activities.

In addition, summary reports will be prepared on a monthly basis during the lactate injection, performance monitoring, and assessment period. The monthly summary reports will include a summary of the field data for the lactate injection and groundwater monitoring wells, and available laboratory analytical data. The monthly summary reports will be provided to the Department of the Navy (DON) and the regulatory agencies on an informal basis by e-mail and as soon as the data are tabulated.

This Remedial Design/Work Plan (RD/WP) also includes procedures for implementation of LUCs. LUCs will be implemented to prevent exposure to CVOC-contaminated groundwater by preventing the use of contaminated groundwater, protecting equipment, allowing access for sampling, installing new monitoring wells, implementing any remedial measures that may be needed in the future, and to maintain the integrity of the remedial action until remediation goals are achieved. LUCs will be implemented over the footprint of the plume and an associated buffer zone. The buffer zone will extend 500 feet from the edge of the plume (DON, 2004). LUC will commence with the start of the remediation and will be implemented consistently with current NAVWPNSTA Seal Beach policies, and policies outlined in the National Environmental Policy Act (NEPA) Compliance Procedures Handbook (DON, 1998). LUCs will remain in effect until monitoring data show that the remediation goals established in the ROD have been achieved (DON, 2004).

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ABBREVIATIONS AND ACRONYMS

°C	degrees Celsius
°F	degrees Fahrenheit
1,2-DCE	1,2-dichloroethene
µg/L	micrograms per liter
AOC	area of concern
ARAR	applicable or relevant and appropriate requirement
Basin Plan	Water Quality Control Plan, Santa Ana River Basin
BEI	Bechtel Environmental, Inc.
bgs	below ground surface
BNI	Bechtel National, Inc.
Cal/EPA	California Environmental Protection Agency
Cal. Pub. Res. Code	California Public Resources Code
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFGC	California Fish and Game Code
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethene
COC	chemical of concern
COD	chemical oxygen demand
COPC	chemical of potential concern
CPRC	California Public Resources Code
CQC	contractor quality control
CVOC	chlorinated volatile organic compound
CZMA	Coastal Zone Management Act
DCE	dichloroethene
DHE	*Dehalococcoides ethenogenes*
DHS	Department of Health Services
DO	dissolved oxygen
DON	Department of the Navy
DOT	Department of Transportation

ABBREVIATIONS AND ACRONYMS
(Continued)

DPM	Deputy Program Manager
DTSC	Department of Toxic Substances Control
DWR	California Department of Water Resources
EMI	electromagnetic induction
EPA	U.S. Environmental Protection Agency
ERSE	Extended Removal Site Evaluation
ESA	Endangered Species Act
FID	flame ionization detector
FS	Feasibility Study
FSI	Focused Site Inspection
gpm	gallons per minute
GPR	ground-penetrating radar
IAS	Initial Assessment Study
IDW	investigation-derived waste
IR	Installation Restoration
IRP	Installation Restoration Program
ISB	in situ bioremediation
JEG	Jacobs Engineering Group, Inc.
KB-1™	proprietary microbial culture containing the bacterium DHE
L	liter
LDR	Land Disposal Restriction
LEL	lower explosive limit
LTM	long-term monitoring
LUC	land-use control
MCL	Maximum Contaminant Level
mg/L	milligrams per liter
MNA	monitored natural attenuation
MSDS	Material Safety Data Sheet
mV	millivolts
NA	not available

ABBREVIATIONS AND ACRONYMS
(Continued)

NAVWPNSTA	Naval Weapons Station
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NEPA	National Environmental Policy Act
NFECSW	Southwest Division, Naval Facilities Engineering Command
NHPA	National Historic Preservation Act
ORP	oxidation/reduction potential
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
OVA	organic vapor analyzer
PCE	tetrachloroethene
PID	photoionization detector
PLFA	phospholipid fatty acid
PPE	personal protective equipment
ppm	parts per million
PQCM	Project Quality Control Manager
PRG	Preliminary Remediation Goal
psi	pounds per square inch
PVC	polyvinyl chloride
QC	Quality Control
QED	QED Environmental Systems
Q-PCR	quantitative polymerase chain reaction
RAC	Remedial Action Contract
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD/WP	Remedial Design/Work Plan
RFA	RCRA Facility Assessment
RI	Remedial Investigation
ROD	Record of Decision
ROI	radius of influence

ABBREVIATIONS AND ACRONYMS
(Continued)

ROICC	Resident Officer in Charge of Construction
RPM	Remedial Project Manager
RWQCB	Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SBNWR	Seal Beach National Wildlife Refuge
Sch.	Schedule
SCS	Soil Conservation Service
SDWA	Safe Drinking Water Act
SHSP	Site-Specific Health and Safety Plan
SHSS	Site Health and Safety Specialist
SI	Site Inspection
SiREM	Site Recovery & Management
SWMU	solid waste management unit
SWRCB	State Water Resource Control Board
TCE	trichloroethene
TCG	target cleanup goal
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solids
TOC	total organic carbon
trans-1,2-DCE	trans-1,2-dichloroethene
TSDF	treatment, storage, and disposal facility
TtFW	Tetra Tech FW, Inc.
USACE	United States Army Corps of Engineers
USC	United States Code
USCS	Unified Soil Classification System
VC	vinyl chloride
VOC	volatile organic compound
WBZ	water-bearing zone
WET	Waste Extraction Test
WQO	Water Quality Objective

1.0 INTRODUCTION

This Remedial Design/Work Plan (RD/WP) defines the technical and operational requirements for remediation of groundwater contaminated with chlorinated solvents at Installation Restoration Program (IRP) Site 40, Naval Weapons Station (NAVWPNSTA) Seal Beach, California (Figures 1-1, 1-2, and 1-3). Tetra Tech FW, Inc. (TtFW) prepared this document for Southwest Division, Naval Facilities Engineering Command (NFECSW) under Contract Task Order 0090 of the Remedial Action Contract (RAC) Program, Contract No. N68711-98-D-5713.

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1.1 PURPOSE AND SCOPE

The purpose of this RD/WP is to define the technical and functional requirements for remediation of groundwater contaminated with chlorinated solvents at IRP Site 40. The scope of work for this RD/WP consists of enhanced ISB and performance monitoring, LUCs, MNA and long-term groundwater monitoring. The implementation, inspection, reporting, and enforcement of the LUCs will be conducted in accordance with the current NAVWPNSTA Seal Beach procedures, and as outlined in Section 6.7.

1.2 INFORMATION INCORPORATED BY REFERENCE

This RD/WP was developed from information contained in the ROD (DON, 2004), and from the following technical reports that document the previous investigations, groundwater monitoring, and pilot testing conducted at IRP Site 40:

- Final Extended Removal Site Evaluation Report [Bechtel National, Inc. (BNI), 1999]
- Final Groundwater Feasibility Study (FS) Report (BNI, 2000)
- Final Work Plans for Long-Term Groundwater Monitoring [Bechtel Environmental, Inc. (BEI), 2000a; 2000b]
- Final Annual Groundwater Monitoring Reports (BEI, 2002; 2003a; 2003b)

- Final Work Plans for Pilot-Test Program (BEI, 2001; 2003c)
- Final Technical Memorandum on Pilot Test for In Situ Enhanced Bioremediation (BEI, 2003d)
- Draft Pilot Test Report for In Situ Enhanced Bioremediation (BEI, 2004)

The RD/WP is supported by additional project-specific documents that will be referenced as appropriate to provide further detail. These additional documents include a Sampling and Analysis Plan (SAP) for chemical data acquisition (Appendix A), a Project Contractor Quality Control (CQC) Plan (Appendix B), a Site-Specific Health and Safety Plan (SHSP) (Appendix C), and Inspection Forms (Appendix D).

1.3 GENERAL APPROACH

TtFW will proceed with implementation of the RD/WP following approval by the DON and the regulatory agencies. The implementation measures and procedures described in the RD/WP will be followed to assure compliance with the applicable design criteria, Remedial Action Objectives (RAOs), and regulatory requirements. A number of pre-construction activities, such as notifications and procurement, will be performed as a part of field implementation planning. The field activities will be conducted in two phases. The first phase will involve field activities associated with pre-remediation construction such as drilling and construction of monitoring and injection wells, and the installation of the necessary injection and nutrient conveyance equipment. The second phase would involve field activities associated with remedial system operation and performance monitoring. The major activities for each phase are listed below:

Phase I Field Activities:

- Land survey to mark the planned well locations (groundwater monitoring wells, groundwater injection wells, and soil vapor monitoring wells)
- A geophysical survey of areas where intrusive activities will be performed
- Drilling, well installation, and well development
- Installation of dedicated well pumps and equipment
- Construction of the nutrient delivery and injection system

Phase II Field Activities:

- Injecting sodium lactate into the subsurface at a specified number of groundwater injection wells (biostimulation to degrade chlorinated ethenes)
- Introducing non-indigenous microorganisms to the groundwater (bioaugmentation to complete the dechlorination process)
- Groundwater, soil vapor, and indoor air monitoring (performance monitoring)

The RD/WP also provides details on the procedures for implementing, inspecting, reporting, and enforcing the LUCs. The remainder of this RD/WP is divided into eight sections, as follows:

- Section 2.0 describes the facility and previous investigations, provides an assessment of the impacts including discussions on the physical, geologic, and chemical characteristics of the site, and discusses risk evaluation.
- The regulatory framework and the target cleanup goal (TCG) determination for the site contaminants are presented in Section 3.0. Section 3.0 also defines the remedy and the performance criteria applicable to each element of the remedy.
- The remedial system design is discussed in Section 4.0.
- Section 5.0 provides a detailed description of the different tasks associated with implementing the pre-remediation construction activities.
- The remediation operations, monitoring, and reporting requirements are described in Section 6.0.
- Waste management and disposal requirements are described in Section 7.0.
- The Project Management Plan, including the project schedule, is discussed in Section 8.0.
- References are included in Section 9.0.

2.0 SITE CONDITIONS

Pertinent information on site description and history, previous investigations, geology, hydrology, hydrogeology, chemical characteristics of the contamination, and the health risk evaluation are presented in this section.

2.1 FACILITY AND SITE DESCRIPTION

This section describes the facility location and site description.

2.1.1 NAVWPNSTA Seal Beach

NAVWPNSTA Seal Beach is located about 30 miles south of the Los Angeles urban center. NAVWPNSTA Seal Beach consists of approximately 5,000 acres of land along the Pacific Coast within the city of Seal Beach in Orange County, California (Figure 1-1). NAVWPNSTA Seal Beach is bordered on the southwest by Anaheim Bay, on the north by Interstate 405 (San Diego Freeway), on the east by Bolsa Chica Road, on the west by Seal Beach Boulevard, and on the southeast by a flood control channel. Originally commissioned in 1944, NAVWPNSTA Seal Beach is part of the Navy Region Southwest. NAVWPNSTA Seal Beach provides fleet combatants with ready-for-use ordnance. Because of its geographic location, the NAVWPNSTA serves as a supply point for the operating forces of the DON and United States Marine Corps forces in the southern California region. Figure 1-2 shows a map of NAVWPNSTA Seal Beach, including the location of IRP Site 40.

2.1.2 Site Description and History

IRP Site 40 (Figure 1-3) includes a concrete pit located in the Locomotive Shop (Building 240) and a gravel area located north of, and adjacent to, the building. The concrete pit formerly provided a collection point for oil and solvents spilled during locomotive maintenance activities. Until 1978, oil that collected in the pit discharged into the gravel area through a drainpipe. The pipe was plugged in 1978. Currently, the area north of Building 240 is paved and area northwest of Building 240 is unpaved. Four railroad spurs terminate in Building 240 and provide locomotive access to the repair shop. Additional tracks traverse the asphalt-paved area to the south.

2.2 PREVIOUS INVESTIGATIONS

A number of investigations have been conducted at NAVWPNSTA Seal Beach:

- General facility investigations
  - Initial Assessment Study (IAS) [Naval Energy and Environmental Support Activity (NEESA), 1985]

  - Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) (Kearney, 1989)
  - Addendum to the Preliminary Assessment (IAS) (NEESA, 1990)
- Investigations at IRP Site 40
  - Site Inspection (SI) of Operable Unit (OU) 4 sites [Jacobs Engineering Group, Inc. (JEG), 1995]
  - Focused SI (FSI) of OU 4 and 5 sites (JEG, 1996)
- Extended Removal Site Evaluation (ERSE) of IRP Sites 40 and 70 (BNI, 1999).
- FS Activities (BNI, 2000)
  - Bench-scale study
  - Pilot-test study

Following is a summary of these investigations.

2.2.1 General Facility Investigations

In 1985, the DON conducted an IAS to investigate potentially contaminated sites at NAVWPNSTA Seal Beach (NEESA, 1985). The IAS was conducted under the DON Assessment and Control of Installation Pollutants Program. Twenty-five potentially impacted sites at NAVWPNSTA Seal Beach were identified on the basis of record searches, aerial photographs, field inspections, and interviews with facility personnel. The study concluded that 9 of the 25 sites warranted further investigation. In response to the IAS findings, an SI was performed. In 1989, the U.S. Environmental Protection Agency (EPA) contracted with A.T. Kearney, Inc., to perform a RFA at NAVWPNSTA Seal Beach (Kearney, 1989). The RFA was performed to determine whether there had been, or were likely to be, releases of hazardous substances from locations where hazardous wastes or materials had been used, treated, stored, or disposed.

The RFA was based on historical information, interviews with NAVWPNSTA personnel, visual inspections of the sites, and preliminary review of data available from an ongoing SI. The RFA listed 69 solid waste management units (SWMUs) and 9 areas of concern (AOCs) and recommended several of these for further investigation.

In response to the Department of Toxic Substances Control (DTSC) concerns, NEESA completed a preliminary assessment as an addendum to the 1985 IAS (NEESA, 1990). This preliminary assessment reevaluated the 16 sites recommended for no further action in the IAS. The preliminary assessment also included investigating other potentially impacted sites identified in the 1990 RFA. As a result, 16 more sites were recommended for further study, including IRP Site 40.

2.2.2 Summary of Investigations and Studies at IRP Site 40

In 1995, JEG conducted a SI of 16 OU 4 sites, including IRP Site 40 (JEG, 1995). The SI found that two chemicals of potential concern (COPCs), carbon tetrachloride and PCE, had been released to the groundwater at this site. The SI report also recommended an FSI to evaluate the nature and extent of chlorinated hydrocarbons in the groundwater. An FSI was conducted at IRP Site 40 in conjunction with further investigations at seven additional sites in OUs 4 and 5 (JEG, 1996). The FSI concluded that a plume of chlorinated hydrocarbons containing PCE, TCE, and 1,2-dichloroethene (1,2-DCE) was present in groundwater beneath IRP Site 40. The study delineated the lateral extent of the plume in the shallow water-bearing zone (WBZ) as approximately 270 feet by 200 feet. Because PCE, TCE, and 1,2-DCE were detected at levels exceeding state and federal Maximum Contaminant Levels (MCLs), further action was recommended.

In 1998, an ERSE was conducted to supplement data from previous investigations at IRP Site 40 (BNI, 1999). The ERSE included soil and groundwater sampling, and the findings enabled the DON to support a decision for a no further action, removal action, or further evaluation. Although no immediate threat to human health or the environment from groundwater was indicated, the ERSE Report recommended a response action to address groundwater at IRP Site 40 because cumulative human-health risk exceeded the generally acceptable range as defined in the NCP. The DON determined that the ERSE for IRP Site 40 substantially complied with the requirements of a Remedial Investigation (RI) under CERCLA and that it was appropriate to proceed directly to an FS.

An FS Report for groundwater cleanup at IRP Site 40 (Concrete Pit/Gravel Area) was developed (BNI, 2000). The FS Report did not identify or recommend a preferred remedial alternative for IRP Site 40. The FS evaluated enhanced in situ bioremediation for IRP Site 40. The technology offers the possibility of significantly accelerating the overall cleanup time frame. A consideration is that intermediate by-products can be formed that may be more toxic and hazardous than the primary chemicals of concern (COCs). The technology must, therefore, be implemented in a manner that completes the anaerobic biodegradation of the volatile organic compounds (VOCs) to harmless by-products. Because limited data existed on the technology, bench-scale and pilot-scale testing was recommended in the FS Report (BNI, 2000).

A bench-scale test was performed from May to October 2000. Groundwater samples and soil samples from the saturated zone were collected from IRP Site 40 in April 2000. Four aqueous bioreactors inoculated with small amounts of soil (100 grams of soil and 800 milliliters of groundwater) were then formulated in the laboratory and actively monitored for 5 months during the bench-scale test.

The results of the bench-scale test were used to help predict what microbiological activities and chemical and physical conditions might be observed in the field. Dechlorination was not reported

during the bench-scale test. The overall goal of the laboratory test was to verify the existence of a complete anaerobic degradation pathway with a reaction rate that would enhance the remediation time frame. The study showed that indigenous microbes capable of lactate fermentation and sulfate reduction were present in the samples obtained from IRP Site 40. The presence of dechlorination daughter products [cis-1,2-dichloroethene (cis-DCE) and TCE] provided strong evidence that microorganisms capable of reductive dechlorination were present at the site, although they were not apparent in the bench-scale test (BEI, 2004).

Based on the results of the bench-scale test, a pilot-scale test was designed and implemented by DON in order to generate the critical performance and cost data necessary for remedy evaluation and selection, and to verify that the process can meet the site's cleanup criteria (BNI, 2004). Specifically, the goal of the pilot-scale test was to verify the effectiveness of enhanced ISB on PCE and its natural degradation products [TCE, dichloroethene (DCE), vinyl chloride (VC), and ethene] at IRP Site 40.

The pilot-scale test was conducted in two phases. Phase I (conducted from July 2001, to April 2002) involved biostimulation of indigenous bacteria with sodium lactate. During Phase II (conducted from March to December 2003), bioaugmentation was conducted using bacteria that were not indigenous to the site.

Reductive dechlorination was confirmed during Phase I, but the reaction process was incomplete. PCE was reduced to DCE, but DCE was not reduced further to VC or ethene. It was reasoned that an appropriate microbial consortium for complete reductive dechlorination was not present at the site. Bacterial characterization tests indicated that the specific bacteria strain known to be capable of complete dechlorination from PCE to ethene was not present at IRP Site 40.

Phase II involved adding a bacteria culture that has been shown to completely dechlorinate PCE to ethene in other aquifers. Additional sodium lactate injections were performed over a 5-month period. In the second month, a commercially available bacterial culture capable of carrying out complete reductive dechlorination was added to each of two bioaugmentation wells. Effects were monitored over an 8-month period using groundwater and soil gas wells. Results indicated that the introduced bacteria were able to overcome the limitation on dechlorination. Based on the results of the pilot-scale test, the DON believes that sufficient information was generated to select enhanced ISB, followed by MNA, as the preferred remedial alternative for IRP Site 40 (BEI, 2004).

2.3 PHYSICAL SETTING AND CLIMATE

NAVWPNSTA Seal Beach is situated at latitude 33° 45' 27" and longitude 118° 4' 22", San Bernardino Baseline and Meridian. NAVWPNSTA Seal Beach is located within the Los Angeles-Orange County coastal plain. This northwest-trending structural basin is approximately 50 miles long and 20 miles wide with deposits as much as 20,000 feet thick. Basin morphology

was developed through the mechanisms of folding, faulting, erosion, and fluctuating sea levels (JEG, 1994).

Most of the NAVWPNSTA Seal Beach lies on predominantly flat alluvial deposits in the southeastern portion of the Los Angeles Basin. The Los Angeles Basin is bounded on the north by the Santa Monica Mountains; on the northeast by the Repetto and Puente Hills; on the east and southeast by the Santa Ana Mountains and the San Joaquin Hills; and on the south, southwest, and west by the Palos Verdes Hills and the Pacific Ocean. The land at NAVWPNSTA Seal Beach slopes evenly from approximately 20 feet above sea level in the northwestern part of the NAVWPNSTA Seal Beach to sea level in the tidal flats of the Seal Beach National Wildlife Refuge (SBNWR) in the southeast (Figure 1-2). The most pronounced topographic feature at the NAVWPNSTA is part of Landing Hill on the southwest. Landing Hill reaches a maximum elevation of about 50 feet (JEG, 1994).

The area climate is classified as a marine-influenced southern California coastal region with mild winters that average 52 degrees Fahrenheit (°F) and summers that average 68 °F. Temperature ranges from winter lows in the 30s °F to summer highs in the 90s °F. Annual precipitation averages 12.5 inches, with approximately 90 percent occurring between the months of November and April. Although precipitation is low, a high humidity level is sustained because of the proximity of the Pacific Ocean (JEG, 1994). Prevailing winds average 3.8 miles per hour from the west. Occasional strong, dry winds from the northeast, known as the "Santa Anas," occur in the fall, winter, and early spring (JEG, 1994). Periodically, the region is subjected to a phenomenon called "El Nino," which brings unusually high precipitation, flooding, high winds, and temperatures outside the expected range. The NAVWPNSTA was subjected to this El Nino weather pattern in 1997 and 1998, resulting in extremely high winds, higher than normal tidal cycles, a rise in groundwater level, flooding, and ponding in otherwise dry areas.

2.4 REGIONAL GEOLOGY/HYDROLOGY/HYDROGEOLOGY

Regional geology and hydrogeology is summarized in the remainder of this subsection. The FS (BNI, 2000) provides more details.

2.4.1 Regional Geology

Affected substrate at NAVWPNSTA Seal Beach is primarily Recent Age (Holocene) alluvial deposits within the Los Angeles Basin. Sources for this alluvium were the ancestral Los Angeles, San Gabriel and Santa Ana Rivers, and Upper Pleistocene sand and clay deposits. The ancestral rivers cut trenches through the rising Newport-Inglewood uplift to depths from 120 to 180 feet below mean sea level. Soils at the NAVWPNSTA contain abundant clay and silt and are poorly drained. Six soil types have been identified. The Bolsa series (JEG, 1995) [Soil Conservation Service (SCS), 1978] covers approximately two-thirds of NAVWPNSTA Seal Beach including IRP Site 40. These soils are somewhat poorly drained, moderately alkaline, and calcareous and

have developed from largely flat alluvial and coastal deposits. The soils extend to approximately 49 inches below ground surface (bgs) and are moderately to slowly permeable.

Stratigraphic sequence underlying NAVWPNSTA Seal Beach, from youngest to oldest, is:

- Recent alluvium
- Upper Pleistocene Lakewood Formation
- Lower Pleistocene San Pedro Formation
- Pleistocene Pico Formation

Maximum thickness of recent deposits in the region is approximately 80 to 100 feet. The upper 50 feet of this unit consists of fine sands, silty clays, and clays, while the lower unit consists of alluvial sands and gravels, silty sands, silty clays, and clays. Transitional, shallow marine, and fluvial deposits of great variability are part of the Upper Pleistocene sand and clay deposits, starting at approximately 80 to 100 feet. Units are discontinuous and contain zones of high and low permeability. The maximum thickness of the Lakewood Formation is approximately 350 feet in the city of Lakewood [California Department of Water Resources (DWR), 1961].

2.4.2 Hydrogeology

NAVWPNSTA Seal Beach is located at the southwestern corner of the Orange County Basin of the Los Angeles Groundwater Basin. The Orange County Basin contains the Artesia, Gage, Hollydale, Jefferson, Lynwood, and Silverado aquifers. The Lynwood and Silverado aquifers are merged across most of the NAVWPNSTA (JEG, 1994).

There are four general aquifer zones (JEG, 1994):

- A semi-perched, unconfined zone within the upper recent alluvial deposits
- A confined fresh groundwater zone contained in lower recent alluvial deposits
- Late and Early Pleistocene deposits of the Lakewood and San Pedro Formations, respectively, and deposits of the Late Pliocene Pico Formation in some parts
- A confined zone of saline water underlying the freshwater zone

The principal freshwater body tapped to supply NAVWPNSTA Seal Beach is a large confined aquifer occupying two zones. The first zone is about 75 to 200 feet deep and saline; and it is no longer used for water supply. The second zone is approximately 250 to 1,000 feet deep. This aquifer is the primary water supply source both to the NAVWPNSTA and neighboring cities (JEG, 1994).

The groundwater underlying the NAVWPNSTA is within the Lower Santa Ana River Groundwater Basin (Santa Ana Pressure Sub-basin) [Regional Water Quality Control Board

(RWQCB), 1995]. Beneficial uses of groundwater within the Santa Ana Pressure Sub-basin include municipal and domestic supply, agricultural, industrial service supply, and industrial process supply. Currently, shallow groundwater underlying IRP Site 40 does not serve as a water source for any of the beneficial uses designated in the *Water Quality Control Plan, Santa Ana River Basin* (Basin Plan) (RWQCB, 1995).

Groundwater levels in the principal freshwater zone fluctuate from year to year because of variations in pumping, infiltration, and recharge. Recharge to this aquifer is primarily from unconfined upgradient areas, and from unlined rivers that are hydraulically connected to the aquifer. Seasonal variations occur with highs in the wet winter months and with lows in the dry summer months when large quantities of water are used for irrigation (JEG, 1994).

2.5 SITE CONDITIONS AT IRP SITE 40

This section presents general information on site conditions at IRP Sites 40, including observed geologic units, conceptual model, aquifer test results, groundwater flow, general groundwater chemistry, nature and extent of contamination, and contaminant fate and transport. See the FS (BNI, 2000) for more details.

IRP Site 40 is contaminated primarily with chlorinated solvents. The site has a region of soil contamination and a groundwater contaminant plume to approximately 66 feet bgs. The lateral and vertical extent of the plume has been delineated. The groundwater gradient is relatively flat, and movement of the plume in groundwater is relatively slow. The sediments span a wide range of lithologies and grain sizes [see cross sections in the FS (BNI, 2000)].

2.5.1 Observed Geologic Units

The geologic units observed at IRP Site 40 are as follows (BNI, 1999).

- Surficial soils - Silty sands and clayey sands, as well as sandy clay and clays, with considerable lithological variation laterally
- First sand unit - Sands to silty sands within a few feet of the water table extending to 7.5 to 10 feet bgs
- Second sand unit - Saturated sands to silty sands at 9 to 21 feet bgs, extending to 28 to 41 feet
- Third sand unit - Saturated sands to silty sands at 38 to 52 feet bgs, depending on the location

Lower permeability intervals containing clay, silty clay, and silt separate the coarser grained units noted above.

2.5.2 Conceptual Model

The site physical conceptual model (Figure 2-1) generally represents the location and assumed lateral continuity of the hydrostratigraphic units beneath the IRP Site 40 vicinity. The model incorporates the uppermost soil layer, approximately 80 feet bgs, which includes Late Pleistocene sediments of the Lakewood Formation. The model was developed during the ERSE (BNI, 1999)

2.5.3 Aquifer Test Results

The hydraulic conductivities of screened intervals in selected ERSE groundwater monitoring wells were determined on the basis of aquifer (slug) tests (BNI, 1999). Hydraulic conductivity values, highest for the shallowest well and lowest for the deep interval wells, were as follows:

- Shallow depth (9.5 to 20.5 feet bgs), 91.01 to 103.53 feet per day
- Intermediate depth (20 0 to 30.3 feet bgs), 28.56 to 54.13 feet per day
- Deeper zone (45 to 55 feet bgs), 2.96 to 20.20 feet per day

All of these hydraulic conductivity values are typical of published values for unconsolidated silty sands to sands (Freeze and Cherry, 1979).

2.5.4 Groundwater Flow

Based on a tidal influence study from the ERSE, water levels are locally tidally influenced (BNI, 1999). The data indicated that the water table occurred at an approximate depth of 8 to 9 feet bgs. There are no continuous shallow confining layers evident at IRP Site 40.

The varying effects of tidal lag time and head differences are seasonal. In October 1997, head difference between well pairs ranged from 0.04 to 0.08 foot. Pressure response from tidal fluctuations varied from 0.1 to 0.2 foot in wells. Groundwater-level contours for intermediate-depth monitoring wells showed the hydraulic gradient direction is to the southeast, toward the tidal marsh. The average gradient magnitude is approximately 0.0002. Groundwater-level contours for deeper monitoring wells indicate that the overall hydraulic gradient direction is to the southeast, toward the tidal marsh; however, the gradient direction between individual wells varies. The average gradient magnitude was also approximately 0.0002. Head differences of -0.02 to -0.14 foot between well pairs indicate a downward vertical gradient. Seasonal influences appear to change the groundwater surface levels in all three zones, although the direction does not change, and the gradient changes relatively little.

2.5.5 General Groundwater Chemistry

General groundwater chemistry data (BNI, 1999) indicate:

- Groundwater at IRP Site 40 appears to vary from fresh to brackish, based upon total dissolved solids (TDS) data

- Chloride appears to be the major anion present in groundwater.
- Major cations include sodium, calcium, and magnesium.
- Minor amounts of dissolved gases (methane and ethene) are present.
- Based on alkalinity values, groundwater appears to be generally hard to very hard.
- Dissolved iron is locally present up to about 6 milligrams per liter (mg/L).
- Total organic carbon is present locally; the highest concentrations were reported in a center-of-plume location within the defined boundary of the VOC plume.
- Specific conductance indicates that shallow groundwater underlying the site ranges from fresh to brackish to slightly saline;
- pH values suggest that the groundwater is slightly basic.
- Dissolved oxygen (DO) and oxidation reduction potential (ORP) data indicate moderately reduced to reduced conditions.
- Ferrous iron is locally present.

2.5.6 Nature and Extent of Contamination

Previous investigations identified the potential sources of contamination at IRP Site 40. The SI identified a release to groundwater of the COPCs carbon tetrachloride and PCE (JEG, 1995). The FSI report concluded that a plume of chlorinated hydrocarbons containing PCE, TCE, and 1,2-DCE at levels exceeding MCLs exists beneath the site (JEG, 1996). The FSI delineated the lateral extent of the plume in the shallow groundwater as approximately 270 feet by 200 feet, but did not determine a vadose-zone source.

BNI further investigated soil contamination at IRP Site 40 during the ERSE (BNI, 1999). The ERSE concluded that the potential for continued leaching of soil COPCs to groundwater is low to negligible. Releases of chlorinated solvents migrated through the soil, resulting in a groundwater plume containing primarily PCE with lesser concentrations of TCE, cis-1,2-DCE, trans-1,2-dichloroethene (trans-1,2-DCE), and chloroform. However, concentrations of these VOCs in the vadose-zone soil indicate most of the original releases have already leached to groundwater or volatilized to the atmosphere (BNI, 1999). The potential for transport of soil COPCs through runoff is low to negligible. The ERSE further concluded human-health risk for soils is below the NCP-defined departure point, and site development should not adversely impact ecological receptors (BNI, 1999).

The lateral and vertical extent of the groundwater contaminant plume, consisting largely of VOCs, has been delineated (BNI, 1999). PCE is present at depth intervals of less than 20 feet, 20 to 45 feet, and greater than 45 feet (Figures 2-2 through 2-4, respectively). PCE and TCE concentrations in groundwater as of March 2003 are shown in Figure 2-5. See the FS (BNI, 2000) for more details.

2.5.7 Contaminant Fate and Transport

The ERSE (BNI, 1999) concluded the following:

- The potential for continued leaching of soil COPCs to groundwater is low to negligible.
- There is a negligible potential for COPCs to have migrated deeper than that determined by the ERSE sampling. Downward migration of chlorinated VOCs apparently has been limited to approximately 66 feet bgs (BNI, 1999).
- A slight downward gradient was indicated by the typical head difference of 0.1 to 0.2 foot at well pairs in October 1997, thus the potential for downward migration exists. Based on the absence of significant concentrations of chlorinated VOCs below the second Interbedded Unit, the slight downward gradient has not caused an impact at lower intervals.
- Significant biodegradation of PCE has occurred, and conditions are conducive to continued degradation; therefore, natural attenuation will continue to reduce existing VOC concentrations.
- The potential for the COPC plume to reach the SBNWR boundary at concentrations exceeding acceptable levels is low because of lithologic controls on groundwater flow and the apparent degradation taking place.

The FS (BNI, 2000) further discusses the fate and transport characteristics of contaminants at IRP Site 40.

2.6 RISK EVALUATION

The ERSE concluded that no complete exposure pathway exists between chemicals in groundwater and ecological receptors at IRP Sites 40. Thus, chemicals reported in groundwater were not evaluated further for ecological risk.

For the human-health screening risk assessment, COPCs were screened by comparing their maximum reported concentrations in soil and groundwater with concentrations representing a level of acceptable risk. The basic tenet of this approach is that the risk presented by a given concentration of a chemical is acceptable when it does not exceed the concentration established by regulatory agencies.

Screening was conducted as follows.

- COPCs were matched to the respective tap water Preliminary Remediation Goal (PRG) values and were evaluated as two groups. The first group was composed of those COPCs with cancer-based PRG values; and the second was composed of the COPCs with non-cancer, hazard-based PRG values.
- The ratio of the maximum reported chemical concentration and cancer/non-cancer/ saturation-based PRG were calculated for each COPC.

- The ratio of each carcinogen was multiplied by 1×10^{-6} to obtain a cancer risk estimate.
- The cancer risk estimates were summed to obtain an estimate of total cancer risk.
- The ratios for the noncarcinogens were summed to obtain an estimate of total chronic toxicity. The sum of these ratios is called the "hazard index."

Detailed results for the human-health screening risk assessment are presented in the FS (BNI, 2000) and summarized as follows for IRP Site 40.

- The human-health risk screening for IRP Site 40 groundwater estimated a total cancer risk of 4.1×10^{-3} and a hazard index of 85, resulting primarily from PCE and TCE. Approximately 88 percent of the total cancer risk is from PCE, and 85 percent of the total hazard index is from PCE and TCE.

3.0 REGULATORY FRAMEWORK

The primary objective of the proposed remedial action is to protect human health and the environment. RAOs and TCGs were developed to provide objectives used to define and evaluate remedial action alternatives. Potential applicable or relevant and appropriate requirements (ARARs) were identified and evaluated to assist in determining RAOs and recommended TCGs.

3.1 REGULATORY OVERVIEW

Cleanup at IRP Site 40 is being conducted as part of the IRP. The program identifies, assesses, characterizes, and cleans up or controls pollutants from past hazardous waste disposal operations and spills. The program was established to comply with federal requirements regarding cleanup of hazardous waste sites. These federal requirements are outlined in CERCLA, as amended by the Superfund Amendments and Reauthorization Act.

The DON, under the Defense Environmental Restoration Program, follows the EPA RI and FS protocols. An RI/FS involves characterizing the nature and extent of risk posed by hazardous waste sites and evaluating options for cleanup. The NCP [Title 40 Code of Federal Regulations (CFR) 300] provides the RI/FS protocols.

3.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

In situ enhanced bioremediation, followed by MNA, will comply with the substantive portions of all ARARs. Section 121(e) of the CERCLA, United States Code (USC,) Section 9621(e), states that no federal, state, or local permit is required for remedial actions conducted entirely on site. Therefore, actions conducted entirely on site must meet only the substantive requirements of the ARARs. Any action conducted off site is subject to the full requirements of federal, state, and local regulations. The chemical-, location-, and action-specific ARARs for the selected remedy for IRP Site 40 are discussed in the following subsections.

3.2.1 Chemical-specific ARARs

Chemical-specific ARARs are health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, establish the acceptable amount or concentration of a chemical that may be found in or discharged to the ambient environment. If a chemical has more than one remediation goal, the most stringent level has been identified as an ARAR for this remedial action. The selected remedial action will be implemented to comply with chemical-specific ARARs.

Chemical-specific ARARs have been identified for groundwater and soil. Groundwater is a medium of concern at IRP Site 40 because it is a potential source of drinking water. Soil is not a medium of concern, but soil cuttings generated from construction of monitoring and injection

wells will require characterization as potential hazardous waste prior to disposal. Surface water is not a medium of concern at IRP Site 40.

The substantive provisions of the following requirements were identified as the most stringent of the potential federal and state groundwater ARARs for remedial actions at IRP Site 40:

- Basin Plan for the Santa Ana Region, 1995 (specifying water quality objectives, beneficial use, waste discharge limitations)
- Federal MCLs listed in the Safe Drinking Water Act (SDWA)
- State primary MCLs in California Code of Regulations (CCR) Title 22, Section 64444
- RCRA groundwater protection standards in CCR Title 22, Section 66264.94(a)(1), (a)(3), (c), (d), and (e)

The most stringent of these requirements are the RCRA groundwater protection standards and CCR Title 22, Section 66264.94 requirements to restore affected groundwater to background conditions, if possible, or else attain the best water quality that is technically and economically feasible. A fate and transport study was conducted as part of the ERSE (BNI, 1999). Results indicate that migration through vadose zone soil leaching is considered negligible for existing conditions.

The DON has determined that the substantive provisions of CCR Title 22, Section 66264.94(a)(1), (a)(3), (c), (d), and (e) constitute relevant and appropriate federal requirements for groundwater. These provisions are considered a federal ARAR because this requirement was approved by EPA in its 23 July 1992 authorization of the state of California's RCRA program and is federally enforceable. The state of California disagrees with the DON; this regulation is a part of the state's authorized hazardous waste control program, so the state contends that the regulation is a state ARAR and not a federal ARAR.

Detailed discussion of the chemical-specific ARARs for groundwater can be found in the ROD (DON, 2004). Based on the ROD, the DON and the state of California have not agreed on whether SWRCB Resolution 92-49 and Resolution 68-16 and CCR Title 23, Section 2550.4 are ARARs for this response action. The ROD however, has documented each parties' position on the resolution but does not attempt to resolve the issue.

3.2.2 Location-specific ARARs

Location-specific ARARs are restrictions on the concentrations of hazardous substances or on activities solely because they are in specific locations such as floodplains, wetlands, historic places, and sensitive ecosystems or habitats. The selected remedial action will be implemented to comply with location-specific ARARs.

The substantive provisions of the following requirements were identified as the most stringent of the potential federal and state location-specific ARARs for the remedial actions at IRP Site 40:

- 40 CFR, Part 6.302(a) (Executive Order No. 11990, Protection of Wetlands)
- 40 CFR, Part 6.301(a) [Historic Sites, Buildings, and Antiquities Act of 1935 (16 USC, Sections 461–167)]
- 40 CFR, Part 6.301(b) [National Historic Preservation Act (NHPA) of 1966, as Amended (16 USC, Sections 470–470x-6)]
- 40 CFR, Part 6.301(c) [Archaeological and Historic Preservation Act (16 USC, Sections 469–469c-1)]
- 16 USC, Sections 1531–1543 [Endangered Species Act (ESA)]
- 16 USC, Sections 1451–1464 [Coastal Zone Management Act (CZMA)]
- 16 USC, Sections 703--712 (Migratory Bird Treaty Act)
- California Fish and Game Code (CFGC), Section 2080 (California ESA)
- California Public Resources Code (CPRC), Sections 30000–30900; CCR Title 14, Sections 13001–13666.4 (California Coastal Act)

3.2.2.1 Wetlands

Jurisdictional wetlands exist at NAVWPNSTA Seal Beach, identified by the United States Army Corps of Engineers (USACE0 and are located close to IRP Site 40. Title 40 CFR Section 6.302(c) requires that actions within wetlands be implemented to minimize the destruction, loss, or degradation of wetlands. The DON will take appropriate action during the remedial design and remedial action phase to minimize impact on wetlands and will consider the location of the wetlands in siting the injection and monitoring wells and their associated piping and equipment.

3.2.2.2 National Historic Preservation Act

An archaeological survey conducted at NAVWPNSTA Seal Beach indicates the presence of 186 out of the 250 structures surveyed as eligible for contributing to the historic district. Building 240 located at IRP Site 40 is listed. NHPA requires that potential impacts to federally funded properties included in or eligible for the National Register of Historic Places (National Register) be identified and mitigated. The DON will coordinate with the State Historic Preservation Officer as required to minimize impacts on this structure.

3.2.2.3 Endangered Species

IRP Site 40 remedial actions might affect areas that support federal and California-listed endangered species or habitat. The SBNWR supports endangered species. Five bird species and one plant species are listed as endangered either by federal or state agencies and are known to inhabit NAVWPNSTA Seal Beach and the wetlands of the SBNWR. Salt marsh bird's beak is

listed as an endangered plant species by federal and state agencies. Because of the rapidly disappearing habitat on the coast of southern California, two species of federally listed endangered birds, the California least tern and the light-footed clapper rail, rely on the limited habitat at NAVWPNSTA Seal Beach for their survival. One other federally listed endangered bird, the California brown pelican, along with the state-listed Belding's Savannah sparrow, also use the habitat at NAVWPNSTA Seal Beach and the SBNWR wetlands. The ESA of 1973 (16 USC, Sections 1531-1543) provides a means for conserving various species of fish, wildlife, and plants that are threatened with extinction. The ESA defines an endangered species and provides for the designation of critical habitats. Federal agencies may not jeopardize the continued existence of any listed species or cause the destruction or adverse modification of critical habitat. Under Section 7(a) of the ESA, federal agencies must carry out conservation programs for listed species. The Endangered Species Committee may grant an exemption for agency action if reasonable mitigation and enhancement measures such as propagation, transplantation, and habitat acquisition and improvement are implemented. Consultation regulations at 50 CFR, Section 402, are administrative in nature, and therefore, are not ARARs. However, the DON will comply with substantive provisions of the ESA (CFGC, Section 2080).

3.2.2.4 Coastal Zone Management Act

Under the CZMA, federal land is specifically excluded from the definition of a coastal zone. The CZMA (16 USC, Sections 1451-1464) and the accompanying implementing regulations in 15 CFR, Section 930, require that federal agencies conducting or supporting activities directly affecting the coastal zone, conduct or support those activities in a manner that is consistent with the approved state coastal zone management programs. A state coastal zone management program (developed under state law and guided by the CZMA) sets forth objectives, policies, and standards to guide public and private uses of lands and water in the coastal zone. Activities affecting the coastal zone including lands thereunder and adjacent shore land will be conducted in a manner consistent with approved state management programs. This ARAR is relevant and appropriate. This ARAR is not applicable because federal land is excluded from the definition of coastal zone.

3.2.2.5 California Coastal Act of 1976

California Public Resources Code (Cal. Pub. Res. Code), Sections 30000-30900, and CCR, Title 14, Sections 13001-13666.4 regulate activities associated with development to control direct significant impacts on coastal waters and to protect state and national interests in California coastal resources. The California Coastal Act policies set forth in the act constitute the standards used by the California Coastal Commission in its coastal development permit decisions and for the review of local coastal programs. These policies contain the following substantive requirements: protection and expansion of public access to the shoreline and recreation opportunities (Cal. Pub. Res. Code, Sections 30210-30224); protection, enhancement, and restoration of environmentally sensitive habitats including intertidal and nearshore waters,

wetlands, bays and estuaries, riparian habitat, grasslands, streams, lakes, and habitat for rare or endangered plants or animals (Cal. Pub. Res. Code, Sections 30230-30240), protection of productive agricultural lands, commercial fisheries, and archaeological resources (Cal. Pub. Res. Code, Sections 30234, 30241-30244), protection of the scenic beauty of coastal landscapes (Cal. Pub. Res. Code, Section 30251), and provisions for expansion, in an environmentally sound manner, of existing industrial ports and electricity-generating power plants (Cal. Pub. Res. Code, Section 30264).

3.2.2.6 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (16 USC, Sections 703-712) prohibits at any time, using any means or manner, the pursuit, hunting, capturing, and killing or attempting to take, capture, or kill any migratory bird. This act also prohibits the possession, sale, export, and import of any migratory bird or any part of a migratory bird, as well as nests and eggs. A list of migratory birds for which this requirement applies is found at 50 CFR, Section 10.13.

3.2.3 Action-specific ARARs

Action-specific ARARs are technology- or activity-based requirements or limitations for remedial activities and apply to particular remediation activities. Actions that trigger these ARARs at IRP Site 40 include installation of injection and monitoring wells, and groundwater monitoring.

Injection of chemicals into groundwater for in situ treatment does not trigger federal or state ARARs. There are no specific federal or state ARARs concerning injection of nutrients/adjuvants and/or chemical reagents into the groundwater. In addition, RCRA 3020(a) (bans hazardous waste disposal by underground injection above a formation that contains an underground source of drinking water) does not apply to this action because commercial chemicals or chemical by-products injected into groundwater for in situ treatment are not considered hazardous waste (EPA, 2000).

Federal and state action-specific ARARs for installation of wells and groundwater monitoring are discussed in the following subsections.

3.2.3.1 Federal

Federal laws that give rise to potential ARARs for actions to be undertaken as part of the selected alternative include RCRA requirements for monitoring and for characterizing, managing, and treating hazardous waste.

RCRA

RCRA requirements for monitoring and for identification, management, and treatment of hazardous wastes (soil cuttings, wastewater generated in the course of installing monitoring and injection wells) are federal action-specific ARARs identified for the selected alternative. Portions of the RCRA groundwater protection standards contained in CCR Title 22 are considered relevant and appropriate for the groundwater potentially impacted by the releases from IRP Site 40 because the hazardous chemicals being addressed by this alternative are similar or identical to those found in RCRA hazardous wastes.

The DON has determined that soil and groundwater at IRP Site 40 would not be classified as RCRA-listed hazardous wastes. However, testing would still be required to classify these materials with respect to the RCRA hazardous waste characteristics. This determination would be made at the time the waste is generated. If testing at the time of generation indicates a hazardous waste, then the appropriate RCRA requirements for storing, treatment, and disposal would be potentially applicable ARARs for on-site activities.

Substantive provisions of the following requirements are relevant and appropriate to the development and implementation of the monitoring program:

- Groundwater monitoring and response (CCR Title 22, Sections 66264.91[a] and [c]), except as it cross-references permit requirements
- Requirements for monitoring groundwater, surface water, and the vadose zone (CCR Title 22, Section 66264.97[e])
- Detection monitoring (CCR Title 22, Section 66264.98)
- Corrective-action monitoring (CCR Title 22, Section 66264.100[d])

These regulations are not applicable because the sites are not RCRA-regulated units.

3.2.3.2 State

State laws that give rise to potential ARARs for actions to be undertaken as part of the selected alternative include state requirements for characterizing non-RCRA hazardous waste.

RCRA

Waste streams generated in the course of implementing the selected alternative would be characterized with respect to state criteria for identification of non-RCRA hazardous waste. Waste materials that would be tested under this requirement are the soil cuttings and development water from installation of monitoring and injection wells. Waste exhibiting a characteristic of non-RCRA hazardous waste (although existing sample results do not indicate this will occur) would be managed in accordance with the appropriate requirements of CCR Title 22, Section 66264 already identified as federal ARARs in Section 3.2.3.1.

3.3 REMEDIAL ACTION OBJECTIVES AND REMEDIATION GOALS

The following RAOs were developed for IRP Site 40 groundwater cleanup (DON, 2004):

- Consistent with EPA, State Water Resources Control Board (SWRCB), California Environmental Protection Agency (Cal/EPA), and RWQCB Santa Ana Region policies and regulations, protect existing beneficial uses of the shallow aquifer underlying NAVWPNSTA Seal Beach to the extent practicable while preventing or minimizing VOC migration beyond the current NAVWPNSTA Seal Beach boundaries at concentrations exceeding site remediation goals
- Protect human health by preventing extraction of VOC-impacted shallow groundwater for domestic use until site remediation goals are achieved

Two chlorinated VOCs, PCE and TCE, are the primary COCs for IRP Site 40 groundwater. However, since the biological degradation of PCE and TCE will result in the formation of 1,2-DCE and VC, these chemicals are also considered to be COCs.

The TCGs for IRP Site 40 groundwater were developed based on an analysis of ARARs and are listed in Table 3-1. These groundwater remediation goals support the RAO of restoring the shallow aquifer underlying NAVWPNSTA Seal Beach as a potential drinking water supply to the extent practicable. The values listed in the table are federal MCLs for drinking water promulgated by EPA or California MCLs established by the Department of Health Services, whichever is lower for a given constituent (DON, 2004).

The attainment area for this remedial action is defined as the footprint of the PCE concentrations exceeding the MCL of 5 micrograms per liter (µg/L) at IRP Site 40. The DON does not intend to establish a point of compliance for this remedial action (DON, 2004).

3.4 SELECTED REMEDY

The selected remedy for groundwater at IRP Site 40 is enhanced ISB, MNA, and LUCs. Enhanced ISB will consist of biostimulation and bioaugmentation. Sodium lactate will be injected into the groundwater at locations containing the highest reported concentrations of PCE and TCE to stimulate the growth of indigenous microorganisms capable of biologically degrading chlorinated ethenes. Based on the results of pilot testing conducted at the site between July 2001 and November 2003 (BEI 2003d; 2004), it is expected that indigenous microorganisms will be capable of reducing the PCE and TCE to 1,2-DCE; however, complete dechlorination to innocuous end products (ethene, ethane, carbon dioxide) will require bioaugmentation using microorganisms not found at the site, followed by MNA. The bacterium *Dehalococcoides ethenogenes* (DHE), which is capable of complete reductive dechlorination, will be injected into the contaminant plume. The DHE will be obtained as a culture from a commercial supplier, or extracted from the IRP Site 40 pilot test area as DHE-laden groundwater. The selected remedy, enhances natural biodegradation processes within the areas of highest PCE concentrations through injection of lactate while

employing MNA throughout the remaining portions of the plume MNA relies on natural processes to reduce contaminant levels in the plume and will occur throughout the duration of the remediation at the site. The performance criteria for ISB and MNA are discussed in the following Sections 3 5 and 3.6, respectively.

The selected remedy for groundwater includes:

- Construction, operation, and maintenance of a network of groundwater monitoring wells and injection wells
- In situ treatment of groundwater using sodium lactate injection to accelerate biodegradation of chlorinated VOCs
- Injection of a commercially available DHE culture, and/or extraction and reinjection of DHE-laden groundwater
- Performance monitoring throughout the remedial action
- Confirmatory groundwater sampling at the end of remediation to confirm that VOC concentrations meet specified cleanup levels
- Subsequent MNA until remediation goals are achieved
- LUCs to prevent the use of contaminated groundwater, protect equipment, and allow access for sampling, installing new monitoring wells, and implementing any remedial measures that may be needed in the future

The functional and operational requirements of the enhanced ISB system will consist of injection and monitoring criteria. The injection and monitoring components and the detailed description of the functional and operational requirements for the ISB system are described in Section 6.0. The performance criteria for enhanced ISB and MNA, and LUCs requirements are described below.

3.5 ENHANCED IN SITU BIOREMEDIATION PERFORMANCE CRITERIA

Performance criteria for ISB are itemized in Table 3-2. A total of eight wells are proposed for performance monitoring during the enhanced ISB phase. These wells will be located within the active treatment areas. Performance monitoring during the enhanced ISB active remediation will consist of field testing and laboratory analysis of groundwater, and groundwater level measurements.

MNA will complete remediation once quarterly performance monitoring results indicate that contaminant removal has become relatively constant, indicating that the active remediation has reached a low level of economic or technical efficiency and is no longer effective. If the proposed performance monitoring well(s) within the active remediation area, indicates that CVOCs concentration have reached asymptotic levels for two consecutive quarters, and if the CVOCs concentrations are less than 10 times their respective TCG levels, the well(s) will be switched to

and monitored for MNA. Otherwise, the enhanced ISB and performance monitoring will continue to be conducted on quarterly basis, and until the above criteria or the TCGs are met.

3.6 MONITORED NATURAL ATTENUATION PERFORMANCE CRITERIA

MNA is the process of monitoring the groundwater contaminant plume concentrations and target parameters to confirm that natural attenuation processes are occurring and that the plume is stable and/or shrinking. Following the completion of active remediation and performance monitoring in the treatment areas (areas of highest PCE concentrations), MNA will be conducted to verify that the reductive dechlorination process within these areas are occurring.

MNA will also be conducted with the commencement of the remediation activities for the areas within the plume boundaries but outside the active treatment areas. Select existing wells located along the limits of the plume and outside the active treatment areas will be used for monitoring natural attenuation in these areas. MNA will be conducted for at least 1 year. MNA will be conducted on quarterly basis for the first year and semiannually for up to an additional 2 years. However, if at any time the concentrations of the CVOC in any well(s) remain less than their respective TCGs for 1 year, the monitoring frequency for the well(s) will be reduced to annually. The objective of the annual monitoring will be to ensure that the CVOCs concentrations remain below the TCGs.

MNA will include groundwater level measurements, field testing, and laboratory analysis of groundwater that will be collected from monitoring wells proposed for MNA phase of the remediation. The parameters proposed for field testing and laboratory analysis for the MNA are similar to those proposed for the ISB performance monitoring. The field and laboratory testing parameters for the MNA may be modified following assessment of the ISB phase. Performance criteria for MNA are summarized in Table 3-3. The MNA protocol and procedure is discussed in Section 6.6.

4.0 REMEDIAL SYSTEM DESIGN

This section discusses the design basis, design specifications, and process and equipment descriptions for the full-scale ISB system.

4.1 RATIONALE AND DESIGN

Basic elements of the enhanced ISB design include:

- Discussion of design concept
- Injection, monitoring, and soil vapor well field design
- Sodium lactate enhancement details

These design elements are discussed in the following subsections.

4.1.1 Discussion of Design Concept

The design concept was developed based on the results of a pilot test that was conducted by BEI to assess lactate addition to groundwater to enhance the dechlorination of PCE and TCE at IRP Site 40. The BEI pilot test report provided the following site-specific information on in situ enhanced bioremediation that is used here to develop the design concept for the full-scale implementation:

- Lactate addition drives reductive dechlorination of PCE and TCE.
- A radius of influence (ROI) of 25 feet downgradient and 20 feet cross-gradient at one well, using an injection rate of 4 gallons per minute (gpm) of a 3 percent sodium lactate solution at a frequency of 8 hours of injection for 2 days per week, for 8 weeks is needed.
- Bioaugmentation with DHE is required to degrade the DCE and VC that form from the dechlorination of PCE and TCE.
- Distribution of the inoculum throughout the plume may be required.

This design document will scale up the parameters from a one-well pilot-scale study to a multi-well full-scale application. Therefore, the objective of this design is to provide:

- Engineering specifications for a full-scale system that will sufficiently dose the identified contaminant plume in groundwater with lactate.
- Application parameters for full-scale lactate dosing (using 3 percent sodium lactate solution) including injection rate, frequency, and duration.
- Engineering specifications for a full-scale inoculum injection system and distribution system in which void space of piping network can be deoxygenated to promote the survival of injected microbes.

- An operations plan to describe how the system will be operated.
- A performance monitoring plan to demonstrate the effectiveness of the system.

4.1.2 Well Field Design for Injection, Monitoring, and Soil Vapor Wells

The following subsections discuss the rational for the injection well, groundwater monitoring well and soil vapor/gas monitoring well field design and arrangement.

4.1.2.1 Injection Well Field Design

The injection system design has been selected to apply the lactate enhancement technology. The well injection network selected for this design is shown in Figure 4-1. The injection well network consists of 17 injection wells using ROI design criteria of 25 feet downgradient and 20 feet cross-gradient. These ROI design criteria are based on findings of the pilot test study conducted by BEI. In the pilot test study, lactate migration was observed at distances of approximately 20 to 25 feet away from the injection well after a period of approximately 4 weeks using a injection flow rate of 4 gpm at a frequency of 8 hours of injection for 2 days per week for 8 weeks.

The justification for placement of the injection wells is as follows:

- Injection wells IW-1 and IW-2 are placed upgradient of Building 240 to achieve lactate dosing underneath this structure; similarly, injection wells IW-9, IW-10, and IW-15 are placed upgradient of Building 239 to achieve lactate dosing underneath this structure.

- Injection wells IW-3 through IW-9, IW-12, IW-13, and IW-14 are placed to achieve lactate dosing of the current and historic plume "hot spots" as defined by the 100-µg/L contour line. Existing monitoring well MW-40-27 will be converted and used as an injection well and designated as IW-5. This well was installed as part of the pilot test program and has a screen interval of 15 to 35 feet bgs has the same design depth and construction specifications that is specified for the proposed injection wells.

- Injection wells IW-11, IW-15, IW-16, and IW17 are placed downgradient of the 100-µg/L contour lines to achieve lactate dosing of groundwater that potentially may be displaced downgradient as a result of the injection of high volumes of solution at the areas of the plume with the greatest impact.

The initial strategy will be to inject lactate into the well field by group. The injection well field will be divided into two groups of six wells and one group of five wells for a total of three groups. Each group will be dosed for 2 days per week; therefore, dosing will occur over a 6-day period per week. Wells are not grouped by proximity, but by the opposite criterion – by maximization of the spacing between wells. This strategy of grouping wells with maximum spacing will minimize flow interference between injection wells and thus achieve closer to ideal

radial flow at each well. The injection schedule and well groupings are discussed in detail in Section 6.1.2.2.

Once the injection has begun, it may be necessary to adjust the operations to optimize the lactate dosing strategy. Adjustments may include changes in injection rate, frequency, and duration. In addition, if design ROIs are not observed at all the injection wells, then proposed monitoring wells (discussed below) and/or existing wells potentially may be converted into injection wells.

4.1.2.2 Monitoring Well Field Design

Based on the size of the PCE-impacted groundwater area and the number of injection wells, the existing 12-well network (40-MW-03, -05, MW-40-07, -08, -12, -14, -15, -16, -17, -18, -19, -20, and -21) will not be adequate to monitor within the main VOC-impacted areas. These wells are all located outside the proposed injection well field, with exception of well 40-MW-14. An additional ten groundwater monitoring wells are proposed. Eight wells will have a shallow interval screen (15 feet to 35 feet bgs); and two wells will have a middle interval screen (45 feet to 55 feet bgs). The locations of the proposed wells are shown on Figure 4-1. Table 4-1 lists the proposed and existing wells at the site and data for the screen intervals and depth.

The purpose of the monitoring wells is to demonstrate:

- Effective delivery of lactate
- The presence of DHE throughout the plume
- The degradation of COCs into daughter products
- Sulfate-reducing and methanogenic conditions throughout the plume
- Changes in hydraulic head as a result of the lactate injection

The general rationale for the locations of the monitoring wells is to allow for monitoring for the aforementioned conditions at various radial distances in the upgradient, downgradient, and cross-gradient directions. By having this capability, a general assessment can be made as to the effectiveness of the method in delivering adequate amounts of lactate throughout the plume, particularly at distances medially located between injection wells.

The justification for the location of each proposed new monitoring well is as follows:

- MW-40-30 (shallow) will be used to monitor for adequate dosing medially between injection wells IW-4, IW-8, and IW-9 in the hot spot area according to the design ROI; if the cross-gradient and downgradient design ROIs are not achieved at these three injection wells, MW-40-30 can be converted into an injection well.
- MW-40-31 (middle) will be used to monitor for vertical migration of contaminants into the deeper portion of the water-bearing zone and to assess the degree of lactate dosing in the deeper portion of the water-bearing zone.

- MW-40-32 (shallow) will be used to monitor for adequate dosing medially between injection wells IW-9 and IW-10 according to the cross-gradient design ROI; if the cross-gradient design ROI is not achieved at these two injection wells, MW-40-32 can be converted into an injection well. Additionally, the data from this well will show if contaminants are being displaced outward due to high-volume injection in the hot spot area.
- Existing MW-40-14 (shallow) will be used to monitor for adequate dosing downgradient of injection wells IW-5 and IW-6.
- MW-40-33 (shallow) will be placed southeast of proposed injection well IW-11, south of proposed injection well IW-12, and west/southwest of proposed injection well IW-16. The data from this well will be used to show if contaminants are being displaced outward due to high-volume injection in the hot spot area.
- MW-40-34 (shallow) will be used to monitor for adequate dosing medially between injection wells IW-13, IW-16, and IW-17 according to the design ROI; if the cross-gradient and downgradient design ROIs are not achieved at these three injection wells, MW-40-34 can be converted into an injection well. Additionally, the data from this well will show if contaminants are being displaced outward due to high-volume injection in the hot spot area.
- MW-40-35 (middle) will be used to monitor for vertical migration of contaminants into the deeper portion of the water-bearing zone and to assess the degree of lactate dosing in the deeper portion of the water-bearing zone.
- MW-40-36 (shallow) will be used to monitor for adequate dosing medially between injection wells IW-7, IW-8, IW-14, and IW-15 in the hot spot area according to the design ROI; if the cross-gradient and downgradient design ROIs are not achieved at these four injection wells, MW-40-36 can be converted into an injection well.
- MW-40-37 (shallow) will monitor for adequate dosing 25 feet downgradient from IW-15 according to the design ROI. Additionally, the data from this well will show if contaminants are being displaced outward due to high-volume injection in the hot spot area.
- MW-40-38 (shallow) will be installed northeast of injection well IW-4, north of injection well IW-9 and northwest of injection well IW-10. MW-40-38 will be located approximately 70 feet north of the proposed injection well IW-9. The data from this well will be used to show if contaminants are being displaced outward due to high-volume injection in the hot spot area.
- The DON also proposes to install an additional shallow well (which will be designated as MW-40-39) for further monitoring of the plume downgradient of well MW-40-07. This well will be located approximately 100 feet downgradient and southeast of existing monitoring well MW-40-07 and approximately 70 feet south of Building 239. This well will be constructed with a screened interval of 20 to 30 feet below ground surface (bgs).

In addition, if necessary, all or a select number of the existing monitoring wells 40-MW-01, 40-MW-02, MW-40-07, -08, -12, -13, -15, -16, -17, -18, -19, and -20 would also be used for groundwater monitoring and to assess the effectiveness of the lactate delivery.

Wells 40-MW-01 and 40-MW-02 are shallow (20 feet deep and screened from 6 feet to 16 feet bgs). These wells would be able to provide limited information regarding the lactate dispersion in injection wells IW-1 and IW-2, and with regards to the contaminant concentrations in groundwater within the depth of less than 20 feet bgs.

MW-40-06, -07, -08, -15, -17, and -19 are shallow wells (approximately 34 feet deep) and are screened from approximately 20 feet to 30 feet bgs. These wells would be used to monitored the contaminant concentrations and assess the remediation effectiveness in groundwater within the 20 feet to 35 feet bgs. MW-40-06 is located upgradient of the injection well field, and the remaining wells are located downgradient of the injection well field.

Existing monitoring wells MW-40-10, -12 and -13 are middle interval wells that are approximately 58 feet deep and are screened from approximately 42 feet to 55 feet bgs. If necessary, these wells will be used to monitor the contaminant concentrations and assess the remediation effectiveness in groundwater within the deeper zone (50 feet to 60 feet bgs). MW-40-10 is located upgradient of the injection well field, and monitoring wells MW-40-12, and -13 are located downgradient of the injection well field. The monitoring and sampling frequency of the existing wells are further discussed in Section 6.0.

4.1.2.3 Soil Vapor/Gas Monitoring Well Field Design

Pilot test results have also indicated the need to monitor soil gas concentrations. There are currently two soil gas monitoring wells (VW-40-01 and VW-40-02) at IRP Site 40. Four additional soil vapor wells are proposed. The soil vapor wells will be used to monitor levels of methane, hydrogen sulfide, and VC in the vadose zone. The proposed locations of the soil vapor wells are shown on Figure 4-1. The soil gas/vapor monitoring well details are described in Section 4.2.7.

The justification for the locations of the soil vapor wells is as follows:

- VW-40-3 is for vapor monitoring in the hot spot area proximal to Building 240.
- VW-40-4, VW-40-5, and VW-40-6 are for vapor monitoring proximal to Building 239 and 260.

In addition, a nested probe for monitoring soil gas concentrations will be installed in each of the injection and the groundwater monitoring well boreholes. The nested probe will be installed adjacent to the injection or monitoring well casings. The injection well and groundwater monitoring well details are described in Sections 4.2.1 and 4.2.5, respectively. The probes will be

used for field monitoring of the soil gas concentrations including methane and hydrogen sulfide and for collecting soil gas samples for laboratory analysis. The probes are also designed to be used for passive venting or active evacuation of soil gasses (pumping) in particular methane gas. In the event high levels of subsurface methane gas concentrations resulting from the ISB processes are detected, the probes would be used for venting or pumping in order to prevent methane gas concentrations from reaching hazardous levels, and further migrate beneath the nearby buildings.

4.1.3 Sodium Lactate Enhancement Details

Sodium lactate will be used as the nutrient enhancement product to stimulate the microbial activity and accelerate reductive dechlorination rates. Sodium lactate enhances microbial growth, which increases the rate of anaerobic biodegradation of chlorinated ethenes in groundwater.

Sodium lactate in solution is comprised of sugars and water that has undergone a fermentation process. Sodium lactate (chemical formula is $C_3H_5O_3Na$) is a colorless and odorless liquid (Mallinckrodt Baker, Inc., 1999), and is completely soluble in water. It has a molecular weight of 112.07 grams per mole and a specific gravity of 1.31. Sodium lactate has a boiling point of 113 °C (235 °F) and a melting point of 17 °C (63 °F). It is stable under ordinary conditions of use and storage. Sodium lactate is a nonproprietary, environmentally safe substance. No potential health effect has been identified; however, safe industrial procedures and good personal hygiene should be practiced when handling the product.

Used for a wide variety of industrial, medical, and domestic applications, sodium lactate is available for commercial use from two companies, PURAC and JRW Technologies. PURAC is a Netherlands-based company with offices throughout the world, including a warehouse in the Los Angeles, California, area. PURAC has supplied their product, Purasal®, for the purposes of environmental application. Purasal® is an aqueous form of sodium lactate at a concentration of 60 percent. Purasal® is available in 55-gallon drums or in bulk (by tanker truck or totes). JRW Technologies is located in Lenexa, Kansas, and provides industrial and medical grade sodium lactate. The sodium lactate available through PURAC and JRW Technologies will be evaluated for cost, effectiveness and application prior to purchase and delivery to the site.

4.2 SYSTEM OVERVIEW

Implementation of enhanced ISB to remediate groundwater contamination at IRP Site 40 consists of the following:

- An array of injection wells sufficient to disperse reagent (sodium lactate) and DHE throughout the saturated zone
- A reagent injection system to deliver the sodium lactate to the injection well array

- A mechanism for injection of commercially available DHE culture (KB-1™) and/or extraction and reinjection of DHE-laden groundwater
- A monitoring well network to adequately monitor target parameters

Other components of the enhanced ISB system will include:

- Vapor monitoring wells to monitor potentially produced gases (methane, VC, and hydrogen sulfide)
- An automated vapor monitoring system for adjacent buildings, if necessary

4.2.1 Injection Well Construction Details

The construction details for the injection wells are typical and will only vary slightly between wells based on encountered subsurface and drilling conditions. 12-inch-diameter boreholes will be drilled for the construction of the injection wells. The shallow-interval wells will consist of a 4-inch-diameter schedule 40 polyvinyl chloride (PVC) 0.01-inch slotted screen interval from approximately 15 to 35 feet bgs and a 4-inch-diameter schedule 40 PVC blank well casing completing the well from 15 feet bgs to ground surface. The middle-interval wells will be constructed similarly with the screened interval placed from approximately 45 to 55 feet bgs. A #2/16 sand (or equivalent) will be used as well packing from approximately 6 inches below to 3 feet above the screen interval. A minimum 3 feet bentonite seal will be placed above the sand interval to a depth of approximately 10 feet bgs. An approximately 10-foot-long nested soil gas probe consisting of a ½-inch-internal diameter PVC pipe will be placed inside the upper 10 feet of the borehole and next to the 4-inch-diameter injection casing. The probe will be perforated from approximately 3 feet to 10 feet bgs and placed in a #2/16 sand pack. The top of the well will be sealed with hydrated bentonite chips from the top of the sand pack (2.5 feet bgs) to approximately 0.5 foot bgs. A ¼-inch lab valve will be placed at the top of the probe as shown on Figure 4-2 and would be used as sampling port.

The well will be covered with a 12-inch flush-mounted well box approximately 0.5 inch above ground surface (in the middle) and tapered down to the edges. The typical well construction is presented in Figure 4-2.

An inflatable well packer will be set in the injection well casing between the water table and the top of the well screen. The packer will be used to seal the well from the atmosphere and control hydraulic head in the well during lactate injection. Lactate will be fed through the packer and injected into the aquifer near the top of the well screen interval, below the water table. The packer consists of two tubing connections with compression fittings - a ¼-inch connection to accommodate nitrogen used for packer inflation and a ½-inch pass-through connection for lactate injection. The packer will be connected to a well cap via polyethylene tubing (¼-inch and ½-inch) and a support cable. The well cap will be equipped with a quick disconnect fitting for nitrogen. DHE will be injected by the supplier using the pass-through connection.

4.2.2 Reagent Injection System

The Dosatron International product injector, Model DI210, is the equipment proposed to mix and inject the lactate enhancement solution into the aquifer. This equipment includes a non-electric proportional injector that uses water pressure as a power source. This equipment was used during the ISB pilot study and found to be reliable. The water activates the dispenser, which takes up the required percentage of lactate concentrate directly from the solution container. Inside the dispenser, the concentrate is mixed with the water, and then the water pressure transports the mixture to the injection well. The injector system consists of an 80 micron/200 mesh water filter on the inlet side, a solenoid valve, liquid dispenser, and a check valve on the outlet side. A schematic diagram of the Dosatron International product injector and manifold is presented in Figure 4-3.

This product injector can handle a flow up to 11 gpm and a pressure ranging from 7 to 57 pounds per square inch (psi). It can mix solutions at a ratio from 1:50 to 1:10. Since the lactate solution is available from the manufacturer at a concentration of 60 percent; a mixing ratio of 1:20 will produce the desired 3 percent concentration. The apparatus will be mounted on a portable cart to inject the solution to the wells throughout the site. The cart is designed with pneumatic tires for easy hauling on rough surfaces. One cart will be designated for each injection well; therefore, a total of six carts will be required. Existing fire hydrants will be used as a source of water for the injection system. Each injector cart will be connected to the main water supply line from the three hydrants via a header manifold of PVC piping and hosing or to the nearest tap water source. In addition, there are three tap water hose bibs at the site, which are located outside Buildings 240 and 260 that can be used as water source. Further, each injector cart will be connected to a 260-gallon tote or a 55-gallon drum containing the 60-percent lactate solution. The details of the fire hydrant piping are discussed in Section 4.2.4.

An in-line deoxygenating chamber will be placed upstream of the product injector and downstream of the fire hydrant piping header to remove oxygen from the water supply. The deoxygenating chamber is a membrane contactor that is a vacuum-only degassing process and, therefore, does not require a sweep gas. The proposed model is Liqui-Cel NB by Membrana. Deoxygenation of the water supply prior to injection will improve the performance of the technology by minimizing the upset to required anaerobic conditions during dosing.

A process and instrumentation diagram is included as Figure 4-4.

4.2.3 Distribution System

To facilitate DHE distribution, initial bioaugmentation activities may include distribution of existing DHE-laden groundwater from successful injection points to other wells throughout the injection well array. The groundwater will be redistributed using a system comprised of submersible groundwater pumps, tubing, piping, flexible hose, appropriate fittings, control

valves, flow meters, pressure gauges, and a portable power generator. The wellhead setups at the extraction wells and the injection wells and the piping/hose between the wells will be constructed above ground. Prior to groundwater pumping, nitrogen gas injection will be performed to deoxygenate the void space in the piping network. Check valves and ball valves will serve as isolation valves and bleed valves during the nitrogen gas injection. The injection wells will contain the same inflatable well packers that were used during lactate delivery. A process and instrumentation diagram for this distribution system is contained in Figure 4-5. A generator will be used to power the submersible pump.

In the event that the redistributed microorganisms do not propagate and thrive at necessary rates, additional inocula of DHE will be delivered to the injection wells. An inlet for injection of inoculum has been incorporated into the wellhead construction details of the injection wells.

4.2.4 Fire Hydrant Piping

There are three fire hydrants available close to the site that can be used as a water source for the lactate injection system. The fire hydrants will be modified to allow the use of water during the injection process. The modification will be flexible to quickly revert to the original fire hydrant configuration for any emergency use by the fire department. In addition, there are three tap water hose bibs located outside buildings 240 and 260 that can also be used as water source. The location of the fire hydrant and the hose bibs are shown on the site layout plan on Figure 4-6.

The modifications will include installation of a fire hose adapter at the fire hydrant outlet, followed by a quick disconnect hose adapter (Camlock connection at one end), hose with Camlock fittings, PVC piping with a back-flow preventer, a pressure regulator, and a ball valve. After the ball valve, the piping will consist of PVC piping header, flexible hoses, and flow valves to deliver water to the portable injection carts. Flexible hoses will be used at road crossings and locations where hard pipe routing is not appropriate. The fire department will be able to access the fire hydrant by disconnecting the quick disconnect adapter. Detailed configuration of the fire hydrant piping is shown in Figure 4-7.

4.2.5 Groundwater Monitoring Well Construction Details

The construction details for the groundwater monitoring wells is the same as the injection wells and will only vary slightly based on encountered subsurface and drilling conditions. The groundwater monitoring wells will be constructed inside 12-inch-diameter boreholes drilled to the design depths. The shallow-interval wells will consist of a 4-inch-diameter schedule 40 PVC 0.01-inch slotted screen interval from approximately 15 to 35 feet bgs and a 4-inch-diameter schedule 40 PVC blank well casing completing the well from 15 feet bgs to surface. The middle-interval wells will be constructed similarly with the screened interval placed from approximately 45 to 55 feet bgs. A #2/16 sand (or equivalent) will be used as well packing from approximately 6 inches below to 3 feet above the screen interval. A minimum 3-foot bentonite seal will be

placed above the sand interval to a depth of approximately 10 feet bgs. An approximately 10-foot-long nested soil gas probe consisting of a ½-inch internal diameter PVC pipe will be placed inside the upper 10-feet of the borehole and next to the 4-inch-diameter injection casing. The probe will be perforated from approximately 3 feet to 10 feet bgs and placed in a #2/16 sand pack. The top of the well will be sealed with hydrated bentonite chips from the top of the sand pack (2.5 feet bgs) to approximately 0.5 foot bgs. A ¼-inch lab valve will be placed at the top of the probe as shown of Figure 4-2 and used as a monitoring and sampling port.

The well will be covered with a 12-inch flush-mounted well box approximately 0.5 inch above the ground surface (in the middle) and tapered down to the edges. The typical well construction for a shallow-interval well is presented in Figure 4-2.

4.2.6 Gas-operated Bladder Pumps

Dedicated QED Environmental Systems (QED) Well Wizard ® Model P1101S gas-operated bladder pumps (or equivalent) will be installed in all the proposed groundwater monitoring wells to facilitate low-flow purging and sampling of these wells during implementation of the groundwater monitoring program outlined in Section 6.0. Implementation of a low-flow purging and sampling program is intended to provide representative groundwater quality samples while minimizing turbidity and the volume of water that must be removed from the well during purging.

The pumping system will consist of a PVC-bodied bladder pump equipped with a Teflon® bladder and an inlet screen, Teflon-lined polyethylene twin-bonded tubing (⅜- or ½-inch discharge line bonded to ¼-inch air line), a downwell Teflon water level probe with polyethylene tubing, and a well cap sized for each well application. Use of PVC and Teflon pump components is intended to counter the corrosive effects of groundwater.

4.2.7 Vapor Monitoring Well Construction Details

The typical soil gas monitoring well design will consist of a 2-inch-diameter schedule 40 PVC 0.01-inch slotted screen interval from approximately 3.0 to 10.0 feet bgs and a 2-inch-diameter schedule 40 PVC blank well casing completing the well from 3.0 feet bgs to surface. The well casing will be installed inside a 10-inch-diameter borehole drilled to a minimum depth of 10 feet bgs. The bottom and top of the well casings will be fitted with 2-inch-diameter PVC pipe caps. A ½-inch PVC lab valve will be installed at the center of the pipe cap at the top of the casing and will be used as monitoring port. A #2/16 sand (or equivalent) will be used as well packing from approximately 6 inches below to 6 inches above the screen interval. A minimum 1-foot bentonite seal will be placed above the sand interval and a grout seal (95 percent Portland cement and 5 percent bentonite gel) will complete the well to surface.

The well will be covered with a 12-inch flush-mounted well box approximately 0.5 inch above the ground surface (in the middle) and tapered down to the edges. The soil gas monitoring well details are presented on Figure 4-8.

4.2.8 Chemical Requirements and Storage

Based on the proposed injection strategy, electron donor requirements on the order of approximately 1,700 gallons of 60 percent sodium lactate (35,000 gallons of 3 percent sodium lactate solution) per injection well is required over the 9-week injection period. For a total of 17 injection wells for full-scale implementation, the total volume of electron donor required is approximately 30,000 gallons of 60-percent sodium lactate (600,000 gallons of 3 percent sodium lactate solution).

The 60 percent lactate solution will be delivered in 260-gallon totes or 55-gallon drums, and stored in a fenced secondary containment at a designated area A site plan showing the equipment and material layout area is shown in Figure 4-6.

Table 4-2 summarizes the specifications of the full-scale system.

5.0 PRE-REMEDIATION CONSTUCTION ACTIVITIES

This section describes the specific construction activities and procedures involved in site preparation, equipment installation, and associated mobilization activities in preparation for implementation of the planned remediation activities at IRP Site 40. The preparatory activities include subcontracting/procurement, notifying the responsible agencies, and a kickoff meeting with the DON project personnel. As part of the preparatory activities, a geophysical survey also will be performed in the areas where wells will be drilled. Subsequently, the required equipment, personnel, and material will be mobilized to the site, and the pre-remediation construction activities will begin (remediation operation activities are described in Section 6.0). All waste generated during the field activities will be disposed of in an appropriate manner and as described in Section 7.0. Upon completion of the field activities, the site will be restored to its pre-construction condition to the extent feasible, and all equipment and personnel will be demobilized from the site.

5.1 SUBCONTRACTING/PROCUREMENT

All field activities will be performed under the direct supervision of TtFW with assistance from several specialty subcontractors. The procurement of appropriate subcontractors and required services and materials will be performed in a manner consistent with the terms of the contract and applicable Federal Acquisition Regulations.

Prior to the field removal activities, a geophysical surveyor and a land surveyor will be retained. The geophysical surveyor will assist in locating and marking any underground utilities or features and provide utility clearance. The land surveyor will assist in locating and marking the proposed well locations in the field.

Specialty subcontractors will be procured to assist in the specific aspects of the construction activities. These subcontractors include a fencing subcontractor, drilling and well installation subcontractor, a hazardous waste hauler/transporter, a treatment, storage, and disposal facility (TSDF), an analytical laboratory, and DHE vendor/subcontractor. The DHE vendor/subcontractor will provide the inoculum, if needed, for the bioaugmentation and conduct the injection of the inoculum inside the wells. The analytical laboratory will perform the required chemical analysis on the soil samples during waste characterization and verification sampling. The laboratory also will perform liquid analyses on any wastewater (decontamination water) that may be generated during the remedial action. The hazardous waste hauler/transporter will transport the soil cuttings from the well drilling to the identified regulatory-approved TSDF.

A fencing subcontractor will be retained for installing the necessary security fencing and gates around the temporary equipment and material storage area.

Other subcontracting services will be used to provide waste containers, a vacuum truck, and wastewater treatment and disposal services. Waste containers include 6,900-gallon capacity Baker Tank and 55-gallon drums for storage of decontamination wastewater and a dumpster for storage of trash/solid waste and used polyethylene liners/personal protective clothing. Vacuum truck services may be used to transport the decontamination water to an off-site CERCLA-approved wastewater treatment and disposal facility.

Vendor procurement will involve a lactate vendor, leasing an office trailer, portable toilets, and health and safety monitoring equipment. Other miscellaneous equipment such as sampling and testing equipment, construction tools, PVC pipe and fittings, sandbags, and so forth, will be procured on an as-needed basis.

TtFW will setup and install all the necessary injection and pumping equipment and install the piping and equipment for the lactate conveyance system.

5.2 NOTIFICATIONS

TtFW will obtain all necessary authorizations from NAVWPNSTA Seal Beach for completing the planned removal action at IRP Site 40. Prior to the field activities, TtFW will notify the DON RPM, ROICC, and the appropriate NAVWPNSTA department personnel about the nature of the anticipated work. Underground Service Alert will also be notified to obtain utility clearance prior to drilling activities. In addition, TtFW will obtain a dig permit from the NAVWPNSTA Seal Beach Public Works department prior to conducting any intrusive activities at IRP Site 40.

5.3 KICKOFF MEETING

At least 2 weeks prior to the start of the field activities at IRP Site 40, a kickoff meeting will be held between the DON and TtFW. The purpose of this meeting is to develop a mutual understanding of the remediation activities and the CQC details, including forms to be used, administration of on-site work, and coordination of the construction management and production. TtFW will prepare minutes of the meeting for submittal to the DON. The following DON representatives will be requested to attend: RPM, ROICC, NAVWPNSTA IR Program Coordinator, NAVWPNSTA Ordnance and Security and Emergency/Fire Department. TtFW representatives will include the Project Manager, Project Superintendent, Project Quality Control Manager (PQCM), and SHSS.

5.4 MOBILIZATION

Mobilization activities include site preparation, movement of equipment and materials to the site, as well as training and site orientation of field personnel. At least 2 weeks prior to mobilization, the appropriate DON personnel, including the RPM and the NAVWPNSTA IR Program Coordinator, will be notified about the planned schedule for mobilization and the remediation activities. A list of the field personnel and their respective certification records and personal data will be delivered to

the DON to arrange for authorized entry and badges. In order to obtain NAVWPNSTA decals for site vehicles, a list of the vehicles, along with the required documentation including insurance records, will be provided to the DON.

Upon receipt of appropriate records and authorizations, the field personnel and temporary facilities will be mobilized to the site. Mobilization of temporary facilities will involve the establishment of a suitable staging area to support the project activities. The support facilities to be installed in the staging area will include an office trailer, restroom facilities, and equipment and material laydown area. The support facilities will be located in an area determined by the appropriate NAVWPNSTA Seal Beach representative. Once support facilities are transferred to the site, utility connections will be furnished for power, water, and communications. Figure 4-6 shows a proposed layout of the site including laydown area, security fence around the temporary equipment and material storage area, and tap water sources and fire hydrant locations.

Equipment mobilization will be initiated with site preparation activities. In order to minimize storage requirements, equipment and materials will be mobilized to the site on an as-needed basis. A dedicated laydown area will be used for short-term storage of equipment and materials. If needed, a secure storage trailer will be mobilized to the site for short- and long-term storage of materials small equipment and tools required for the project.

All construction equipment will be delivered to the site in a clean condition. All equipment will be inspected and photographed upon arrival at the site.

5.5 FIELD CONSTRUCTION ACTIVITIES

Field construction activities include the following.

- Survey of the proposed well locations.
- Obtain geophysical utility clearance at proposed well locations.
- Drill, install, and develop 16 injection and 10 new monitoring wells and 4 soil vapor wells.
- Survey new well coordinates and elevations.
- Decontaminate equipment.
- Manage investigation-derived waste (IDW).

Details regarding the field construction activities are described in the remainder of this section.

5.5.1 Land Survey

Prior to the start of intrusive activities, each proposed new well location will be marked with survey stakes and clearly identified. Following installation, well casing elevations will be measured to the nearest 0.01 foot. The reference point will be a notch on the north side of the top

of each well casing. Horizontal control will conform to the California State Plane Coordinates system, North America Datum, 1983. Vertical control will conform to National Geodetic Vertical Datum, 1929. A California licensed land surveying contractor under the direction of TtFW will perform the land surveying.

5.5.2 Geophysical Survey

Prior to commencement of intrusive activities, NAVWPNSTA utility maps will be reviewed and a geophysical utility survey will be conducted to locate buried utilities. Underground utility clearance will be completed prior to drilling at all new groundwater monitoring well, injection well, and soil vapor well installation locations. TtFW will conduct a site reconnaissance to locate utilities on as-built drawings to find evidence of any undocumented utilities. Active utilities present within the areas where wells will be drilled will be located prior to any intrusive work. A 10-foot by 10-foot area around each well location will be swept using ground-penetrating radar (GPR) and/or an electromagnetic induction (EMI) instruments and marked as clear where appropriate. The GPR and EMI will produce an image of the subsurface conditions identifying discontinuities in the soil column. These discontinuities can be identified as non-native objects such as metallic pipes or debris. TtFW will mark the proposed drilling locations and the utility lines in the immediate vicinity, using color-coded surveyor paint, and evaluate the presence of other physical constraints. The results of the geophysical survey will be compared to the latest available versions of as-built drawings to determine if any undocumented utilities or other features exist in the survey area.

Wherever possible, a transmitter/receiver unit will be attached to the exposed pipe or utility to trace metallic pipes or utilities that are either indicated on NAVWPNSTA utility maps or are obvious via surface expression. The location of the utility will be marked on the ground using color-coded surveyor paint.

If a utility is identified within 3 feet of the proposed drilling location, the drilling point will be moved and the clearance procedures will be repeated. The clearance of each boring location will be documented in the field logbook.

Drilling at each well location will be initiated by hand auguring to a depth of approximately 5 feet bgs to minimize the risk of encountering underground utility lines that may have escaped detection during the utility and geophysical clearance efforts. Once a depth of 5 feet is reached, a truck-mounted drill rig equipped with continuous flight, hollow-stem augers will be positioned over the boreholes to advance the boreholes to a the desired depths at all well locations.

5.5.3 Drilling Activities

Monitoring well boreholes will be drilled using truck-mounted drilling rig equipped with continuous flight, hollow-stem augers. The drill cuttings will be observed continuously as the

boreholes are drilled for soil classification, and the lithology encountered during drilling of the soil borings will be recorded on boring logs. Borehole logging will be conducted by a geologist under supervision of a State of California Registered Geologist. In addition, soil samples will be collected from proposed well locations IW-3, IW-11, IW-17, MW-40-32, MW-40-35, and MW-40-37. Soil samples will be collected at every 5-foot interval from 5 feet bgs to the depth of the borehole, using split-spoon sampler. Soil samples will be classified using Unified Soil Classification System (USCS). Soil classification will consist of an evaluation of physical characteristics such as grain size, soil type, and moisture content.

5.5.4 Well Construction and Development

Injection well construction details are described in Section 4.2.1. Groundwater monitoring well construction details are described in Section 4.2.5. Vapor/soil gas monitoring well construction details are described in Section 4.2.7. Proposed well locations are shown on Figures 1-3 and 4-1. The location of the proposed wells may be adjusted in the field based on field conditions such as proximity to the railroad tracks, buildings or other physical factor.

Each well surface completion will consist of a traffic-rated vault or a steel well monument that is set in concrete. The top of the well casing will be secured with a watertight, locking well cap and lock to help deter unauthorized entry. The well designation will be marked on the well vault.

The proposed groundwater monitoring wells and injection wells will be developed after the well seal has cured for at least 24 hours to improve hydraulic conductivity between the wells and the surrounding formations. Development typically consists of surging during construction and then removing approximately five well volumes of water from each well while noting changes in turbidity, pH, conductivity, and temperature. Development will be performed using a well development rig capable of bailing, surging, and pumping groundwater. Development water will be placed in a 6,900-gallon Baker Tank or in 55-gallon drums and will be temporarily stored on site or in the waste storage yard on Bolsa Avenue, between 8th and 9th Streets. Following profiling and characterization activities, the waste will be disposed of in accordance with applicable state and federal laws and as described in Section 7.0.

5.5.5 Installation of Dedicated Gas-operated Bladder Pumps

All pumps will be installed at a depth corresponding to the midpoint of the screened interval in each proposed groundwater monitoring well. The downwell water-level tubing and probe will be designed to terminate just above the top of the pump. Wells will be contained within flush-mounted traffic box and will be fitted with watertight locking well caps equipped with quick-connect fittings to prevent entrance of water or other liquids into the well casing.

Each pump will be tested, cleaned, and laboratory-certified to be free of VOCs prior to shipment. All components necessary for each pump installation will be shipped to the project's on-site field office as a well-specific package ready for assembly and installation

Field team members responsible for installation of the bladder pumps will receive training from the vendor's technical representative prior to commencing the field activities.

Upon arrival at each well to be equipped with a dedicated bladder pump, an inspection of the well will be conducted to assure that the surface seal, the outer steel protective casing, and the well lock are in good condition. Any necessary repairs will be noted in the field logbook and will be completed before the first monitoring event. The field team leader will also verify that the correct pump system is being installed in each well and will record this information in the field logbook. Clean plastic sheeting will then be laid out on the ground adjacent to the well. All pump components to be installed in the well will be laid out on this plastic sheeting to prevent contact with possible contaminants on the ground surface.

When the well cap is initially removed, the top of the casing will be monitored for organic vapors. If organic vapor is measured at the top of the well, the breathing zone will be monitored during pump installation. All measurements will be recorded on an air sampling/monitoring data sheet. All field activities will be conducted in accordance with the worker health and safety provisions provided in the SHSP (Appendix C).

A multisensor gas meter will be used to screen for the presence of flammable vapors, carbon monoxide, hydrogen sulfide, and oxygen-deficient and oxygen-enriched atmospheres during field activities. If flammable vapors (for example methane gas) are detected at 10 percent of lower explosive limit (LEL) or greater, work will cease and the area will be ventilated. If oxygen levels below 20.8 percent or above 22 percent are encountered, personnel will leave the area and the area will be ventilated. If hydrogen sulfide is detected at 5 parts per million (ppm), or 1 ppm or detectable odor at the perimeter of the site, work will be stopped and the area will be allowed to be ventilated. A flame ionization detector (FID) or photoionization detector (PID) will be used to determine the presence and concentration of organic vapor. If VOC concentrations in the breathing zone exceed 10 ppm, the work area will be evacuated and the area will be allowed to ventilate. The ROICC and the IR Program Coordinator will be notified and consulted if the above adverse conditions are encountered, to determine if further actions and/or measurements are warranted to prevent or minimize exposure of other workers in the area. In addition, in order to protect other workers in the area, the area will be cordoned off with caution tape, and signs will be placed around the cordoned area to prevent them from accessing or entering the areas of concern

Prior to installing the pump, the total depth of the well will be measured to confirm that the casing is open and unobstructed. The measured total depth of the well will be recorded in the

field logbook. A measurement of the static water level will also be made and recorded to confirm the groundwater conditions remain consistent with those upon which the well-specific pump installation was designed. Once the condition of the well and the static water level have been verified, the pump will be installed in the well.

The air/discharge tubing and the water-level probe and tubing will be attached to the well cap, and the pump will be attached to the other end of the air/discharge tubing using fittings provided by the manufacturer specifically for this purpose. The assembled pump will then be lowered slowly into the well to minimize mixing of the stagnant water column in the casing above the screened interval and to minimize disturbance of suspended sediment that may have accumulated at the bottom of the well. When the pump has been lowered to its design depth, the well cap will be secured to the top of the casing.

Immediately following installation, the operation of the pump and the water-level measurement probe will be tested to assure proper operation of all components, to establish optimal fill and discharge cycles for the pump, and to provide baseline data on drawdown associated with pumping at different discharge rates. This information will be used to develop well-specific operational criteria for subsequent groundwater monitoring events and to allow for well-specific pre-programming of the pump controller unit prior to a sampling event. All data pertaining to pump fill/discharge cycle times and well drawdown will be recorded in the field logbook. Refer to Section 4.2.6 for additional installation details.

5.5.6 Injection Equipment Installation

Reagent injection will require the management and storage of delivered reagent. Reagent will be delivered in 260-gallon totes or 55-gallon drums and will be stored in a fenced secondary containment. During injection events, the reagent tote will be moved to the injection location via a fork-lift. The reagent will be injected into each well via the injection system as described in Section 4.2.3. Refer to Section 4.2.2 for additional installation details. The injector will be connected to the appropriate container and injection well via tubing, hose, and proper fittings. A sodium lactate Material Safety Data Sheet (MSDS) is provided in the SHSP (Appendix C, Attachment 1).

5.6 DEMOBILIZATION

Demobilization will consist of decontamination of all heavy equipment, cleaning the project site, inspection, and certification of completion. The activities will include decontamination and removal of all construction equipment and materials, as well as collection and disposal of all contaminated material including decontamination wastewater and disposable equipment. Transportation and disposal of waste generated from the construction and remediation activities is discussed in Section 7.0.

Heavy equipment will be decontaminated using heavy brushes to remove soil and dirt attached to the equipment surfaces. Special attention will be paid to removing material from the drill rig and auger flights. Tools and items for which decontamination is difficult or impossible to verify will remain on site until completion of the work for subsequent packing and off-site disposal at an approved disposal facility. Decontamination of temporary facilities located within the support zone will be limited to exterior cleaning.

Prior to removal from site, all decontaminated equipment and material will be inspected and accepted by the SHSS and the Project Superintendent. These individuals will certify that decontamination was performed for all equipment and materials. A copy of each decontamination certificate will be provided to the ROICC and vendors, if requested. The original certificate will be maintained in the project file.

Site cleaning work will include repair of any erosion or runoff-related damage; removal of all materials such as excess construction material, wood, debris and other foreign material; and removal of all construction equipment. The site administrative support complex will be disconnected from electrical, telephone, and water lines. All office and storage trailers will be removed and returned to the rental company.

6.0 REMEDIATION OPERATIONS, PERFORMANCE MONITORING, AND REPORTING

This section outlines the on-site activities in conjunction with remediation operations and performance monitoring of the selected remedy, and the reporting. Performance monitoring would be conducted to optimize enhanced ISB, track mass reduction, verify containment of the IRP Site 40 plume, and demonstrate successful remediation of the groundwater. Monitoring would include water-level measurements, as well as collection and analysis of samples from wells placed within the plume areas. A general summary of the activities associated with the remediation operations, and performance monitoring as follows:

1. Initiate in situ sodium lactate injection for approximately 9 weeks and make process and operational measurements and adjustments to optimize dispersion and persistence of the lactate.
2. Take field measurements to assess aquifer conditions and initial status of the ISB process.
3. When the aquifer is supportive of reductive dechlorinating conditions, perform bioaugmentation to facilitate completion of the reductive dechlorination process.
4. Perform groundwater monitoring to verify field measurements and provide additional information regarding aquifer conditions and system performance, and to assess contaminant behavior.
5. Conduct health and safety monitoring and reporting.

Specific procedures and requirements are discussed in the following sections.

6.1 APPLICATION OF LACTATE

Lactate (delivered as sodium lactate) serves as the primary substrate, or electron donor, in stimulating growth of indigenous (or non- indigenous) bacteria. Through microbial growth and respiration, lactate is metabolized, initially generating anaerobic conditions, and ultimately leading to conditions supportive of reductive dechlorination. These include generation of increased biomass, highly reduced conditions, and fermentation breakdown products that ultimately drive the reductive dechlorination process. Following is a description of the activities involved with the application of sodium lactate.

6.1.1 Assessment of Baseline Parameters

Prior to injection activities, a full suite of analyses will be conducted to establish baseline concentrations of the parameters that will be used to assess aquifer conditions and system performance. These parameters are given in Table 6-1 and include field and laboratory analyses. Field and laboratory analyses will be conducted on samples collected from the groundwater

monitoring wells located within the injection well network. The field and laboratory testing parameters may be adjusted following review of results, or later during project execution. Prescribed field testing and laboratory analytical methods are discussed in more detail in Sections 6.3

6.1.2 Sodium Lactate Injection

Based on the results of the pilot testing activities, approximately 35,000 gallons of a 3 percent sodium lactate solution will be injected into each injection point. The proposed injection well array consists of 17 wells. Approximately 600,000 gallons of a 3 percent sodium lactate solution will be needed for injection during full-scale enhanced ISB implementation. The procedures associated with lactate injection are outlined below.

6.1.2.1 Dosing Procedures

A qualified field technician will be employed at the site on a full-time basis to operate the lactate injection system and to apply the sodium lactate solution in the injection wells. The preliminary dosing will be conducted in accordance with the pilot test results. Accordingly, approximately 4 gpm will be injected for 8 hours per day for 2 days per week per well. The prescribed flow rates will require approximately 65,000 gallons of tap water per week. At a 3 percent sodium lactate mixture, approximately 3,300 gallons of 60 percent sodium lactate will be mixed with the tap water for each week. Following lactate solution injection, the Dosatron product injector will be turned off and at least five borehole volumes of clean water will be injected to flush lactate solution from the well to reduce the potential of biofouling. This will be performed after every field day for wells which have been dosed with lactate. Periodically, during injection, the field technician will record site conditions, injection flow rates, and Dosatron product injector settings in a field logbook.

6.1.2.2 Well Selection/Injection Schedule

The initial injection strategy will be injection of lactate into the well field by group. The injection well field will be divided into two groups of six wells and one group of five wells for a total of three groups. Injections will be conducted on a 1-week cycle. Injection will be conducted at group No. 1 for 8 hours for Day 1 (Monday) and 8 hours for Day 2 (Tuesday) of the cycle; group No. 2 for 8 hours on Day 3 (Wednesday) and 8 hours for Day 4 (Thursday) of the cycle; and group No. 3 for 8 hours on Day 5 (Friday) and 8 hours for Day 6 (Saturday) of the cycle at a rate of 4 gpm per well. This schedule will be continued for 9 cycles (9 weeks). A typical schedule for a cycle is as follows:

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	Group No.1	Group No.1	Group No.2	Group No.2	Group No.3	Group No.3

Well groups are as follows:

- Group No. 1: IW-1, IW-4, IW-5, IW-7, IW-15, and IW-16
- Group No. 2: IW-2, IW-6, IW-8, IW-10, IW-11, and IW- 13
- Group No. 3: IW-3, IW-9, IW-12, IW-14, and IW- 17

While injection is occurring, the field technician will collect groundwater samples and test the samples in the field to assess lactate migration using field test kits (discussed in the following sub-section 6.1.2.3). This injection frequency schedule will be maintained for approximately 9 weeks, at which time, the frequency and amount of reagent injection may be adjusted based on results from the field analyses. Injection activities, in general, will continue for approximately 6 months. The lacate injection would be further extended if the dechlorination process is not complete and additional electron donor is necessary.

A summary of the operating parameters for the system is shown in Table 4-2.

6.1.2.3 Lactate Migration Assessment

Lactate migration is essential for effective enhanced dechlorination. Injection of the lactate solution will create an artificial hydraulic gradient radiating from the injection well. This artificial gradient should cause vertical and lateral migration of the lactate and the dissolved phase contaminants. Based on modeling results conducted by BEI, lactate migration is anticipated to be radial and travel a distance of approximately 20 to 25 feet from the injection well after 4 weeks; further pilot test field results showed a chemical oxygen demand (COD) level between 100 and 500 mg/L at distances of 20 to 25 feet from the injection well. As mentioned above, lactate migration will be initially assessed during injection activities to optimize injection rate and/or frequency. This will involve measurements of COD and water levels, as explained below.

1. *Analytical Assessment*: During injection, COD measurements will be taken to determine the presence of lactate in the injection wells, proposed monitoring wells, and existing monitoring wells, which are located near the injection points. It is well known that lactate can be rapidly transformed to various metabolites, including propionate, acetate, and butyrate. Data from the pilot test at IRP Site 40 indicated that COD served as an adequate indicator of the presence of lactate and its breakdown products and could be monitored cost-effectively through the use of a field test kit. Thus, increased COD in monitoring wells relative to baseline results will indicate the presence of lactate (or its breakdown products, acetate, butyrate, propionate, and pyruvate). As a point of reference, COD levels as high as 11,916 mg/L were observed in monitoring wells during the pilot test.

   Additionally, lactate migration will be assessed by the interpretation of field parameter data and laboratory analytical data (discussed in Section 6.4). Oxygen depletion and the onset of denitrification, iron reduction, and sulfate reduction, should correspond with

lactate migration and will provide additional evidence that lactate has migrated to each monitoring well within the injection field design ROI.

2. *Groundwater Levels*: Groundwater levels will be monitored to assess mounding effects as described in Section 6.3.3.

If after 3 to 4 weeks of injection, COD levels are significantly below 100 mg/L with no corresponding rise in the water table from baseline levels at monitoring wells located medially between injection wells, then lactate injection frequency and concentration will be adjusted accordingly.

6.2 BIOAUGMENTATION

Phase I pilot test analytical results indicated that biological activity was stimulated, but the reductive dechlorination process was incomplete. PCE and TCE were reduced to DCE, but DCE was not reduced further to VC or ethene. Evidence suggested that an appropriate microbial consortium for complete reductive dechlorination was not present at the site. It was then determined that bioaugmentation (introduction of microorganisms not indigenous to the site) would be tested during a Phase II pilot test.

This involved injecting an environmentally benign, commercially available bacterial culture into the saturated zone. The culture, KB-1™, was obtained from Site Recovery & Management (SiREM) of Guelph, Ontario, Canada. The KB-1™ culture has proven capable of complete anaerobic dechlorination, and contains the bacterium DHE. The culture was injected into wells MW-40-22 and MW-40-25. Phase II pilot test analytical results indicated that the reductive dechlorination process proceeded past DCE to VC and ethane, thus indicating that bioaugmentation is required to accomplish complete reductive dechlorination at IRP Site 40.

In order to implement a full-scale enhanced ISB system, bioaugmentation with DHE will be performed as soon as sulfate-reducing conditions are achieved which is predicted to be approximately 1 month after lactate injection initiation. Pilot test data indicate that the organisms are spread by growth and migration at IRP Site 40, and adequate distribution can be achieved by adding a commercially available inoculum into the proposed injection wells, or by extracting groundwater from the existing pilot test wells that contain DHE and reinjecting the water into the proposed injection wells.

Bioaugmentation will be conducted based on the following criteria:

- If quantitative polymerase chain reaction (Q-PCR) analysis indicates that DHE is present in existing wells at significant concentrations[1], redistribution of existing water from these wells would be conducted
- If Q-PCR DNA analysis indicates that DHE is not present in any of the wells, or is present at low concentrations, a commercial culture (KB-1™) will be added.
- Sulfate concentrations should be less than 50 μg/L in the proposed injection areas.
- Electron donors should be present in the injection area, based on detection and distributions of COD and lactate breakdown products.
- Redox conditions should indicate an optimal reductive dechlorination environment [strongly negative – in the range of -150 to -300 millivolts (mV)]
- Physiochemical data indicates that pH is within the range of approximately 6.5 to 8.5, and DO is not detected.

A cost-effective, technically defensible plan for selecting bioaugmentation points, and verification of culture survival/growth, and subsequent bioaugmentation activities will be developed based on groundwater monitoring data. It is expected that this will involve a sequential process of selecting one or more application points, applying inoculum (via pumping from pilot test bioaugmentation well points or fresh cultures) in these application points, assessment of culture survival and aquifer conditions, selection of additional bioaugmentation points, and so forth. It is expected that bioaugmentation activities will be conducted after approximately 1 month of lactate injection, which is within the period of frequent initial lactate injections. This will help to ensure that the culture is transported to the maximum extent, and that optimal aquifer conditions (highly reduced) are maintained. The general procedures for implementing bioaugmentation activities are outlined below:

Bioaugmentation with Fresh Commercial Cultures: If bioaugmentation is required at the outset, KB-1™ will be obtained from SiREM of Guelph, Ontario, Canada. The culture will consist of approximately 20 liters for each injection point. The culture will be injected into proposed injection wells according to the following strategy:

1. Remove access cover and well cap and fit well with PVC wellhead assembly shown in distribution system process and instrumentation diagram (Figure 4-5) and close ball valve V-106. Keep sample ports SP-104 closed.
2. Inflate well packer with nitrogen gas through well packer tubing connection.
3. Inject nitrogen gas through tubing connected to injection pipe and open ball valve V-108 and sample port SP-105, letting atmospheric air escape from assembly.

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[1] During the Phase II Pilot Study, Q-PCR results ranged from 7.4×10^3 to 8.9×10^8 DHE 16s gene copies per liter (L). It is anticipated that DHE would be present within this range and preferably at the higher levels to warrant redistribution of groundwater to facilitate inoculation of other wells instead of augmentation with fresh inoculum

4. Continue nitrogen injection for several minutes and stop injection.
5. Close sample port SP-105 and sample air from sample port SP-104 using landfill gas meter.
6. If gas meter readings indicate 0.2 percent oxygen level or less, stop nitrogen injection and inject culture through SP-105.
7. If gas meter readings indicate oxygen levels greater than 0.2 percent, continue nitrogen injection until oxygen level of 0.2 percent or less is achieved and then inject culture.
8. Remove PVC assembly and replace well cap and access cover.

Distribution of DHE-laden Water from Prior Injection Wells: If DHE is detected in the existing pilot test injection or monitoring wells (refer to Footnote 1, prior page), DHE-laden groundwater will be redistributed from these wells to other wells in the injection array. Depending on the success of the redistribution, further bioaugmentation activities may consist of redistribution of existing DHE-laden groundwater from other successful injection points to remaining wells throughout the injection well array. The groundwater will be redistributed and recirculated using a submersible groundwater pump, tubing, appropriate fittings, control valves, and injection fittings. The PID for the distribution system is shown in Figure 4-5. The startup strategy (for providing oxygen-free blanket) is as follows:

1. Construct and install redistribution system assembly for redistribution of DHE-laden groundwater.
2. Inflate well packer with nitrogen gas through well packer tubing connection.
3. Close isolation ball valves V-103 and V-106.
4. Open bleed valves V-102, V-107, V-108, and sample port SP-105.
5. Inject nitrogen gas through tubing connecting to pipe at extraction wellhead and injection wellhead and at check valve V-110.
6. Continue nitrogen injection for several minutes and stop injection.
7. Close all bleed valves and sample air from sample ports SP-101, SP-103, and SP-104 using landfill gas meter.
8. If gas meter readings indicate oxygen level of 0.2 percent or less, stop nitrogen injection, open isolation valves V-103, V-104, and V-106, and turn on submersible pump.
9. If gas meter readings indicate oxygen levels greater than 0.2 percent, continue nitrogen injection until oxygen level of 0.2 percent or less is achieved and then turn on submersible pump.
10. Continue distribution for 8 hours per day.

6.3 GROUNDWATER SAMPLING AND ANALYTICAL PROCEDURES

Monitoring of various groundwater parameters is required over the course of the remedial action to ensure proper operation of the selected remedy. Monitoring and analytical procedures are outlined in the following subsections. Detailed procedures for groundwater sampling and well purging are presented in the SAP (Appendix A).

Groundwater analyses will include both laboratory samples analysis and field testing using field test kits to establish baseline groundwater conditions. Hach field test kits (or equivalent) will be used for parameters such as nitrate, sulfate, ferrous iron, carbon dioxide, alkalinity, and COD. Additional field parameters will be monitored using a flow-through cell equipped with multiple monitoring probes for analysis of pH, temperature, conductivity, ORP, and DO.

A fixed-base laboratory will be used for analysis of VOCs by EPA Method 8260B, for dissolved gases by gas chromatograph/FID (Kampbell et al., 1989), TDS by EPA Method 160.1, major anions by EPA Method 300, major cations by EPA Method 6010B, alkalinity by EPA Method 310.1, and COD by EPA Method 410.4, and other biological parameters.

Groundwater samples for laboratory analysis will be collected according to procedures outlined in the SAP (Appendix A). After purging has been completed, groundwater samples will be collected from the sampling side of the tee. Field parameters of pH, temperature, conductivity, ORP, and DO will be collected immediately prior to sampling. Groundwater samples will be collected in the following order:

- VOCs
- General chemistry and natural attenuation screening parameters
- Metals

All sampling equipment to be reused will be decontaminated in accordance with the SAP. All field measurements, observations, and calculations will be recorded in the field logbook.

6.3.1 Groundwater Purging and Sampling

The groundwater samples will be collected using low-flow sampling techniques to minimize aquifer disturbances and to assure sample integrity. Low-flow purging and sampling will be conducted using dedicated gas-operated bladder pumps. The objective of low-flow purging is to remove water from the screened interval at a rate that is comparable to the ambient groundwater flow rate. This minimizes aquifer drawdown in the well and limits the mixing of water within the screened interval with overlying stagnant water in the well casing. Low-flow purging allows for collection of representative groundwater samples with minimal disturbance and low turbidity. During purging, DO, pH, conductivity, ORP, and temperature data will be collected using an appropriate field instrument equipped with a flow-through cell.

6.3.2 Groundwater Analysis

A suite of groundwater parameters will be analyzed using both field test methods and laboratory analyses. Table 6-1 provides a list of analytical parameters and the recommended sampling frequency for each parameter.

During the ISB performance monitoring period samples will be collected for laboratory analysis. The sampling frequency will be on monthly basis for the first 3 months and quarterly for the remainder of the first year. Samples will be analyzed for VOCs, general chemistry and natural attenuation screening parameters, and metals. Analytical parameters will be refined based on review of the results to incorporate only data that yield useful information in monitoring the ISB. Field testing and groundwater sampling for laboratory analysis will include:

1. Field testing will be conducted biweekly during the active remediation (lactate injection) period (approximately 6 months). Full suite of analyses will be conducted to establish baseline concentrations of the parameters that will be used to assess aquifer conditions and system performance prior to the remediation activities, this will include both field testing and collecting samples for laboratory analysis. Baseline field testing and sampling for laboratory analysis will be performed on all wells proposed for monitoring during the active remediation.
2. More frequent field testing of the proposed injection wells, and proposed monitoring wells for COD may be needed during lactate injection for assessment of lactate migration.
3. After the first 6 months, field testing frequency will be reduced to monthly or modified as necessary to eliminate analyses that are not providing useful information in a cost-effective manner. After the first year of field tests, frequency will be reduced to quarterly, until the start of MNA. These decisions will be made following evaluation of project data, and will be subject to regulatory input and approval.
4. Biweekly field testing of existing shallow monitoring well 40-MW-02 located near the injection wells IW-1 and IW-2, proposed groundwater monitoring wells (MW-40-30 through 38), and selected injection wells (as deemed necessary) for field parameters.
5. Field testing will include testing for nitrate, sulfate, ferrous iron, carbon dioxide, alkalinity, COD, pH, temperature, conductivity, ORP, and DO. After the start of MNA, the monitoring parameters will be refined to incorporate only pH, conductivity, temperature, ORP, and DO analysis.
6. Sampling of all proposed groundwater monitoring wells (MW-40-30 through 38), and selected injection wells if necessary. The samples will be analyzed in the laboratory for the parameters listed in Table 6-1. Sampling will occur prior to the injection of fresh substrate. For the injection wells, samples will be collected at least 2 days after the injection of substrate in order to obtain a more representative sample. Sampling will occur for the first 3 months on a monthly basis. After the first 3 months, the sampling frequency will be reduced to quarterly, until the start of the MNA.

7. It is expected that during the first year, the list of analytical parameters would be refined based on review of the results, to incorporate only analyses that yields useful data in monitoring the ISB process. Any changes and refinements to the analytical parameters will be communicated and discussed with the RWQCB and the DTSC, prior to finalization of the list of parameters for the follow-up analysis.

As mentioned above, DO, pH, ORP, conductivity, and temperature measurements will be recorded at each well using a flow-through cell field instrument at the time of sampling. Sampling and analytical procedures are discussed in detail in the SAP, and the rationale is outlined in Section 6.4.

6.3.3 Groundwater Level Measurement

Before and during lactate injection, groundwater level measurements will be conducted biweekly in all proposed monitoring wells (MW-40-30 through 37), select existing shallow interval monitoring wells (as a minimum wells 40-MW-03, -04, -05, and MW-40-06, -07, -08, -15, -17, and -19), and select injection wells (as a minimum wells IW-4, and IW-11), to assess mounding effects. Groundwater level measurements will be conducted each time sampling occurs for field measurements and sampling analysis.

Groundwater-elevation measurements will be performed manually using a two-conductor, battery-powered water-level indicator. The indicator probe will be lowered into the casing until it indicates by electric signal that water has been reached. The depth of the groundwater will then be determined by reading the graduated tape at the surveyed reference elevation on the inside top of the well casing. The groundwater elevation can then be calculated by subtracting the depth to groundwater measurement from the surveyed referenced elevation. This information will be used to calculate the groundwater gradient and flow direction within this tidally influenced aquifer.

6.3.4 Soil Gas Monitoring

Soil gas monitoring will be conducted to evaluate the distribution and fate of dechlorination products (VC and ethene) in the vapor phase and to evaluate the extent to which the dechlorination products are partitioning into the gas phase.

The vapor analyses will include VOCs, methane, ethane, and ethene. Soil gas samples will be collected from the existing and proposed soil gas monitoring wells (VW-01 through VW–06) and select probes installed in the proposed injection and groundwater monitoring wells IW-1, IW-3, IW-7, MW-40-31, and MW-40-34. Vapor samples will be analyzed for VOCs on monthly basis for the first year and semiannually thereafter. Methane, ethane, and ethane will be tested for on a monthly basis in the first year and quarterly after the first year.

The samples will be collected in Tedlar™ bags using oil-less vacuum/pressure pump. Approximately 1 well volume (air void volume in the probe screened interval) of gas or 50 liters of gas will be purged from the wells before sampling.

The above-proposed sampling points would be re-evaluated based on the field monitoring data, collected during the field monitoring events described in Section 6.5. A recommendation would be made to the DON to sample and test a select number of the probes based on factors such as proximity to the buildings, methane gas concentrations, and wells with persistent high readings.

6.4 ASSESSMENT OF PROCESS EFFECTIVENESS

The following subsections address the rationale for and expected applications of the data that will be collected over the course of the project. Information regarding the analyses and frequencies related to the following discussions are presented in Table 6-1. Importantly, assessing ISB of CVOCs may not be straight forward at the outset. Therefore, the initial list of analyses to be conducted initially is comprehensive and is meant to identify key parameters that are useful in assessing process efficiency. It is thus expected that some of the analyses discussed herein may be reduced in frequency or eliminated, if deemed appropriate, to streamline the monitoring process over the life of the project. A technical decision tree for the project is presented as Figure 6-1.

6.4.1 Lactate Distribution and Ongoing Optimization

Upon introduction to the subsurface, lactate is subject to rapid biological degradation. This generates organic metabolites (acids), and molecular hydrogen. In addition, some organic acids are further broken down to yield additional molecular hydrogen (among other products). Molecular hydrogen is considered to be the primary electron donor in biological reductive dechlorination. Thus, it will be essential to have an understanding of the distribution of lactate and its breakdown products to provide information regarding biological activity, as well as an assessment of whether adequate substrate is present to drive reductive dechlorination, or if further additional injection of substrate is necessary.

6.4.1.1 Chemical Oxygen Demand

During the initial injection phase (Section 6.1), lactate migration will be assessed through frequent field COD measurements in both injection and monitoring wells. COD was determined to be an acceptable surrogate for assessing lactate and its breakdown products (essentially representing the total available electron donor). The initial lactate injection period is expected to be maintained for approximately 9 weeks. During this period, numerous COD measurements will be taken at various points (proposed groundwater monitoring wells, and select injection wells) located near respective injection points to assess initial coverage. Following this period, the injection frequency and/or volume may be changed, based on the COD data.

COD measurements will be conducted in the field of selected existing monitoring wells located near or within the injection well field (40-MW-02, and MW-40-14), proposed groundwater monitoring wells (MW-40-30 through 37), and selected injection wells (as deemed necessary), in order to provide information needed to make assessments regarding additional substrate injections over the first year of operation. Samples will also be submitted to the laboratory to verify the field measurements (this may be discontinued at some point if deemed unnecessary).

6.4.1.2 Lactate Breakdown Products

As mentioned previously, lactate is biodegraded to form organic acids. These generally include acetate, butyrate, propionate, and pyruvate. Accordingly, lactate and its breakdown products will be measured monthly in samples from monitoring wells (and possibly injection wells) through laboratory analysis to establish and/or confirm that the substrate was delivered to the appropriate zone, to track its area of influence, and to assess whether or not it is being metabolized as expected.

6.4.2 Geochemical Parameters

Demonstrating the effectiveness of bioremediation involves establishing cause and effect relationships, which provide evidence that the desired bioprocesses are occurring, or are likely to occur. This is accomplished, in part, through measurement of concentrations and distributions of a comprehensive suite of geochemical parameters that are considered to be major indicators of actual and potential subsurface biological activity. These include a range of electron acceptors, by-products of various metabolic processes, ORP, and pH. Data from these measurements are expected to help elucidate subsurface conditions such that the prevalent bioprocesses can be deduced, providing insight into the effectiveness of the biological treatment strategy. The following subsections provide a framework for interpretation of the information that will be obtained as outlined in Section 6.3.

6.4.2.1 Terminal Electron Acceptors and Oxidation/Reduction Potential

A variety of terminal electron acceptors can be used sequentially by soil microorganisms, in conjunction with biological oxidation of a substrate (lactate). The preferred electron acceptor for facultative bacteria (capable of aerobic or anaerobic respiration) is oxygen, which provides the greatest amount of energy for growth. When oxygen becomes depleted, the ORP decreases, and the next most effective electron acceptor is preferentially used. The general sequence of electron acceptor use and the associated ORP ranges are as follows:

Electron Acceptor	Indicator Parameter	Approximate ORP (mV)
Oxygen	Oxygen disappearance	800
Nitrate	Nitrate disappearance	700
Manganese (IV)	Manganese (II) formation	500
Iron (III)	Iron (II) formation	-50
Sulfate	Sulfate disappearance; hydrogen sulfide formation	-220
Organic Compounds (fermentation)	Hydrogen formation	-220
Carbon Dioxide	Methane formation	-240

Modified from Pilot Test Report (BEI, 2004)

Reductive dechlorination is generally expected to be most effective at ORP values in the sulfate reducing range or lower.

In addition, lactate-driven biological activity should be reflected by depressed levels of electron acceptors or increases in indicator parameter formation relative to baseline parameters. In summary, differences in these geochemical parameters, notably DO, nitrate, sulfate, iron, and possibly manganese will be assessed in various wells and interpreted (along with measured ORP and substrate data) to infer areas of biological activity and information about the oxidation/reduction status of the system.

6.4.2.2 Dissolved Gases

Several gaseous by-products of various biological processes are also useful as indicator parameters for assessing the status of in situ bioprocesses. For this project, methane, carbon dioxide, hydrogen sulfide, and molecular hydrogen will be monitored through laboratory analysis. In addition, DO will be measured in the field. Since oxygen is the most energetically favorable electron acceptor, depletion of DO is generally the first indicator of biological activity. In addition, carbon dioxide is produced as a by-product of fermentation, and as indicated, is also used as a terminal electron acceptor in biological production of methane (methanogenesis). As the system becomes more reduced, increases in production of hydrogen sulfide, molecular hydrogen, and methane, will provide evidence that the system is favorable for reductive dechlorination.

6.4.2.3 pH and Alkalinity

The pH and alkalinity will also be measured regularly. Due to production of organic acids via degradation of lactate, the pH can be expected to decrease, to a minor extent, initially. In addition, carbon dioxide is generated from metabolism of lactate, which will form bicarbonate at

relevant pH levels, and will be reflected in increased alkalinity. Both of these trends were generally observed during the pilot study. Monitoring of these parameters will be conducted to assess biostimulation due to the lactate injection.

6.4.3 Biological Parameters

Along with evidence provided by substrate and geoparameter data, several biochemical-based techniques will be used to assess the biological status of the subsurface system.

6.4.3.1 Biomass/Phospholipid Fatty Acids

The introduction of lactate is expected to increase general microbiological activity, ultimately generating conditions that favor reductive dechlorination. From a microbiological standpoint, this represents a series of biological processes, which are carried out by various members of the microbial community. In addition to reductive dechlorination, some of these include initial aerobic activity, denitrification, metal reduction, fermentation, sulfate reduction, methanogenesis, and others.

While assessment of geoparameters can provide important insight into subsurface processes, direct measurement of the microbial community is also important in assessing the status of the ISB system. This will be accomplished through the phospholipid fatty acid (PLFA) analysis. PLFA analysis provides information reflecting an overall viable biomass quantity, as well as a general picture of the categories of organisms that are active in the subsurface. Both of these parameters are important indicators of subsurface microbial activity and can be valuable in assessing substrate-induced changes over time. This will allow for assessment of changes in general biomass quantity as well as community structure in response to the injection of sodium lactate.

6.4.3.2 DHE-Specific DNA Probes

It is currently believed that DHE, or DHE-like organisms, are required to bring about complete dechlorination of chlorinated VOCs (specifically the step involving dechlorination of DCE isomers to VC and ethene). Samples will thus be collected and analyzed Q-PCR techniques to assess the presence and quantity of DHE in specified injection wells and select monitoring wells. This will be conducted at various times throughout the project, initially, during the bioaugmentation process, and subsequently to monitor the long-term survival of the bioaugmentation cultures. This will allow for assessment of naturally occurring DHE (not believed to be present, per pilot test results), as well as survival of commercial cultures that were previously introduced through bioaugmentation during the pilot test, and organisms that may be introduced as part of the remedial action.

6.4.3.3 Other DNA-based Indicators

Other DNA-based probes are currently available to enumerate specific bacterial populations, which can provide important insight into subsurface microbial processes specifically related to enhanced reductive dechlorination. For example, sulfate and iron-reducing bacteria, as well as methanogens, can compete with dechlorinating bacteria for available hydrogen. These groups of organisms can currently be quantified through Q-PCR analysis. Because geochemical data can vary and is sometimes difficult to interpret (not consistent with contaminant trends), one or a few wells may be selected to apply these analyses in the initial phases of the project. These wells will be selected to address uncertainties that arise during the project. As noted above, it is expected that during the first year, the monitoring process will be optimized in the interest of cost-effectiveness. In this regard, analyses that provide useful data in assessing dominant subsurface bioprocesses will be retained within the monitoring program whereas analyses that are not useful will be eliminated.

6.4.4 Contamination Assessment

Contaminant concentrations will be regularly monitored throughout the life of the project. The following subsections provide discussions regarding contaminant behavior and approach that will be used in contaminant assessment.

6.4.4.1 Dechlorination Assessment

The major mechanism for biodegradation of chlorinated volatile organic compounds (CVOCs) is reductive dechlorination, whereby CVOCs serve as terminal electron acceptors during anaerobic respiration. In this process, chlorine (Cl) atoms are removed from the respective parent compounds, forming less chlorinated metabolites and the chloride ion (Cl^-). The process coincides with bacterial growth on a suitable substrate (lactate). The primary chlorinated VOCs at IRP Site 40 in groundwater include PCE, TCE, cis-1,2-DCE, and trans-1,2-DCE. The general pathway for destruction of CVOCs can be represented as follows:

$$\text{PCE} \Rightarrow \text{TCE}+Cl^- \Rightarrow \text{DCE}+Cl^- \Rightarrow \text{VC}+Cl^- \Rightarrow \text{ethene} \Rightarrow \text{ethane} \Rightarrow CO_2 \text{ and } H_2O$$

Within this general pathway, reductive dechlorination of PCE and TCE can only occur in a strongly reducing environment, whereas, reductive dechlorination of DCE and VC can occur under less reduced conditions, typically following depletion of PCE and TCE. DCE and VC may also be degraded under more oxidized (including aerobic) conditions via alternate microbial mechanisms (oxidation as a carbon/energy source). Ethene and ethane are innocuous, and are easily degraded aerobically or microaerophilically at the edges of the anaerobic areas generated through substrate emplacement.

In order to assess these processes, CVOC data, encompassing all parent (PCE and TCE) and daughter compounds (DCE isomers, VC, ethane, and ethane), will be collected monthly for the

first year, and biannually thereafter. The dechlorination process will be assessed by the interpretation of degradation of parent compounds and formation and subsequent degradation of daughter compounds over time. Mass and molar concentrations of PCE, TCE, and associated daughter products will be evaluated for each monthly sampling event (including the baseline event) to identify trends and assess the extent to which dechlorination is occurring. The ratios of PCE to the intermediate degradation products (TCE and DCE isomers) and the late degradation product (VC) will be assessed. Dissolved concentrations of these constituents and associated ratios should elucidate general trends concerning dechlorination as a result of lactate enhancement. All CVOC data will be interpreted in conjunction with substrate migration data, geochemical data, and biological data, to reflect in situ processes and the effectiveness of enhanced and natural contaminant degradation over time.

6.4.4.2 Contaminant Mass Balance

A molar balance calculation is an analytical technique in assessing the progress of reductive dechlorination. Using this technique, the molar quantities of parent and daughter compounds at an initial point in time (general baseline sampling), are compared to the molar amounts of parent and daughter compounds at a later point in time (assuming no additional input of contaminants into the groundwater). If an overall decrease in the amount of moles of contaminants is observed between the two points in time, it can be inferred that complete reductive dechlorination has occurred. This, in turn, verifies that removal of contaminant mass from the system (mineralization of parent compounds to carbon dioxide) for some portion of the original mass of parent compounds, has taken place. In particular, the technique is useful in suggesting whether or not a stall has occurred at the DCE step of the reductive dechlorination pathway. Molar estimations of each compound account for both the dissolved phase (by direct laboratory measurement) and adsorbed phase (by soil:water partitioning information). At the end of the remediation or if necessary a mass balance evaluation will be performed to assess contaminant degradation.

6.4.5 Reporting

In order to document and analyze enhanced ISB system operation and subsequent enhanced and/or natural attenuation, semiannual monitoring and remediation status reports will be prepared and submitted to DTSC and RWQCB. The reports will summarize field events including injection and monitoring details, present the data collected for the current monitoring event, make comparisons with data from past events and assess trends, and make recommendations for future site activities.

In addition, summary reports will be prepared on a monthly basis during the lactate injection, performance monitoring, and assessment period. The monthly summary reports will include a summary of the field data for the lactate injection and groundwater monitoring wells, and

available laboratory analytical data. The monthly summary reports will be provided to the DON, the RWQCB, and the DTSC on an informal basis by e-mail and as soon as the data are tabulated.

6.5 HEALTH AND SAFETY MONITORING AND REPORTING

A SHSP has been prepared to address potential hazards that might be encountered during the implementation of enhanced ISB and MNA. The SHSP is presented in Appendix C The SHSP describes the basic safety requirements for performing the field procedures and potential hazards associated with the COCs.

In addition, the SHSP specifies indoor and outdoor vapor monitoring requirements. During reductive dechlorination processes it is common to see an increase in methane, hydrogen sulfide, and other VOCs in the vapor phase. Routine vapor monitoring near injection and surrounding monitoring wells and in or around the well boxes will be conducted during field events, to ensure that there are no harmful concentrations of explosive gasses.

The SHSP also specifies the vapor monitoring requirements, including specific monitoring equipment, vapor monitoring protocol, and anticipated schedule. The SHSP will be revised to incorporate encountered field conditions and necessary adjustments. Indoor and outdoor air monitoring is further discussed in the following subsections.

6.5.1 Groundwater and Vapor Well Monitoring

Groundwater and vapor well monitoring will be conducted during field events as part of the health and safety protocol. Prior to initiating groundwater and vapor monitoring activities, the groundwater and vapor well caps will be removed and the well vapor will be screened with an organic vapor analyzer (OVA) and explosive gas meter. The screening protocol, COC permissible concentrations, and contingency actions are described in the SHSP (Appendix C). In the event that consistently high COC concentrations are encountered, engineering controls may be necessary to minimize exposure. These controls are summarized in the SHSP (Appendix C).

6.5.2 Soil Vapor/Gas and Indoor Air Monitoring

Safety and health concerns regarding the production of methane, hydrogen sulfide, and VC gases were identified during the pilot test. Soil gas monitoring will be conducted to evaluate the presence of methane and hydrogen sulfide gas in the vadose zone, and to monitor migration of the subsurface gasses towards the nearby buildings. Methane is a flammable gas that poses a potential explosion hazard and is asphyxiating. Hydrogen sulfide gas was produced at concentrations at or above the odor threshold, but was not reported above the detection limit in vadose zone samples. Hydrogen sulfide gas is toxic and could become a safety hazard. VC is a human carcinogen.

The vapor monitoring will be conducted on a monthly basis during the first year. After the first year the frequency of field monitoring for soil vapor/gas will be reduced to quarterly until the start of the MNA period. Field testing and monitoring of soil vapor/gas will be conducted in all soil vapor/gas monitoring probes (VW-01 through -06) and all nested probes in the proposed groundwater monitoring and injections wells, and in and around Buildings 240 and 239 and if necessary Building 260. Particular attention will be given to areas where methane gas could migrate into the building through cracks, utility penetrations, or other pathways in the floor slab. Measurements will also be taken outside the buildings, in the work zones, at the enhanced ISB system area boundary, at cracks in the asphalt pavement, and at the sewer manhole covers near the injection areas.

A multi-sensor gas meter will be used to screen for the presence of flammable vapors (methane), carbon dioxide, hydrogen sulfide, and oxygen-deficient and oxygen-enriched atmospheres. The instruments will be equipped with pumps to allow samples to be drawn through a tube connected to the well sampling ports. The frequency of monitoring and the monitoring points will be adjusted based on observed vapor concentrations.

If flammable vapors are at 10 percent LEL or greater, work will cease and the area will be ventilated.

If warranted, an automatic gas detection alarm system may have to be installed in or around Buildings 240 and 239 and potentially Building 260. Active soil gas removal may be necessary if vapor monitoring indicates the potential for migration of soil vapor to nearby buildings at levels that could pose unacceptable risk.

6.6 MONITORED NATURAL ATTENUATION

MNA will involve measuring contaminant concentrations to document plume behavior and trends over time, as well as measuring various groundwater parameters to show that geochemical conditions are suitable for biodegradation, and that biodegradation has occurred, and continues to occur.

As described earlier in Section 3.6, MNA will also be conducted with the commencement of the remediation activities for the areas within the plume boundaries but outside the active treatment areas. In addition, proposed monitoring wells within the active treatment areas will be switched to MNA when active remediation has reached a low level of economic or technical efficiency. Once the proposed performance monitoring well(s) within the active remediation area indicates that CVOC concentrations have reached asymptotic levels for two consecutive quarters or indicates no significant further reduction in contaminant concentrations from continued treatment, and if the CVOC concentrations are less than 10 times their respective TCG levels, the well(s) will be added to the list of MNA monitoring wells. Refer to the flow chart in Figure 6-2.

MNA will be conducted on quarterly basis for the first year and semiannually for up to an additional 2 years. MNA will be conducted for at least 1 year. If at any time the concentrations of the CVOC in any well(s) remain less than their respective TCGs for 1 year, the monitoring objective will be revised to ensure that the CVOC concentrations remain at levels below TCGs, and only the CVOCs will be analyzed.

6.6.1 MNA Proposed Groundwater Monitoring Well

The MNA will encompass various areas within the plume, including the plume perimeter. At this time, existing monitoring wells MW-40-06, -07, -08, -10, -11, -13, -15, -17, -19, -20, –22, and -39 are proposed for MNA. These wells are located outside the active injection areas and within or along the current plume boundary. The location of the wells proposed for MNA is shown on Figure 6-3. The exact number and location of groundwater monitoring wells for MNA may require modification based on the plume extent/shape following the active ISB phase, to encompass various areas within the plume, including the plume perimeter.

Prior to the implementation of MNA, the exact number and locations of the MNA monitoring well network, and any changes to the sampling frequency or analytical parameters will be communicated with the RWQCB and the DTSC.

If additional monitoring points are required for implementing MNA, efforts will first be made to use the available wells at the site, including using one or more of the injection wells, in lieu of drilling and installing additional new wells.

6.6.2 MNA Field Testing and Laboratory Analysis

Both laboratory and field tests will be conducted during the MNA. The sampling protocol and procedures for the collection and analysis of groundwater samples are described in the SAP (Appendix A). At the start of the MNA, a baseline sampling and monitoring will be conducted. MNA data will be compared with the baseline results to evaluate any changes and assess the progress of the natural degradation at various areas within the plume.

MNA will consist of groundwater level measurements, field testing, and laboratory analysis of groundwater that will be collected from monitoring wells proposed for the MNA phase of the remediation. The parameters proposed for field testing and laboratory analysis for the MNA are similar to those proposed for the active treatment performance monitoring phase. The field and laboratory testing parameters for the MNA may be modified following assessment of the active treatment phase. A comprehensive list of chemical data that may be collected is as follows:

- Field parameters: COD, pH, conductivity, ORP, ferrous iron, temperature, nitrate, sulfate, alkalinity, DO, water level, methane gas, oxygen, carbon dioxide in vapor, toxic explosive gas, and hydrogen sulfide gas
- Laboratory parameters:

- VOCs
- Alkalinity
- Dissolved gasses (methane, carbon dioxide, hydrogen sulfide, hydrogen)
- Major anions (sulfate, chloride, nitrate, nitrite)
- Major cations (Ca, Fe, Mg, Mn, K, Na)
- Total organic carbon (TOC)
- COD
- TDS
- Volatile fatty acids
- PLFAs
- DNA Testing for DHE
- Title 22 metals
- Fixed gasses (methane, ethene, and ethane)

The above list of proposed MNA testing parameters may be modified based on the evaluation of the ISB phase data. Any changes to the MNA testing parameters will be made based on discussions and negotiations with the pertinent regulatory agencies including the RWQCB and the DTSC.

Contour maps for the CVOCs will be prepared and used to assess the distribution, relative transport, and mass removal of individual contaminants.

6.7 LONG-TERM GROUNDWATER MONITORING AND REPORTING

Once all MNA monitoring wells reach TCGs for at least 1 year or have been monitored for MNA for 3 years, the long-term monitoring (LTM) program for the entire site will begin. The LTM program is intended to confirm that TCGs are continuing to be met and that there is no recurrence of the contaminants in the groundwater at the site and to assess the effectiveness of the remedial action. During the LTM program, groundwater monitoring and sampling will be conducted on an annual basis for 5 years.

During the LTM program groundwater level measurements will be conducted and samples will be collected and analyzed for VOCs. Groundwater monitoring, sampling and laboratory analysis will be conducted in accordance with the procedures described in the SAP (Appendix A).

Proposed groundwater monitoring wells for the LTM program will consist of existing monitoring wells located upgradient and downgradient of the plume, and select wells (proposed performance monitoring and injection wells) within the enhanced ISB treatment areas. The proposed wells for LTM will consist of shallow-interval groundwater monitoring wells MW-40-06, -7, -15, -32, -33,

-34, -37, -39, and IW-3, and middle-interval groundwater monitoring wells MW-40-10, -13, -16, and -31. The location of the proposed wells for LTM is shown on Figure 6-4. The shallow-interval wells are screened from about 15 feet bgs to about 35 feet bgs. The middle-interval groundwater wells are screened from about 45 feet bgs to about 60 feet bgs. The exact number and locations of the wells proposed for the LTM program may be refined or modified based on the review and evaluation of data collected during the MNA phase. Any changes to the number of wells or well locations will be communicated with the RWQCB and the DTSC prior to the implementation of the LTM program. If additional monitoring points are required for implementing the LTM program, efforts will first be made to use the available wells at the site, in lieu of drilling and installing additional new wells.

The long-term groundwater monitoring program will continue until the RAOs have been met and/or an agreement of "no further action" is reached for this site by all parties.

6.8 LAND-USE CONTROL MONITORING AND REPORTING

LUCs will be implemented to prevent exposure to VOC-contaminated groundwater by preventing the use of contaminated groundwater, protect equipment, allow access for sampling, install new monitoring wells, implement any remedial measures that may be needed in the future, and to maintain the integrity of the remedial action until remediation goals are achieved. LUCs will be implemented over the footprint of the plume and an associated buffer zone as shown on Figure 6-5 The buffer zone will extend 500 feet from the edge of the plume. LUC will commence following the approval of the RD/WP and will be implemented consistent with current NAVWPNSTA Seal Beach policies and policies outlined in the National Environmental Policy Act (NEPA) Compliance Procedures Handbook (DON, 1998). The current NAVWPNSTA Seal Beach policy requires all projects that have potential environmental impact be reviewed by the NAVWPNSTA Environmental Office. The IR Program Coordinator serves as a member for this review process and coordinates any activities that may impact the activities at IRP Site 40 with DTSC and RWQCB. LUCs will remain in effect until monitoring data show the remediation goals established in the ROD have been achieved (DON, 2004).

Specifically, the following policies will be implemented during the LUCs for the IRP Site 40 groundwater plume and the aforementioned buffer zone.

- New groundwater extraction, injection, or drinking water wells shall not be installed within the IRP Site 40 groundwater plume or associated buffer zone without prior review and written concurrence from the DON, DTSC, and RWQCB.
- Injection and monitoring wells and associated piping and equipment that are included in the remedial action shall not be altered, disturbed, or removed without the prior review and written concurrence from the DON, DTSC, and RWQCB.
- The DON, DTSC, RWQCB, and their authorized agents, employees, contractors, and subcontractors shall have the right to:

- enter the premises to conduct investigations, tests, or surveys; and inspect field activities;
- construct, operate, and maintain the remedial action described in this RD/WP; and
- undertake any other remedial response or remedial action as required or necessary under the cleanup program.

LUCs inspection and reporting will be conducted on a semiannual basis for the first 2 years and annually thereafter. LUCs inspection will involve documenting and reporting any changes including addition or removal of injection wells, monitoring wells, or drinking water wells within the buffer zone and any alterations to the injection wells, monitoring wells and remediation piping and equipment system. The inspection data will be summarized and along with all changes will be documented in the semiannual or annual groundwater monitoring reports and submitted to agencies for review. Any site investigation testing or field inspection activities, or construction activities conducted within the buffer zone will also be documented in the inspection report.

The DON will evaluate the implementation and performance of the LUCs during the 5-year review to ensure that human health and the environment are being protected by the remedial action as required by Section 121(c) of CERCLA.

7.0 WASTE MANAGEMENT PLAN

The purpose of this Waste Management Plan is to provide guidelines for the containment, handling, and disposal of waste generated during field activities at NAVWPNSTA Seal Beach.

7.1 WASTE CHARACTERIZATION

State and federal regulations require waste generators to determine if a waste is hazardous. Soil cuttings generated during drilling operations at IRP Site 40 may potentially be classified as hazardous or California non-RCRA hazardous waste.

Waste generated during the field operations will be representatively sampled and analyzed to determine the hazard classification prior to transport off site. Analytical testing will be conducted at a Department of Health Services (DHS)-certified and Naval Facilities Engineering Service Center-evaluated analytical laboratory. The waste profiling (waste classification determination) will be based on the results of the soil sample analyses. Analytical methods used for waste classification may include total metals, Toxicity Characteristic Leaching Procedure (TCLP), and Waste Extraction Test (WET).

7.2 WASTE STREAMS

There are several waste streams that may result from the well installation and associated remediation activities. A description of potential waste streams is presented below:

- Waste soil cuttings and drilling mud from monitoring well and injection well installation
- Decontamination wastewater from drilling, well development, and groundwater sampling equipment cleaning, purge water and development water from groundwater monitoring wells
- Used disposable sampling equipment and personal protective equipment (PPE)
- Liquids and solids, including well material debris generated during well installation
- Inert or non-hazardous solid waste (refuse)

7.2.1 Decontamination Wastewater

Wastewater will be generated from equipment and personnel decontamination. Liquid waste will be placed in temporary storage containers [Baker tanks or Department of Transportation (DOT) 17H 55-gallon drums] on site until their disposal. Upon completion of field activities, the wastewater will be sampled to determine if it is a hazardous waste. Drums of decontamination water will be labeled with respect to contents and will be staged in a predetermined secured area with secondary containment and spill control equipment. Weekly inspections of the drum storage

area will be conducted and documented to ensure that drums are properly labeled, sealed, and in good condition. Following completion of the project, the wastewater will be properly transported to an appropriately permitted facility for treatment or disposal.

7.2.2 Contaminated Drill Cuttings

Solid waste (soil) generated from well installation will be placed in covered portable roll-off bins lined with plastic sheeting or in DOT 17H 55-gallon drums. Solid waste stored in roll-off bins or drums will be temporarily staged on site and transported off site to a permitted disposal facility following characterization and profiling.

Drill cuttings will be transported to an appropriately permitted, CERCLA off-site rule-approved Class I hazardous waste facility.

Use of any disposal facility is subject to approval under TtFW subcontractor qualification procedures.

7.2.3 Used Personal Protection Equipment

All used PPE and disposable sampling equipment will be placed in DOT-approved 17H 55-gallon drums or waste storage and later disposed of at an appropriate landfill. Construction activities will be performed in Level D or modified Level D. Depending upon air monitoring results, protection level may be upgraded to Level C. Management of the drums of PPE will be similar to management of the drums of decontamination wastewater described above.

No contaminated PPE and non-hazardous solid waste (refuse) will be placed in industrial waste bins.

7.2.4 Miscellaneous Debris

Clean miscellaneous debris such as concrete and asphalt resulting from coring operations, PVC pipe sections, and others will be transported to an appropriate licensed landfill for disposal. Use of any disposal facility is subject to approval under TtFW subcontractor qualification procedures.

Mixing regular trash and/or non-hazardous solid waste with potentially contaminated waste will be avoided.

7.3 WASTE CONTAINERIZATION AND ACCUMULATION

Potential hazardous waste (soil cuttings, wastewater, and PPE) will be placed in containers on site. DOT-trained personnel will perform container selection based on type and quantity of waste to be generated. Containers may include DOT-specification drums or roll-off bins for regulated hazardous material. DOT-specification containers are not required for non-hazardous material that does not meet a DOT hazard class. An inventory of hazardous and non-hazardous waste

containers and quantities will be maintained for future reporting and inspection. Typical daily and weekly inspection forms are provided in Appendix D.

All containerized hazardous waste will be stored in DOT-approved containers at designated temporary accumulation area(s) shown on Figure 4-6. The temporary accumulation area will be a fenced area with access provided by a lockable gate. The area will be equipped with spill containment and a spill kit. Where appropriate and feasible, these areas will include secondary containment. The temporary accumulation area and containers will be inspected weekly (See Appendix D for daily and weekly inspection forms). Any deficiencies found during the inspection that require corrective action (unlocked gates, missing or damaged labels, leakage, or missing containers) will be recorded and documented. Containers approaching the 90-day accumulation limit will also be noted.

Containerized hazardous waste must be accumulated in accordance with 22 CCR, Sections 66264.170 through 177 (Use and Management of Containers). Containers of hazardous waste will be inspected and logged weekly and portable tanks inspected daily while the fieldwork is in progress. Inspections will include an evaluation for proper labeling, secure closure, the condition of each container/tank, number of containers/tanks, and condition of the accumulation area(s). Any signs of deterioration, leaking, or dents will be noted, and containers will be immediately over-packed or the tanks will be drained, if necessary. Standing water will be removed from the containment area within 24 hours. Inspection results will be provided to NAVWPNSTA Seal Beach. All containers will be checked to ensure labels and markings are in good condition. DOT information for hazardous materials, including proper shipping descriptions and hazard class labels, will be added to containers prior to shipping. Hazardous waste may be accumulated on site in containers for a maximum of 90 days. Hazardous waste may be accumulated on site in portable tanks for a maximum of 60 days. The 60 and 90 days begin on the date that the waste is first generated and containerized or stockpiled.

7.3.1 Labeling

At the time of generation, all waste containers will be labeled, using indelible ink, with the following information:

- Source and location
- Contents and quantity of material in the container
- Potential health, safety, and environmental hazards
- Accumulation start date (the date the material was first put in the container)
- Date container sampled
- Parameters used for analysis
- "ANALYSIS PENDING - POTENTIALLY HAZARDOUS"

Upon the determination that the material in the waste container is hazardous, the container will immediately be labeled with a completed commercial EPA "HAZARDOUS WASTE" label. The label will include the accumulation start date and other requested information and managed as defined in 22 CCR, Sections 66262.30 through 66262.34, Pre-Transport Requirements.

7.4 WASTE SAMPLING

Waste sampling and analysis will be conducted as described in the SAP (Appendix A).

7.5 WASTE TRANSPORTATION

Hazardous material will be transported by a subcontractor approved under TtFW subcontractor qualification procedures. The transporter will have appropriate licenses, including an EPA identification number. Hazardous material including hazardous waste will be properly classified, described, packaged, marked, and labeled for shipment as required by applicable sections of 49 CFR, Parts 171, 172, 173, 178, and 179, and 22 CCR, Sections 66262.10 through 66262.45. Properly DOT-trained personnel will perform DOT functions.

Shipping Description – Material that does not exhibit one of the nine DOT hazard classes (explosive, flammable, poison, combustible, and so forth) is not regulated under DOT rules for the transportation of hazardous material. The TtFW Compliance Officer or the TtFW DOT Coordinator will confirm this description prior to shipment. The applicable DOT shipping description, EPA hazardous waste number, and the California waste code will be selected based on the results of the waste characterization.

- **Marking and Labeling** – The shipping name, hazard class, identification number, technical names, EPA markings and waste code numbers, and consignee/consignor designations must be marked on packages for shipment in accordance with 49 CFR, Part 172. This information will be marked on each roll-off bin after consultation with the Compliance Officer or DOT Coordinator.
- **Placarding** – Vehicles will be appropriately placarded in accordance with 49 CFR, Part 172.
- **Manifest** – Hazardous materials shipped off site must be properly manifested. Manifests will be completed by TtFW and require DON signature before the waste leaves the site. Copies of all manifests will be retained in the project files, original copies are sent with the transporter.
- **LDR (Land Disposal Restriction) Certification** – LDR Certification will be prepared and will accompany the manifest if applicable. Copies of all LDR Certifications will be retained in the project files with the signed manifest received from the disposal facility.

7.6 WASTE DISPOSAL

All waste materials will be disposed according to methods described in the Waste Management Plan. This section describes the disposal methods for the waste materials generated at the site including solid waste, wastewater, contaminated soil, and uncontaminated soil and debris.

7.6.1 Solid Waste and Wastewater Disposal

All discarded materials, waste materials, or other objects will be handled in such a manner to control the potential for spreading contamination, creating a sanitary hazard, or causing litter to be left on site. All used PPE materials will be temporarily stored in 55-gallon drums and later disposed at a CERCLA-approved and permitted landfill or TSDF. The wastewater generated from personnel and equipment decontamination will be stored in 55-gallon drums. A sample of the wastewater will be collected and analyzed as described in the SAP (Appendix A) to determine if it is a hazardous waste, and then appropriately transported to an off-site disposal and/or treatment facility. It is not expected to have unusable lactate solution at the end of the project. Lactate solution will be procured and delivered to the site on an as-needed basis, so that no unused lactate would be present at the completion of the project.

7.6.2 Contaminated Waste Transportation and Disposal

Following waste classification, all waste material will be disposed of according to the final waste classification. Disposal may be a combination of options determined by the hazardous classifications as follows:

- Soil and debris classified as RCRA hazardous waste will be transported to an appropriately permitted and CERCLA off-site rule-approved hazardous waste landfill for treatment, if necessary, and disposal.
- Soil and debris classified as non-RCRA hazardous waste will be transported to an appropriately permitted and CERCLA off-site rule-approved hazardous waste landfill for disposal.

Contaminated drill cuttings will be transported to an appropriate off-site disposal facilities. A hazardous waste manifest will be filled out for each load and submitted to the DON to sign as generator. Original copies of the manifest will be provided to the transporter for shipment.

Trucks hauling contaminated waste material for off-site disposal will use Gate Number 9 located on Westminster Avenue to exit NAVWPNSTA Seal Beach. The trucks will travel east on Westminster Avenue to Bolsa Chica Road, then go north on Bolsa Chica Road to enter the 405 Freeway. Trucks hauling contaminated waste for off-site disposal will not be allowed to travel on Seal Beach Boulevard.

7.7 WASTE MINIMIZATION

The following waste minimization techniques will be observed during field activities to reduce the volume of waste generated:

- Do not contaminate materials unnecessarily.
- Take only the material (such as chemicals) needed to perform the work activity, additional material can be brought to the work location if it is found to be necessary.
- Materials can be stored in large containers, but the smallest reasonable container will be used to transport the material to the location where it is needed.
- Maintain cleaning and extra sampling supplies outside any potentially contaminated area to keep them clean.
- Maintain or construct prefabricated materials for example, barriers and support equipment outside potentially contaminated areas.
- Perform mixing of detergents or decontamination solutions outside potentially contaminated areas.
- Do not place media of different hazard classification together.
- Use drop cloths or other absorbent material to contain small spills or leaks.
- Avoid a bellows effect when double-bagging contaminated materials.
- Use containers to minimize the spread of contamination.
- Do not place contaminated materials with clean materials.
- Cover wooden pallets inside the exclusion zone with plastic.
- Decontaminate and reuse material and equipment when practical.
- Use volume reduction techniques when practicable.
- Verify that waste containers are solidly packed to minimize the number of containers.
- Use less hazardous substances whenever possible (that is, bring only the volume of standard solutions needed for testing, use minimal amounts of decontamination water and solvent rinses).

7.8 NAVWPNSTA SEAL BEACH APPROVALS

TtFW will coordinate with the ROICC and the NAVWPNSTA IR Program Coordinator to obtain necessary approvals prior to the commencement of the remediation implementation activities at IRP Site 40.

7.9 WORKER HEALTH AND SAFETY

All field activities will be performed in accordance with Occupational Safety and Health Administration (OSHA) requirements for worker safety. The SHSP (Appendix C) provides

requirements and guidelines that will be used in the field to protect the health and safety of workers. A SHSS will provide full-time oversight of activities during construction to ensure compliance with OSHA and the SHSP.

7.10 RELEASE PREVENTION, RESPONSE, AND REPORTING

7.10.1 Spill Prevention

Vehicle fueling and management of decontamination waste are the two primary activities that may result in a spill. Spill prevention practices are described below for these two activities.

- **Fueling** – All vehicles will be fueled and serviced prior to moving onto the site. Any on-site fueling of equipment will be conducted within a designated controlled area. No bulk quantities of fuel will be stored on site.
- **Wastewater** – Wastewater will be containerized in 55-gallon drums or a Baker tank. A secondary containment will be constructed for the drums or the Baker tank. Therefore, any spills from the drums or the tank will be contained and will not be released to the surrounding areas.
- **Lactate** – Any lactate solution spilled during project activities will be cleaned and containerized in 55-gallon drum(s), and hauled off-site for disposal.

7.10.2 Spill Response

In the event of a release of hazardous material into the environment, TtFW will initiate action, as specified in the SHSP, to contain or control the release or evacuate the area if the spill is significant or represents an immediate health threat.

Absorbent pads, shovels, and 55-gallon drums will be kept at the site to address the possibility of spills.

7.10.3 Spill/Release Reporting

The steps below outline the chain of communications to be followed if a significant spill of any hazardous substance occurs.

1. Contact TtFW:

   Site personnel involved in the spill should immediately contact the TtFW Spill/Release On-site Coordinator, Project Superintendent, or SHSS, who will notify the Project Manager. At least one of these two individuals will be on site during all remedial activities:

SHSS/PQCM:	Jeffrey Brenner
On-site Coordinator and Project Superintendent:	Glenn Nardin

The TtFW SHSS/Quality Control (QC) Engineer or the Project Superintendent will contact the NAVWPNSTA IR Program Coordinator or the ROICC identified below:

NAVWPNSTA IR Program Coordinator:	Pei-Fen Tamashiro (562) 626-7897
ROICC:	David Crawley (562) 626-7964

2. If a release of a waste or hazardous substance, regardless of quantity, could threaten human health or the environment outside the facility, the Project Manager will verify that the following have been notified by the DON:
   - DHS at (800) 852-7550.
   - National Response Center at (800) 424-8802.
   - Local Emergency Response Coordinator (Fire Department, if necessary).
   - Report releases and submit written follow-up emergency notice under Superfund Act and Reauthorization Amendments, Title II requirements.

3. After taking the above actions, the following person will be contacted by the Project Manager or the Site Superintendent:

   Kelly McKay-Means
   TtFW
   Regional Environmental Safety and Quality Manager
   Office: (360) 598-8108

7.11 PROJECT AND PERSONNEL REQUIREMENTS

TtFW personnel training requirements and inspection programs applicable to the remedial action at IRP Site 40 are described below. Protocols for inspections by regulatory agencies and third parties are also addressed below.

7.11.1 Personnel Training/Certification Requirements

- Site personnel must have OSHA 40-hour Health and Safety/Emergency Response Hazard Communication and RCRA training.
- Site personnel performing DOT functions (including selecting, packaging, marking, labeling, preparing shipping papers, and loading) must be trained in accordance with the requirements of DOT 49 CFR, Part 172, Subpart H (aka DOT/HM-126F). Subcontractors performing DOT functions must supply proof of training.
- All project personnel (subcontractors and TtFW) will be trained according to TtFW compliance policies and procedures. TtFW personnel records will be verified along with the subcontractors training records prior to project activities.
- All project personnel performing waste management will be certified under TtFW waste management training in accordance with 40 CFR, Part 265.16.

7.11.2 Inspection and Audit Procedures

Site inspections and audits may occur during the remedial activities to assure compliance with this RD/WP, applicable state and federal regulations, and the SHSP

8.0 PROJECT MANAGEMENT

The project management team will be responsible for all technical and administrative aspects of the remedial action. Included among the team's responsibilities are the project schedule, staffing, data management, document control, project meetings, and reporting.

8.1 PROJECT SCHEDULE

The proposed schedule for implementation of the remedial action is included in this RD/WP as Figure 8-1. The schedule is presented in a critical path method format. The schedule has been prepared using a PC-based cost, scheduling, and control system known as PRIMAVERA®. PRIMAVERA® has many features, including the identification of critical paths and the ability to compare initial base plan to current project schedule.

The schedule includes preparatory; pre-remediation field construction activities; and remediation operations, performance monitoring, and reporting activities. Construction and remediation activities have been planned to start after approval of the RD/WP and procurement of the necessary equipment, materials, and subcontracting services.

Five main activities will be followed during the course of this project:

- **Stage 1 – Project Startup.** This stage includes preparation of project submittals that include the Work Plan.
- **Stage 2 – Preparatory Activities.** This stage includes notifications, procurement, and mobilization of equipment, materials, and personnel.
- **Stage 3 – Pre-remediation Construction Activities.** This stage includes a land surveying to mark the planned well locations (groundwater monitoring wells, groundwater injection wells, and soil vapor monitoring wells), a geophysical survey of areas where intrusive activities will be performed, drilling, well installation, well development, installation of dedicated well pumps and equipment, land survey (post-construction) to verify the well locations, and construction of the sodium lactate delivery system.
- **Stage 4 – Remediation Operations, Performance Monitoring, and Reporting Activities.** This stage includes injecting sodium lactate into the subsurface at a specified number of groundwater injection wells (biostimulation to degrade chlorinated ethenes), introducing non-indigenous microorganisms to the groundwater (bioaugmentation to complete the dechlorination process), groundwater monitoring, soil vapor monitoring, and indoor air monitoring, and reporting.

8.2 PROJECT RESPONSIBILITIES

The DON RPM for this project is Mr. Si T. Le. Mr. Le is responsible for project management, budget control, schedule maintenance, and contacting regulatory agencies. Ms. Pei-Fen Tamashiro is the NAVWPNSTA IR Program Coordinator. Ms. Tamashiro will be responsible for community relations activities and ensuring that the field and remedial activities are in compliance with the applicable rules and regulations. Mr. David Crawley is the ROICC and is responsible for the technical oversight of field activities, coordination of field activities with different NAVWPNSTA departments and personnel, and QC. Mr. Chris Leadon is the DON Remedial Technical Manager, responsible for the technical oversight and review of the project documents.

TtFW's Deputy Program Manager (DPM), Dr. Jamshid Sadeghipour, PE, will be responsible for general project administration and will ensure the quality of all project activities and deliverables. TtFW's Project Manager, Mr. Hamlet Hamparsumian, will be responsible for general project administration. Mr. Hamparsumian oversees budget, schedule, document preparation, and will ensure the quality of all project activities and deliverables. Mr. Michael Toy will be the Project Engineer and will be responsible for process design and implementation oversight. Mr. Mark Losi, Project Scientist, will provide necessary technical support during the remediation activities, which would include review and analysis of the field data, and provide the necessary input for making any adjustments to the system. The Project Superintendent, Mr. Glenn Nardin, will manage fieldwork and provide oversight to the subcontractors. Mr. Nardin will coordinate the field activities with the senior technical staff. Mr. Nardin will also coordinate these activities with the SHSS, and coordinate efforts among all subcontractors. Mr. Vince Richards will act as the PQCM and SHSS during the operations and performance monitoring of the ISB. Mr. Jeffrey Brenner will be the Project Geologist and also act as the alternate PQCM and SHSS during the well drilling and installation activities. As PQCM, Mr. Brenner and Mr. Richards will coordinate with the QC Program Manager, Ms. Mary Schneider, to ensure that all field activities are in compliance with the project specifications.

The following is a list of key project personnel contacts:

Agency	Contact	Project Title
Southwest Division, Naval Facilities Engineering Command 1220 Pacific Highway San Diego, CA 92132-5190	Mr. Si Le (619) 532-2295	DON RPM
NAVWPNSTA Seal Beach 800 Seal Beach Boulevard Building 110 Seal Beach, CA 90740-5000	Ms. Pei-Fen Tamashiro (562) 626-7897	NAVWPNSTA IR Program Coordinator

Agency	Contact	Project Title
ROICC Los Angeles NAVWPNSTA Seal Beach Building 230 Seal Beach, CA 90740-5000	Mr. David Crawley (562) 626-7964	ROICC
Southwest Division, Naval Facilities Engineering Command 1220 Pacific Highway San Diego, CA 92132-5190	Mr. Chris Leadon (619) 532-3878	Remedial Technical Manager
California Environmental Protection Agency Department of Toxic Substances Control Office of Military Facilities 5796 Corporate Way Cypress, CA 90630	Ms. Katherine Leibel (714) 484-5446	DTSC-RPM
California Regional Water Quality Control Board, Santa Ana Region 3737 Main Street, Suite 500 Riverside, CA 92501-3348	Ms. Patricia Hannon (951) 782-4498	RWQCB-RPM
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Mr. Jamshid Sadeghipour (949) 756-7519	DPM
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Mr. Hamlet Hamparsumian (949) 756-7520	Project Manager
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Mr Mark Losi (949) 756-7516	Project Scientist (Microbiologist)
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Mr. Michael Toy (949) 756-7532	Project Engineer
TtFW 1940 East Deere Avenue, Suite 100 Santa Ana, CA 92705	Ms. Mary Schneider (949) 756-7586	QC Program Manager
TtFW 1940 East Deere Avenue, Suite 100 Santa Ana, CA 92705	Mr. Glenn Nardin (714) 822-4691	Project Superintendent
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Mr. Jeffrey Brenner (949) 756-7585	Project Geologist, Alternate PQCM/SHSS during well drilling, installation, and development
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Mr. Vince Richard (949) 756-7568	PQCM/SHSS during ISB operations and performance monitoring

Agency	Contact	Project Title
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Mr. David Bertolacci (949) 756-7564	Alternate PQCM/SHSS during well drilling, installation, and development

8.3 DATA MANAGEMENT

The following is a summary of the data management tools that will be employed for the duration of this project:

- PRIMAVERA® and Harper Shuman accounting software will be used for all schedule and project cost tracking.
- Home and field office staff for technical data management will use Microsoft Excel® spreadsheets. Microsoft Word® will be employed for word processing.

8.4 DOCUMENT CONTROL

TtFW's internal document control procedures will be followed for the duration of the project. Additional guidance provided by the DON will be used for document control, particularly for matters relating to regulatory compliance. Management of internal and external correspondence will be administered at the home office in San Diego, California. Document control will include assigning an alphanumeric coding to each submittal. Complete project files will be maintained in a secure, dry area at the field office.

8.5 MEETINGS AND REPORTS

Project status meetings will be held weekly (or at less frequent intervals if desired by the DON) at the field office during the field construction activities. The Project Manager, Project Superintendent, PQCM, SHSS, and other selected individuals will be required to attend these meetings with the ROICC and the NAVWPNSTA IR Program Coordinator. The agenda of the project status meetings will include the following:

- Review and approval of minutes of previous meeting
- Review of work progress
- Field observations, problems, and conflicts
- Problems, which impede construction schedule and proposed corrective actions
- Review of off-site delivery schedules
- Corrective measures and procedures to regain projected schedule
- Revisions to construction schedule
- Forecast of progress for next succeeding work period

- Coordination of schedules
- Review of submittal schedules, if any
- Review of quality/health and safety programs
- Pending changes and substitutions
- Review of proposed changes for effects of construction, completion date, and other aspects of the project
- Other project-related business

Minutes of the meetings will be prepared by TtFW and submitted to the DON. Daily reports will be prepared by the Project Superintendent and the PQCM and submitted to the ROICC during the field construction activities. Weekly reports will be prepared by the Project Manager and submitted to the RPM, NAVWPNSTA IR Program Coordinator, and the ROICC during the field construction activities.

9.0 REFERENCES

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TABLES

TABLE 3-1

REMEDIATION GOALS FOR IRP SITE 40 GROUNDWATER
(micrograms per liter)

Analyte	Federal Maximum Contaminant Level[a]	California Maximum Contaminant Level[b]	Controlling ARAR
cis-1,2-dichloroethene	70	6	6
trans-1,2-dichloroethene	100	10	10
Trichloroethene	5	5	5
Tetrachloroethene	5	5	5
Vinyl chloride	2	0.5	0.5

Notes:

[a] United States Environmental Protection Agency Safe Drinking Water Act, Title 40 Code of Federal Regulations, Part 141

[b] California Code of Regulations, Title 22, Section 64439, Requirements, and Section 64444, Maximum Contaminant Levels

ARAR – applicable or relevant and appropriate requirement
IRP – Installation Restoration Program

TABLE 3-2

PERFORMANCE CRITERIA FOR IN SITU BIOREMEDIATION PROCESS
(micrograms per liter)

Analyte	Performance Criteria	Source
cis-1,2-Dichloroethene	6	a
trans-1,2-Dichloroethene	10	a
Trichloroethene	5	b
Tetrachloroethene	5	b
Vinyl chloride	0.5	b,c

Notes:

[a] California Code of Regulations Title 22, Section 64439, Requirements, and Section 64444, Maximum Contaminant Levels

[b] United States Environmental Protection Agency Safe Drinking Water Act, Title 40 Code of Federal Regulations, Part 141 62

[c] The average reported post-test vinyl chloride concentration in the pilot test area from samples collected from wells MW-40-22, -23, -25, -28, and -29 was 4 14 µg/L

µg/L – micrograms per liter

TABLE 3-3

PERFORMANCE CRITERIA FOR MONITORED NATURAL ATTENUATION PROCESS
(micrograms per liter)

Analyte	Performance Criteria	Source
cis-1,2-Dichloroethene	6	a
trans-1,2-Dichloroethene	10	a
Trichloroethene	5	b
Tetrachloroethene	5	b
Vinyl chloride	0.5	a

Notes:

[a] California Code of Regulations Title 22, Section 64439, Requirements, and Section 64444, Maximum Contaminant Levels

[b] United States Environmental Protection Agency Safe Drinking Water Act, Title 40 Code of Federal Regulations, Part 141.62

TABLE 4-1

EXISTING AND PROPOSED MONITORING WELLS AND PROPOSED INJECTION WELLS

Well ID	Construction Date	Casing Diameter (inches)	Casing Material	Slot Size (inches)	Borehole Diameter (inches)	Top of Casing (feet bgs)	Top of Filter Pack (feet bgs)	Screen Interval (top) (feet bgs)	Screen Interval (bottom)	Well Depth (feet bgs)
EXISTING WELLS										
VW-40-01	3/19/2003	2	Sch. 40 PVC	0.01	8	0.3	2	2.5	7.5	8
VW-40-02	3/19/2003	2	Sch. 40 PVC	0.01	8	0.3	2	2.5	7.5	8
40-MW-01	12/22/1992	2	Sch. 40 PVC	0.01	8	NA	4.0	6.5	16.5	20.0
40-MW-02	12/21/1992	2	Sch. 40 PVC	0.01	8	NA	4.0	6.0	16.0	20.0
40-MW-03	12/21/1992	2	Sch. 40 PVC	0.01	8	0.3	4.0	6.5	16.5	19.0
40-MW-04	12/22/1992	2	Sch. 40 PVC	0.01	NA	0.4	4.0	6.0	16.0	18.0
40-MW-05	10/30/1995	2	Sch. 40 PVC	0.01	10	0.5	6.0	9.5	25.0	26.0
MW-40-06	8/26/1997	4	Sch. 40 PVC	0.01	10	0.4	16.3	20.3	30.3	34.0
MW-40-07	9/15/1997	4	Sch. 40 PVC	0.01	12	0.5	15.0	20.0	30.0	34.0
MW-40-08	9/12/1997	4	Sch. 40 PVC	0.01	12	0.4	13.5	20.0	30.0	34.0
MW-40-09	8/27/1997	4	Stainless Steel	0.01	12	0.3	40.0	45.0	55.0	57.0
MW-40-10	8/28/1997	4	Sch. 40 PVC	0.01	10	0.7	40.0	45.0	55.0	59.0
MW-40-11	9/5/1997	4	Stainless Steel	0.01	12	0.4	40.0	45.0	55.0	57.0
MW-40-12	9/11/1997	4	Sch. 40 PVC	0.01	12	0.6	40.0	45.0	55.0	59.0
MW-40-13	9/15/1997	4	Sch. 40 PVC	0.01	12	0.4	40.0	45.0	55.0	58.0
MW-40-14	9/8/1997	4	Sch. 40 PVC	0.01	12	0.2	25.0	30.0	40.0	59.0
MW-40-15	9/16/1997	4	Sch. 40 PVC	0.01	12	0.4	17.0	20.0	30.0	33.5
MW-40-16	9/16/1997	4	Sch. 40 PVC	0.01	12	0.3	34.0	42.3	52.3	57.5
MW-40-17	4/11/2000	4	Sch. 40 PVC	0.01	10	0.2	17.0	20.0	30.0	32.0
MW-40-18	4/12/2000	4	Sch. 40 PVC	0.01	10	0.0	47.0	50.0	60.0	62.0
MW-40-19	4/12/2000	4	Sch. 40 PVC	0.01	10	-1.5	197.0	19.8	29.8	32.0
MW-40-20	4/13/2000	4	Sch. 40 PVC	0.01	10	-1.8	47.0	49.7	59.7	62.0
MW-40-21	4/11/2000	4	Sch. 40 PVC	0.01	10	-1.8	47.0	50.5	60.5	62.0
MW-40-22	7/6/2001	4	Sch. 40 PVC	0.01	11	0.4	12	15.3	35.5	35.7
MW-40-23	7/9/2001	4	Sch. 40 PVC	0.01	11	0.4	10.5	15.1	35.1	35.5
MW-40-24	7/9/2001	4	Sch. 40 PVC	0.01	11	0.2	12.9	15.1	35.1	35.5
MW-40-25	7/9/2001	4	Sch. 40 PVC	0.01	11	0.6	13	15.3	35.3	35.7

TABLE 4-1

EXISTING AND PROPOSED MONITORING WELLS AND PROPOSED INJECTION WELLS

Well ID	Construction Date	Casing Diameter (inches)	Casing Material	Slot Size (inches)	Borehole Diameter (inches)	Top of Casing (feet bgs)	Top of Filter Pack (feet bgs)	Screen Interval (top) (feet bgs)	Screen Interval (bottom)	Well Depth (feet bgs)
MW-40-26	7/6/2001	4	Sch. 40 PVC	0.01	11	0.2	12.5	15.2	35.2	35.6
MW-40-27	7/9/2001	4	Sch. 40 PVC	0.01	11	0.5	12.6	15.1	35.1	35.5
MW-40-28	7/9/2001	4	Sch. 40 PVC	0.01	11	0.6	11	15.0	35.0	35.4
MW-40-29	3/19/2003	4	Sch. 40 PVC	0.01	10	0.7	13	15.0	35.0	35.5
PROPOSED WELLS										
IW-1	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-2	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-3	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-4	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-5 Existing Monitoring Well MW-40-27	7/9/2001	4	Sch. 40 PVC	0.01	11	0.5	12.6	15.1	35.1	35.5
IW-6	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-7	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-8	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-9	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-10	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-11	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-12	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-13	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-14	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-15	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-16	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-17	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
MW-40-30	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
MW-40-31	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	35.0	55.0	55.0
MW-40-32	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
MW-40-33	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0

TABLE 4-1

EXISTING AND PROPOSED MONITORING WELLS AND PROPOSED INJECTION WELLS

Well ID	Construction Date	Casing Diameter (inches)	Casing Material	Slot Size (inches)	Borehole Diameter (inches)	Top of Casing (feet bgs)	Top of Filter Pack (feet bgs)	Screen Interval (top) (feet bgs)	Screen Interval (bottom)	Well Depth (feet bgs)
MW-40-34	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
MW-40-35	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	35.0	55.0	55.0
MW-40-36	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
MW-40-37	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
MW-40-38	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
MW-40-39	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	20.0	30.0	30.0
VW-40-3	TBD	2	Sch. 40 PVC	0.01	10	TBD	TBD	2.0	9.0	10.0
VW-40-4	TBD	2	Sch. 40 PVC	0.01	10	TBD	TBD	2.0	9.0	10.0
VW-40-5	TBD	2	Sch. 40 PVC	0.01	10	TBD	TBD	2.0	9.0	10.0
VW-40-6	TBD	2	Sch. 40 PVC	0.01	10	TBD	TBD	2.0	9.0	10.0

Notes:

bgs – below ground surface

NA – Not Available

PVC – polyvinyl chloride

Sch. – Schedule

TBD - to be determined

TABLE 4-2

OPERATING PARAMETERS AND REQUIREMENTS

Parameters	Requirements
Lactate injection locations	17 injection wells
Total solution flow rates (potable water + lactate)	4 gpm per injection
Lactate delivery concentration	3% of sodium lactate solution
Well injection volume	600,000 gallons for total initial injection
Lactate base solution concentration	60% sodium lactate
Operating time	Six 8-hour days per week for an initial period of 9 weeks
Electrical	120-volt station power supply or portable generator
Quantity and approximate depth of new wells	17 injection wells to 35 feet bgs 8 shallow-interval monitoring wells to 35 feet bgs 2 middle-interval monitoring wells to 55 feet bgs 4 soil vapor wells to 10 feet bgs 27 soil gas probes in the injection and groundwater monitoring wells
Media to be sampled	Groundwater at injection and monitoring wells Soil gas at vapor wells

Notes:
gpm – gallons per minute

TABLE 6-1

ANALYTICAL TESTING PARAMETERS, FREQUENCY, AND DATA USE

Analyte	Frequency	General Data Use
		IN FIELD
Nitrate	Baseline – Once Biweekly – for the first six months Monthly for the second six months Quarterly – After first year	Alternate electron accepter in anoxic respiration – reduced concentrations relative to control or baseline measurements indicates biological activity.
Sulfate	Baseline – Once Biweekly – for the first six months Monthly for the second six months Quarterly – After first year	Alternate electron accepter in anoxic respiration – reduced concentrations relative to control or baseline measurements indicates biological activity.
Ferrous Iron	Baseline – Once Biweekly – for the first six months Monthly for the second six months Quarterly – After first year	By-product of Fe (III) reduction – increased concentrations relative to control or baseline measurements indicates biological activity.
Carbon Dioxide	Baseline – Once Biweekly – for the first six months Monthly for the second six months Quarterly – After first year	Biogenic gas and alternate electron accepter –concentrations variations relative to control or baseline measurements indicate biological activity.
Alkalinity	Baseline – Once Biweekly – for the first six months Monthly for the second six months Quarterly – After first year	Results from evolution of biogenic carbon dioxide, increases relative to control or baseline measurements indicate biological activity.
COD	Baseline – Once Biweekly – for the first six months Monthly for the second six months Quarterly – After first year	Used as a surrogate for total organic carbon, variations relative to control or baseline measurements indicate substrate presence/depletion.
pH	Baseline – Once Biweekly – for the first six months Monthly for the second six months Quarterly – After first year Semiannually – After first year (MNA Phase)	Values outside the general range of 6-8.5 can impede biological activity, decreases can result from production of organic acids during breakdown of lactate

TABLE 6-1

ANALYTICAL TESTING PARAMETERS, FREQUENCY, AND DATA USE

Analyte	Frequency	General Data Use
Conductivity	Baseline – Once Biweekly – for the first six months Monthly for the second six months Quarterly – After first year Semiannually – After first year (MNA Phase)	General indicator of water quality varies directly with salinity.
ORP	Baseline – Once Biweekly – for the first six months Monthly for the second six months Quarterly – After first year Semiannually – After first year (MNA Phase)	Reflects the concentrations of oxidizers or reducers in groundwater, and their activity or strength. Provides an indication of dominant electron accepting processes that are likely to be occurring in the subsurface.
DO	Baseline – Once Biweekly – for the first six months Monthly for the second six months Quarterly – After first year Semiannually – After first year (MNA Phase)	Primary electron accepter – reduced concentrations relative to control or baseline measurements indicates biological activity.
Water level	Baseline – Once During lactate injection – As needed Monthly – First year Quarterly – After first year Semiannually – After first year (MNA Phase)	Used to assess groundwater flow and mounding.
Methane gas	Baseline – Once Biweekly – for the first six months Monthly for the second six months Quarterly – After first year Each time well caps are removed	Biogenic gas indicating use of carbon dioxide as an electron acceptor under strongly reducing conditions – generally indicates biological activity (methanogenesis) under conditions which favor reductive dechlorination.
Hydrogen sulfide gas	Baseline – Once Biweekly – for the first six months Monthly for the second six months Quarterly – After first year Each time well caps are removed	Biogenic gas in which SO_4^{2-} is used as an electron acceptor under strongly reducing conditions – generally indicates biological activity under conditions which favor reductive dechlorination

TABLE 6-1

ANALYTICAL TESTING PARAMETERS, FREQUENCY, AND DATA USE

Analyte	Frequency	General Data Use
Total explosive gases	Baseline – Once Biweekly – for the first six months Monthly for the second six months Quarterly – After first year Each time well caps are removed	Health and safety parameter.
	IN FIXED LABORATORY	
Alkalinity	Baseline – Once Monthly – First three months Quarterly– After the First three months Semiannually – After first year (MNA Phase)	An indicator of evolution of biogenic carbon dioxide, increases relative to control or baseline measurements indicate biological activity.
COD	Baseline – Once Monthly – First three months Quarterly– After the First three months Semiannually – After first year (MNA Phase)	Used as a surrogate for total organic carbon, variations relative to control or baseline measurements indicate substrate presence/depletion.
Dissolved gases (methane, carbon dioxide, hydrogen sulfide, hydrogen gas)	Baseline – Once Monthly – First three months Quarterly– After the First three months Semiannually – After first year (MNA Phase)	Biogenic gases – indicative of strongly reducing conditions – increases relative to control or baseline measurements generally indicate biological activity under conditions that favor reductive dechlorination.
Q-PCR - DNA testing	Baseline – Once Monthly – First three months Quarterly– After the First three months Semiannually – After first year (MNA Phase)	Provides measurement of specific microorganisms and/or groups of organisms.
Major anions (sulfate, chloride, nitrate, nitrite)	Baseline – Once Monthly – First three months Quarterly– After the First three months Semiannually – After first year (MNA Phase)	Alternate electron accepters (excluding chloride) – reduced concentrations relative to control or baseline measurements indicates biological activity and oxidation/reduction status.
Major cations (Ca, Fe, Mg, Mn, K, Na)	Baseline – Once Monthly – First three months Quarterly– After the First three months Semiannually – After first year (MNA Phase)	General water quality parameters – increased Na relative to control or baseline measurements can indicate lactate migration; increased Fe and Mn relative to control or baseline measurements can indicate use of Fe (III) and Mn (VI) as terminal electron acceptors.
Organic acids	Baseline – Once Monthly – First three months Quarterly– After the First three months Semiannually – After first year (MNA Phase)	Formed in biodegradation of lactate, increased levels relative to control or baseline measurements can indicate lactate migration/breakdown

TABLE 6-1

ANALYTICAL TESTING PARAMETERS, FREQUENCY, AND DATA USE

Analyte	Frequency	General Data Use
Phospholipid fatty acid	Baseline – Once Monthly – First three months Quarterly– After the First three months Semiannually – After first year (MNA Phase)	Provides quantitative information on overall biomass content and community diversity. Used to assess changes in microbial growth and community structure in response to substrate emplacement.
TDS	Baseline – Once Monthly – First three months Quarterly– After the First three months Semiannually – After first year (MNA Phase)	General water quality parameter – increases relative to control or baseline measurements can indicate lactate migration.
TOC	Baseline – Once Monthly – First three months Quarterly– After the First three months Semiannually – After first year (MNA Phase)	Will include lactate (among other organic compounds present), variations relative to control or baseline measurements indicate substrate presence/depletion.
VOC	Baseline – Once Monthly – First three months Quarterly– After the First three months Semiannually – After first year (MNA Phase)	Assessment of primary COCs and daughter products.
Fixed gases in vapor (methane, ethane, ethene)	Baseline – Once Monthly – First year Quarterly– After the First three months	Increases in methane concentrations relative to baseline or control will provide evidence of bioactivity under conditions that favor reductive dechlorination. Increases in ethane and ethene concentrations relative to baseline or control will provide evidence of complete reductive dechlorination.
VOC in vapor	Baseline – Once Monthly – First three months Semiannually – After first year	Provides information regarding volatilization of primary COCs and/or daughter products from the groundwater, increases in daughter products relative to baseline or control measurements will provide evidence of reductive dechlorination.

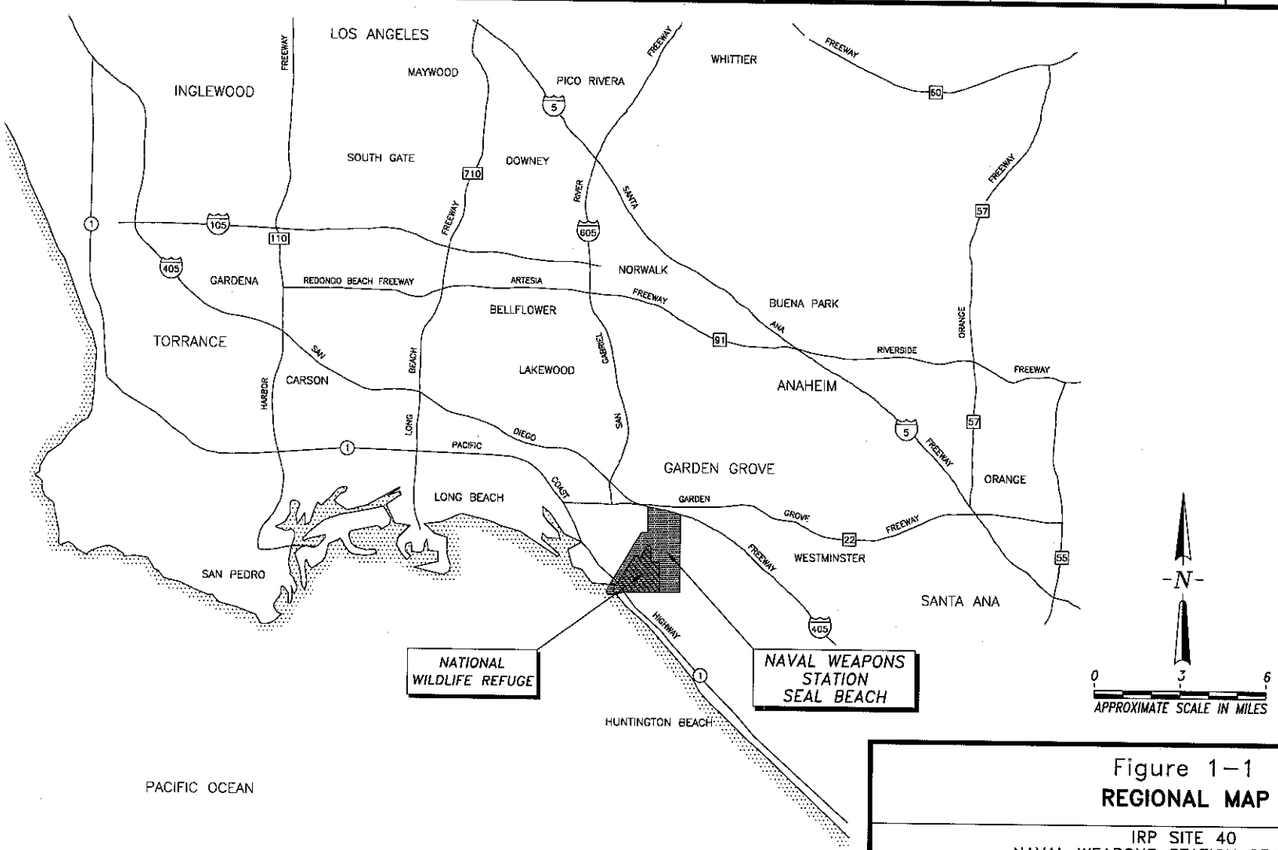
Notes:

COC – chemical of concern
COD – chemical oxygen demand
DNA – deoxyribonucleic acid
DO – dissolved oxygen
ORP – oxidation/reduction potential
Q-PCR – quantitative polymerase chain reaction
TDS – total dissolved solids
TOC – total organic carbon
VOC – volatile organic compound

FIGURES

P:\1990-RAC\CTO-0090\DWG\050380\05038011.DWG
PLOT/UPDATE: FEB 03 2005 10:38:50

DRAWN BY: MD	CHECKED BY: HH	APPROVED BY: HH	DCN: FWSD-RAC-05-0380	DRAWING NO:
DATE: 02/11/05	REV: REVISION 0		CTO: #0090	05038011.DWG



SOURCE: CH2M HILL, 2002.

Figure 1-1
REGIONAL MAP

IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC.

P:\1990-RAC\CTO-0090\DWG\050380\05038012.DWG
PLOT/UPDATE: FEB 03 2005 10:41:44

DRAWN BY: MD	CHECKED BY: HH	APPROVED BY: HH	DCN: FWSD-RAC-05-0380	DRAWING NO:
DATE: 02/11/05	REV: REVISION 0		CTO: #0090	05038012.DWG

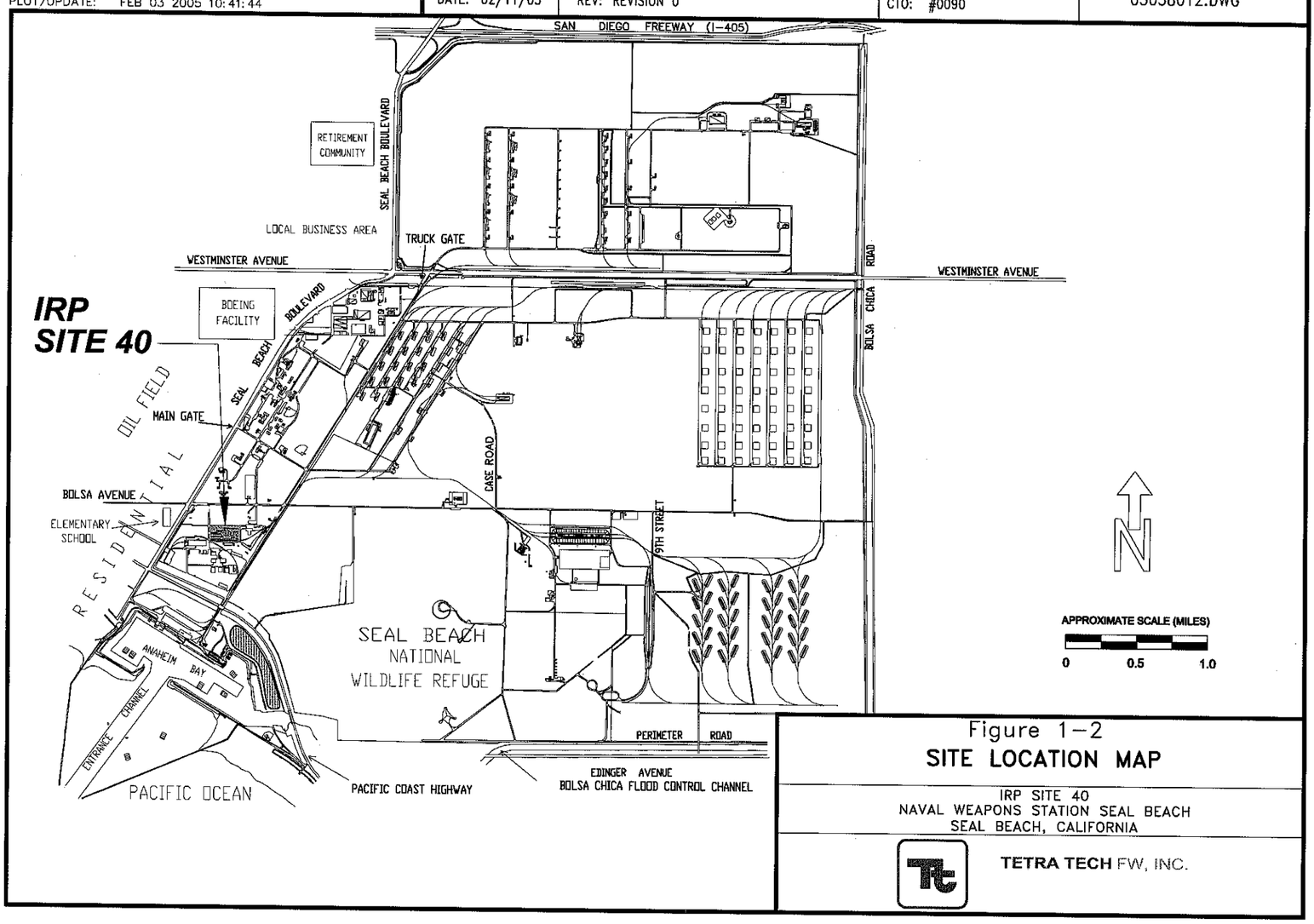


Figure 1-2
SITE LOCATION MAP

IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC.

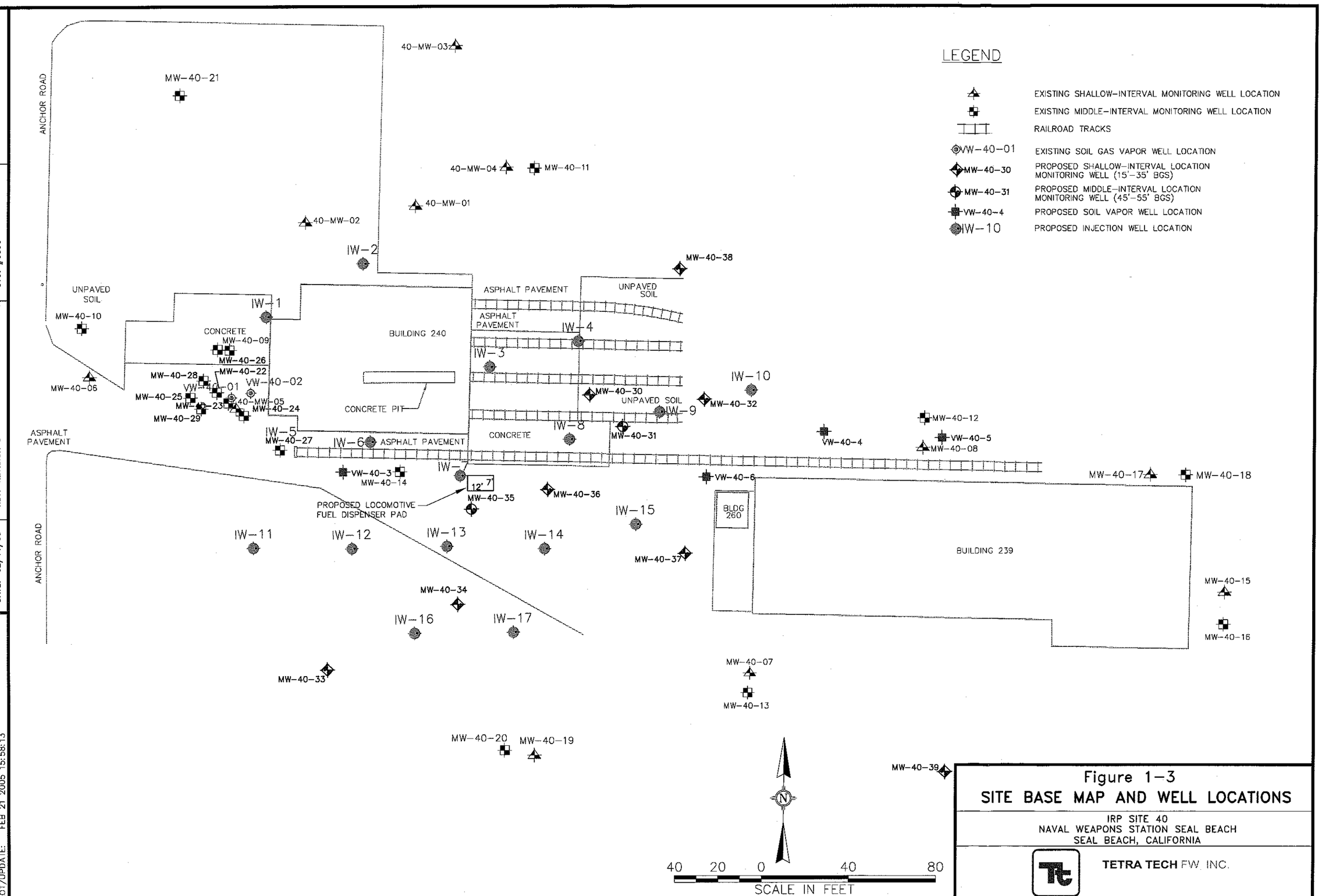


Figure 1-3
SITE BASE MAP AND WELL LOCATIONS

IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC.

DRAWING NO: 05038013.DWG
DCN: FWSD-RAC-05-0380
CTO: #0090
APPROVED BY: HH
CHECKED BY: MT
REV: REVISION 0
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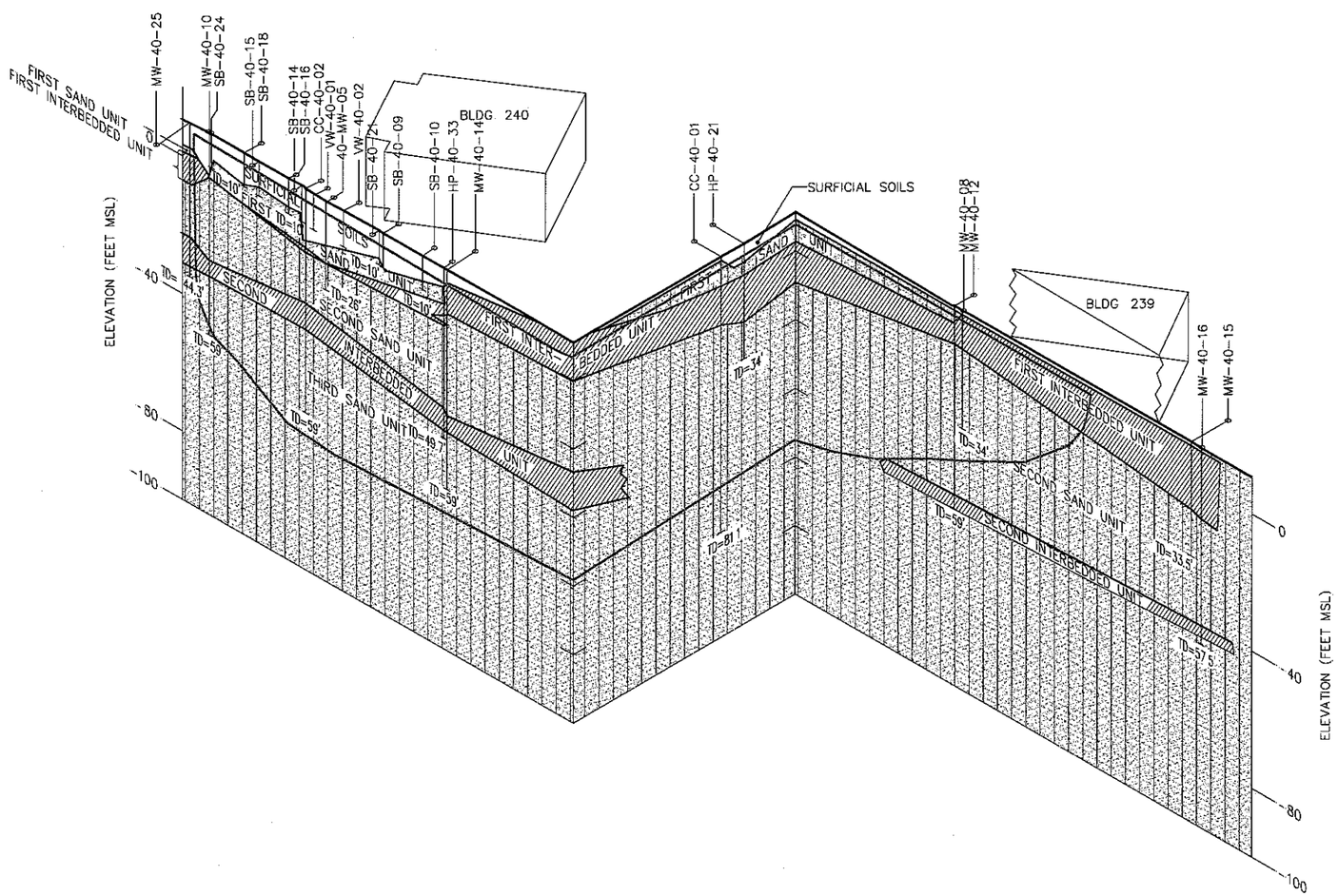

LEGEND

SUBSURFACE STRATIGRAPHIC SYMBOLS

PREDOMINANTLY FINE-GRAINED UNIT (CLAY, SILT, SILTY CLAY, CLAYEY SILT SANDY CLAY AND SANDY SILT)

PREDOMINANTLY COARSE-GRAINED UNIT (SAND, SILTY SAND AND CLAYEY SAND)

UNIT BOUNDARY

APPROXIMATE EXTENT OF VOC PLUME IN GROUNDWATER

IR – INSTALLATION RESTORATION

SOURCE:

BECHTEL ENVIRONMENTAL, INC. 2003. FINAL SECOND ANNUAL GROUNDWATER MONITORING REPORT IR SITES 40 AND 70, NAVAL WEAPONS STATION SEAL BEACH SEAL BEACH CALIFORNIA JULY

0 80 160

FEET

VERTICAL SCALE: 1 INCH = 40 FEET

Figure 2-1
SITE PHYSICAL CONCEPTUAL MODEL

IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC.

DRAWN BY: MD	CHECKED BY: CJ	APPROVED BY: HH	DCN: FWSD-RAC-05-0380	DRAWING NO: 05038021.DWG
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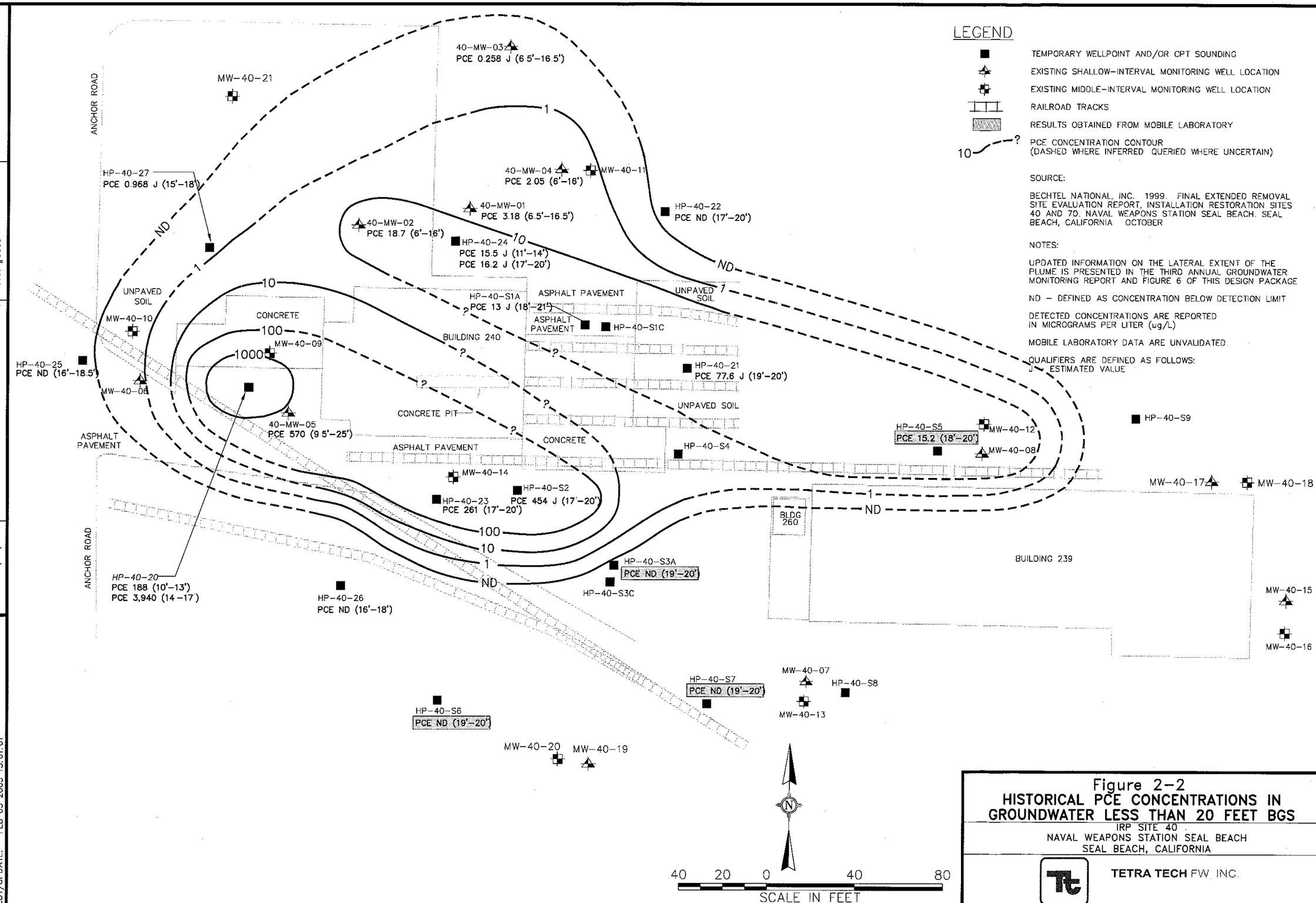

Figure 2-2
HISTORICAL PCE CONCENTRATIONS IN GROUNDWATER LESS THAN 20 FEET BGS
IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC.

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CHECKED BY: CJ
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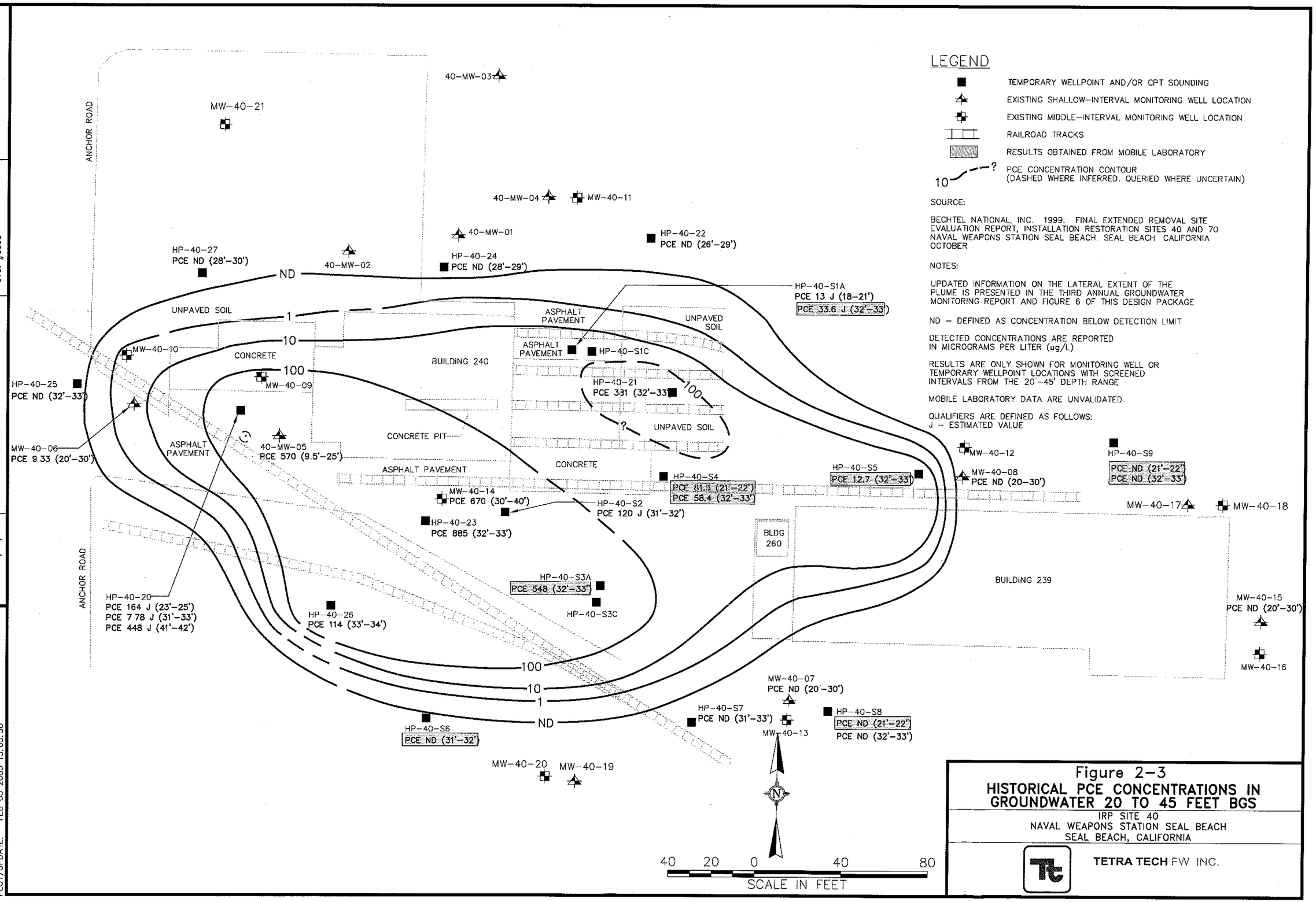

Figure 2-3
HISTORICAL PCE CONCENTRATIONS IN GROUNDWATER 20 TO 45 FEET BGS
IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW INC.

DRAWING NO: 05038023.DWG
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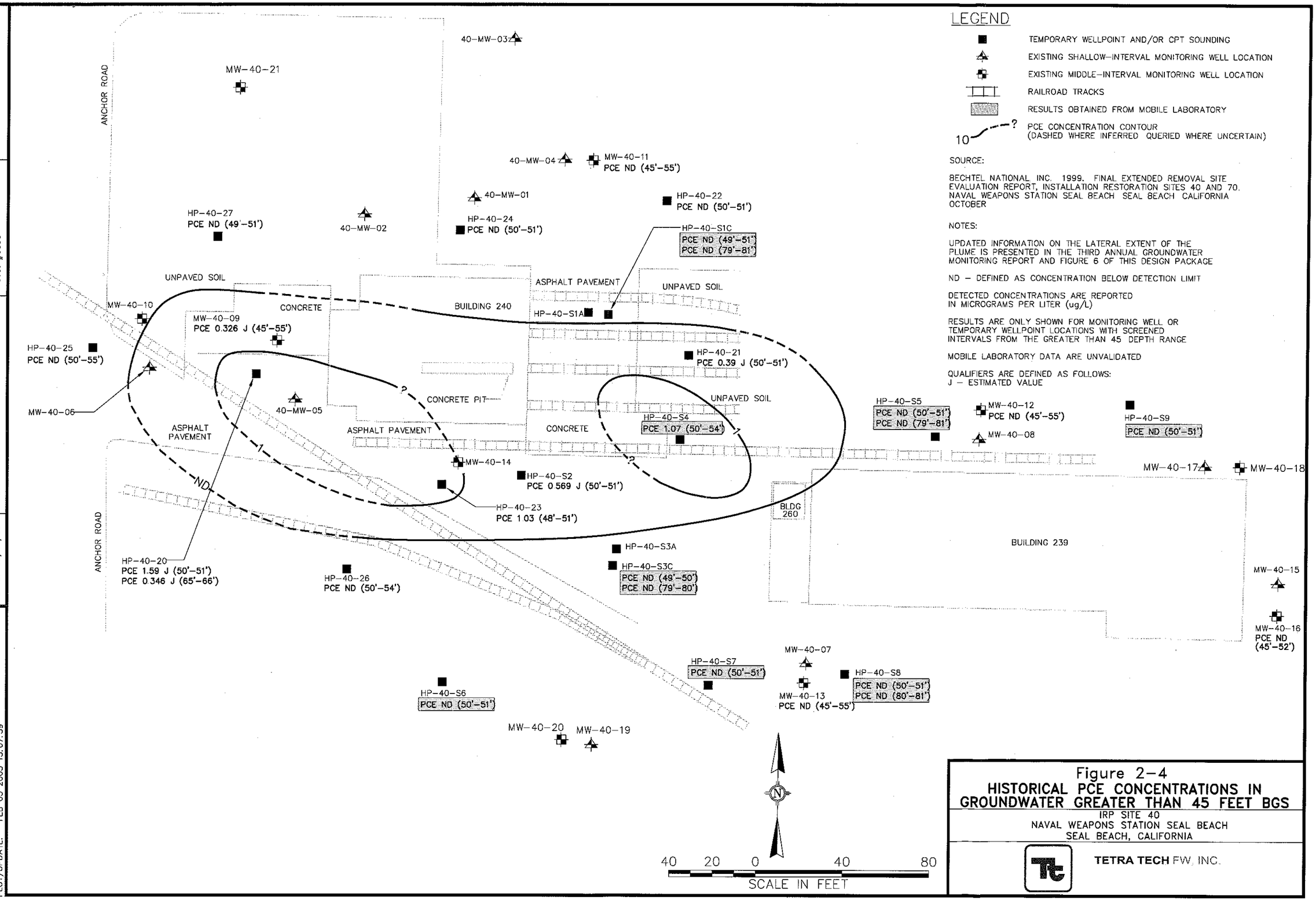

Figure 2-4
HISTORICAL PCE CONCENTRATIONS IN GROUNDWATER GREATER THAN 45 FEET BGS
IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC.

DRAWING NO: 05038024.DWG
DCN: FWSD-RAC-05-0380
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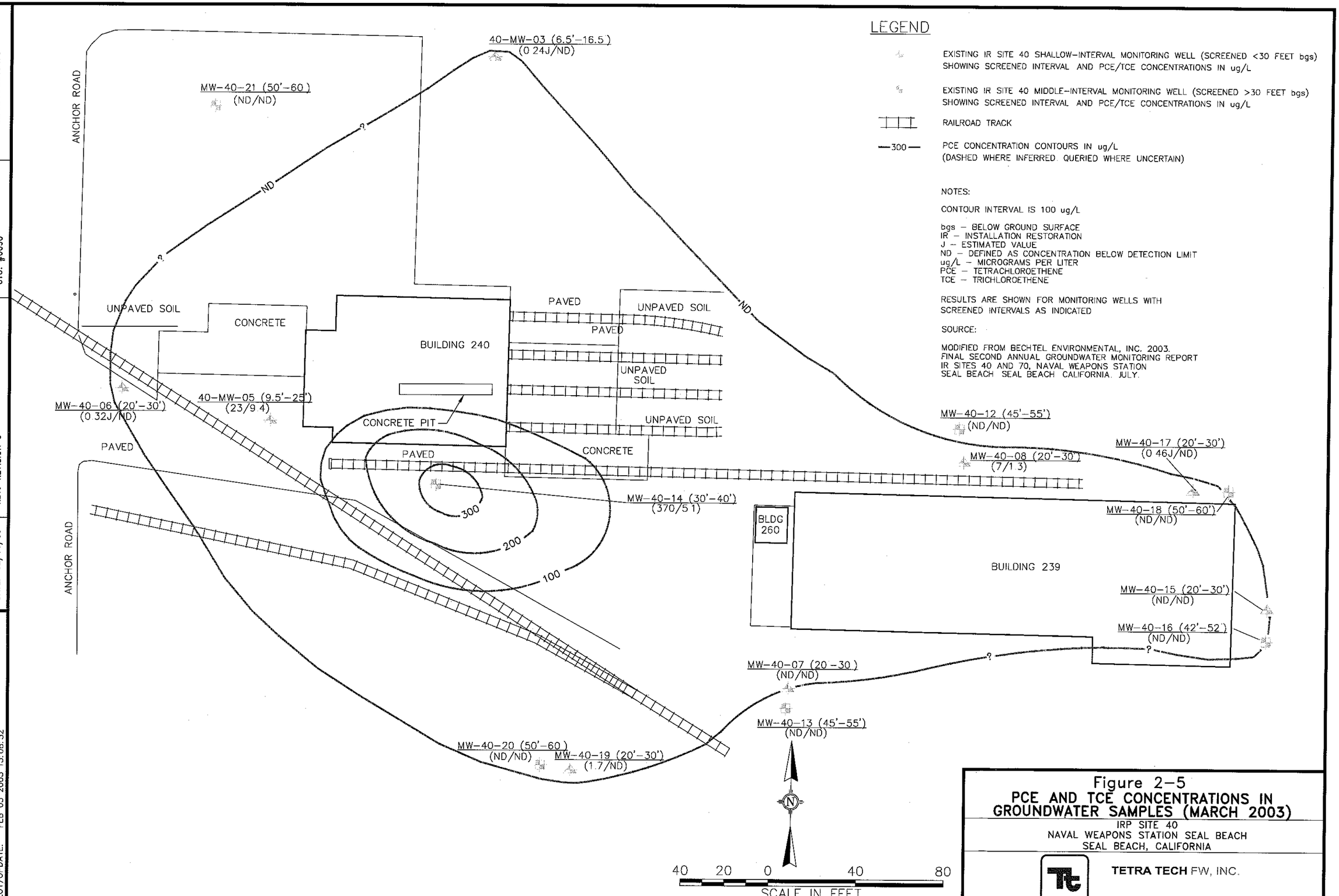

Figure 2-5
PCE AND TCE CONCENTRATIONS IN GROUNDWATER SAMPLES (MARCH 2003)
IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC.

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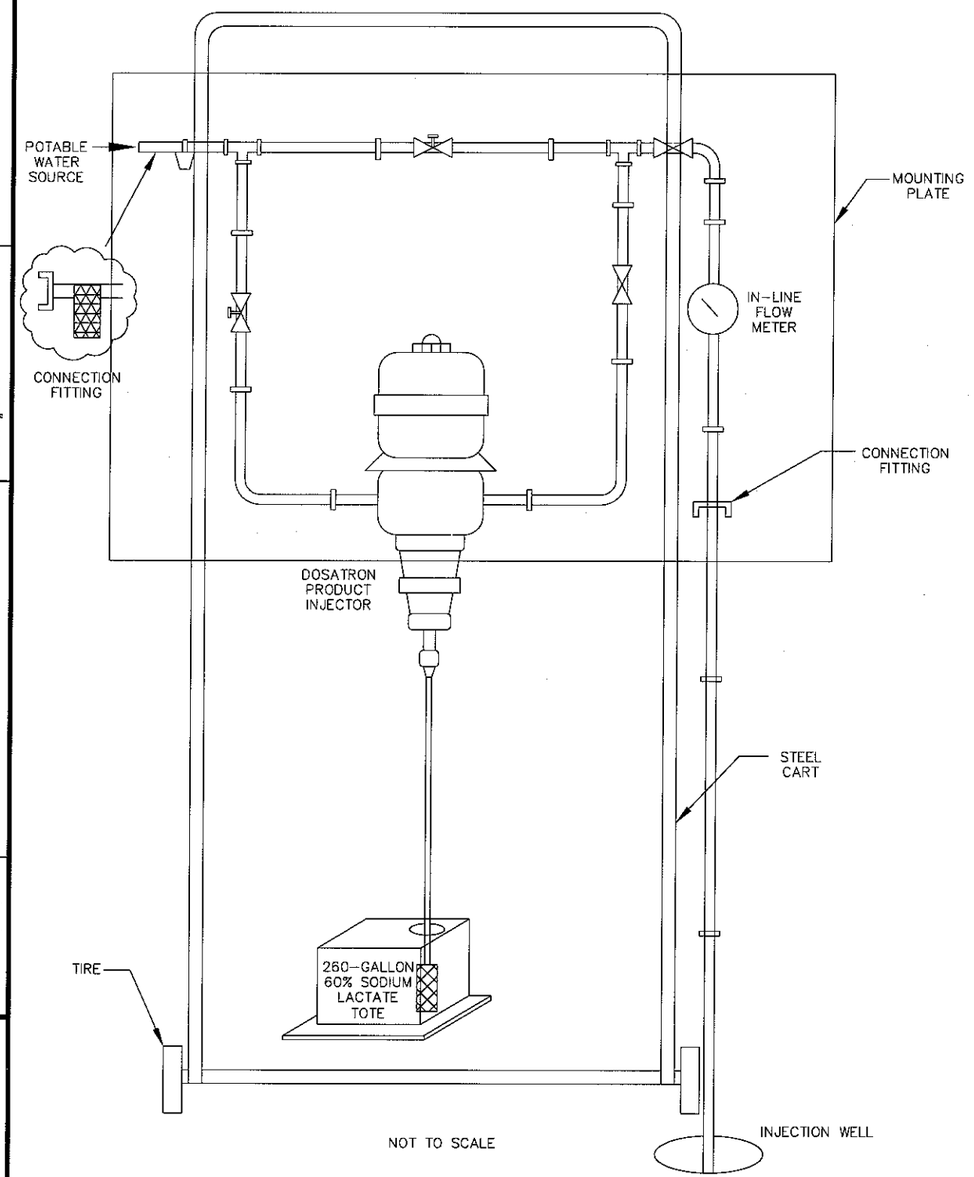

NOTE:
ALL PIPE CONNECTIONS AND FITTINGS SHALL BE FLUSH THREADED NO GLUE SHALL BE USED FOR ATTACHING FITTINGS OR PIPE SECTION TOGETHER.
SOURCE: DOSATRON INTERNATIONAL, INC.

LEGEND:

- FILTER
- PRESSURE REGULATOR
- BALL VALVE
- IN-LINE CHECK VALVE
- TIE DOWN STRAP
- IN-LINE FLOW METER

Figure 4-3
REAGENT INJECTOR SYSTEM SCHEMATIC
IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC.

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DATE: 02/11/05	REV: REVISION 0		CTO: #0090	

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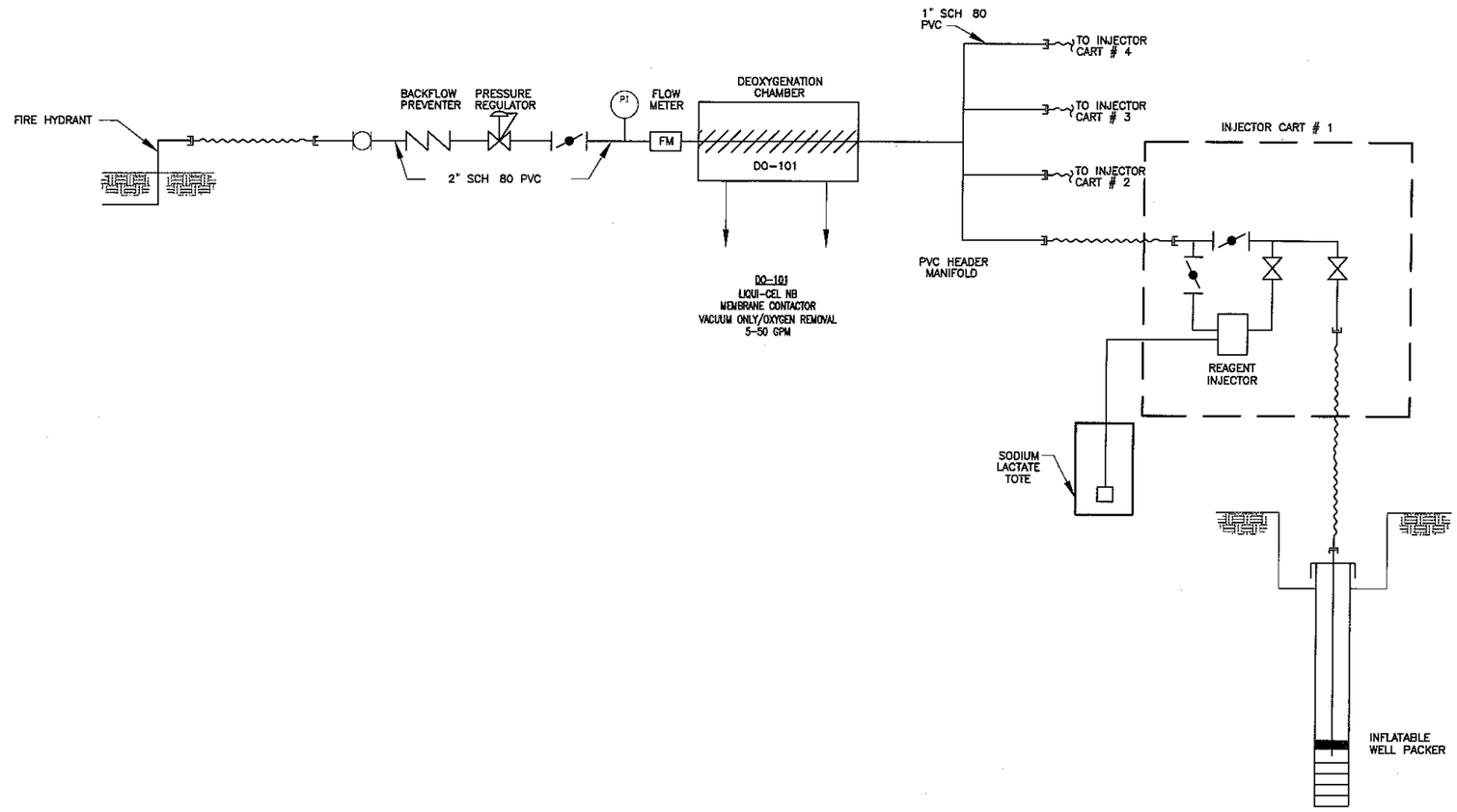

Figure 4-4
INJECTION SYSTEM
PROCESS AND INSTRUMENTATION DIAGRAM
IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC.

DRAWING NO: 05038044.DWG
DCN: FWSD-RAC-05-0380
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CHECKED BY: MT
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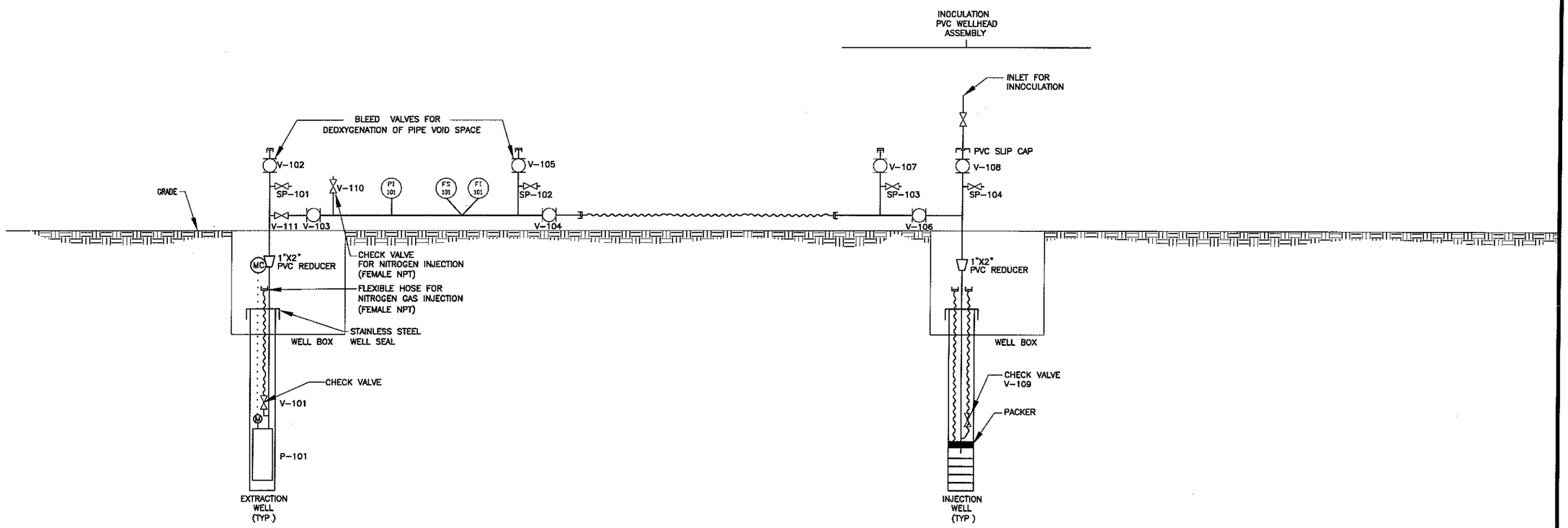

P-101
GROUNDWATER EXTRACTION PUMP
GRUNDFOS REDI-FLO4 5E8
1" FEMALE NPT DISCHARGE OUTLET
100 ML/MIN TO 10 GPM
2.0 HP/230V/3PH/60HZ/6.7A

Figure 4-5
INOCULUM-LADEN GROUNDWATER DISTRIBUTION SYSTEM PROCESS AND INSTRUMENTATION DIAGRAM
IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC.

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DCN: FWSD-RAC-05-0380
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CHECKED BY: MT
REV: REVISION 0
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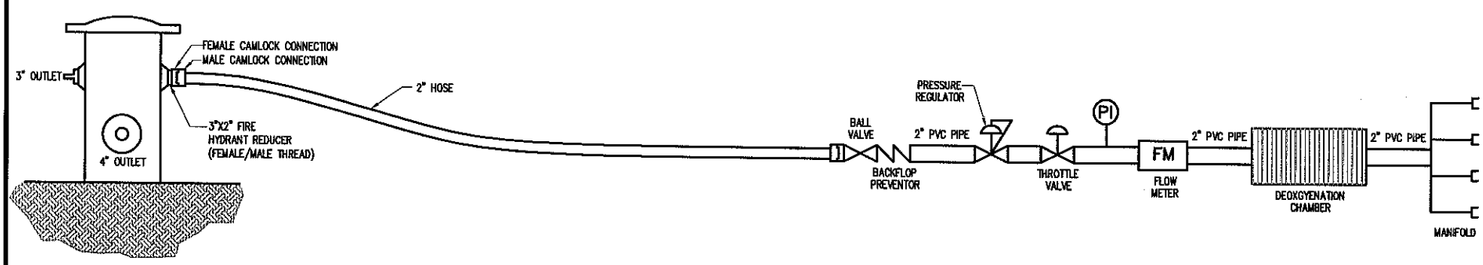
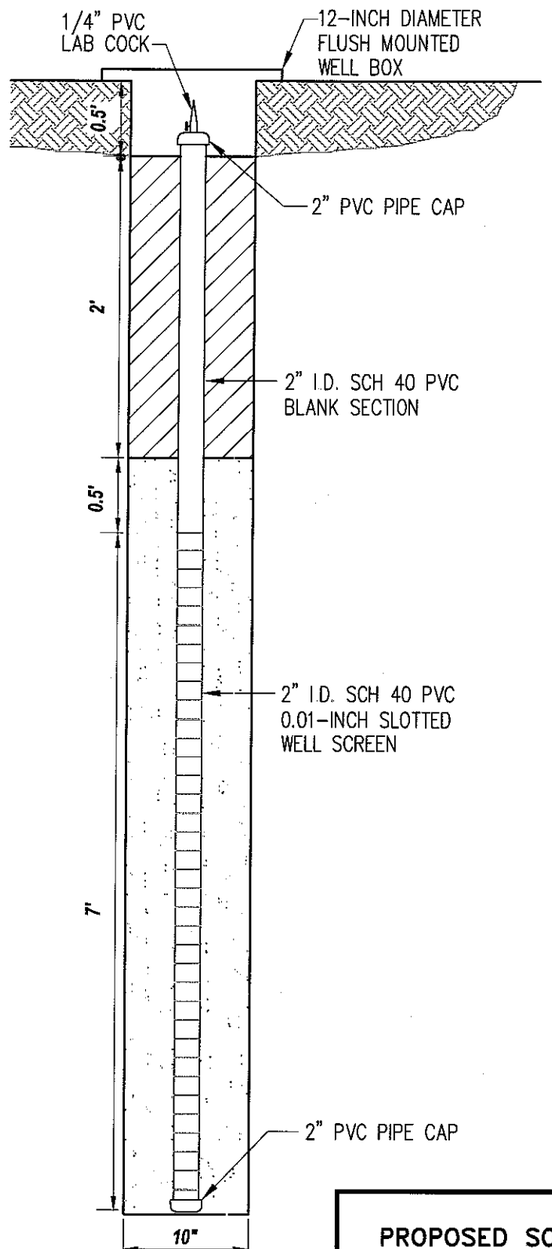


Figure 4-7
FIRE HYDRANT CONNECTION DETAIL

IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC.



ABBREVIATIONS

ID	INTERNAL DIAMETER
PVC	POLYVINYL CHLORIDE
'	FEET
"	INCHES

LEGEND

- #2/16 SAND BACKFILL
- MEDIUM BENTONITE CHIPS

NOTE:
ALL PIPE CONNECTIONS AND FITTINGS SHALL BE FLUSH THREADED. NO GLUE SHALL BE USED FOR ATTACHING FITTINGS OR PIPE SECTIONS TOGETHER

Figure 4-8
PROPOSED SOIL VAPOR MONITORING WELL CONSTRUCTION DETAIL

IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC

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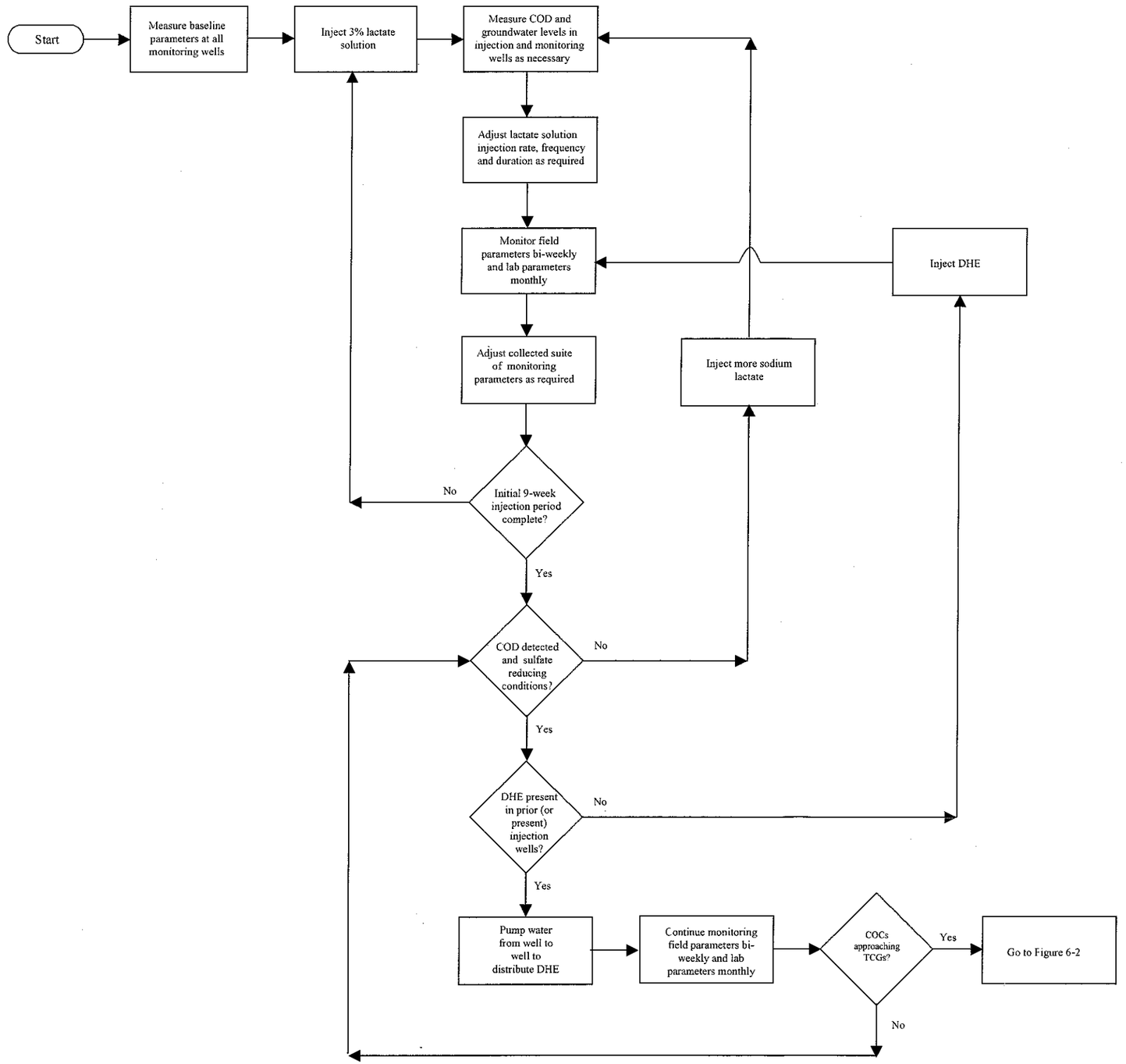

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REV: REVISION 0

DRAWN BY: MD

DATE: 02/11/05

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PLOT/UPDATE: FEB 03 2005 13:40:05

Figure 6-1
ENHANCED IN SITU BIOREMEDIATION AND PERFORMANCE MONITORING FLOW CHART
IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC.

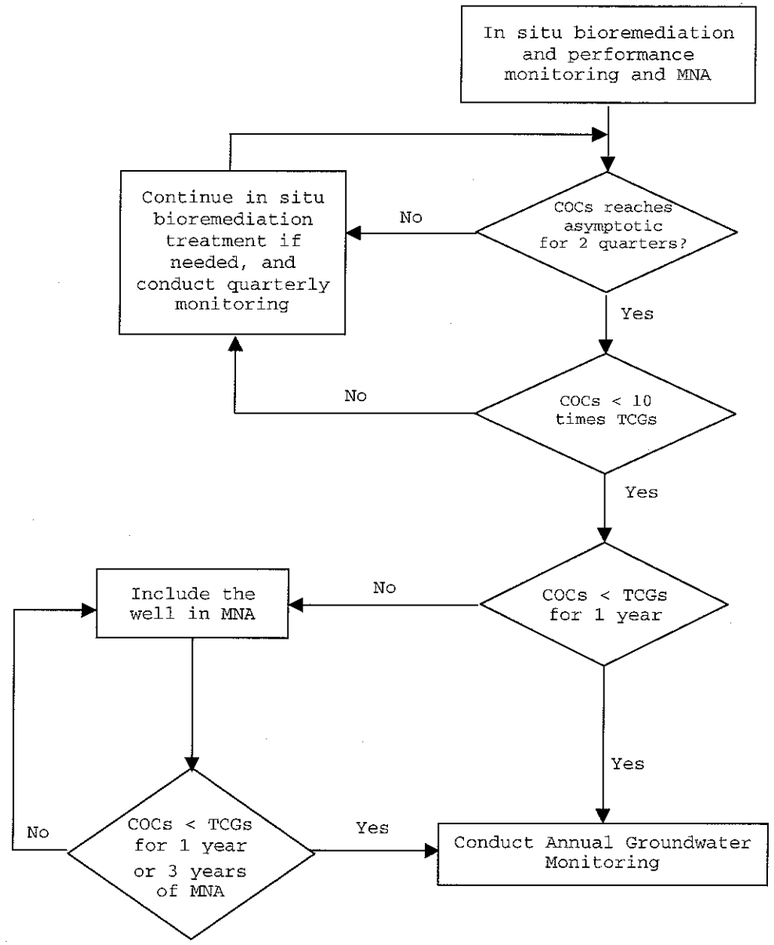

Figure 6-2
REMEDIAL ACTION AND MONITORING FLOW CHART

IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC

DRAWN BY: MD
DATE: 02/11/05
CHECKED BY: MT
REV: REVISION 0
APPROVED BY: MC
DCN: FWSD-RAC-05-0380
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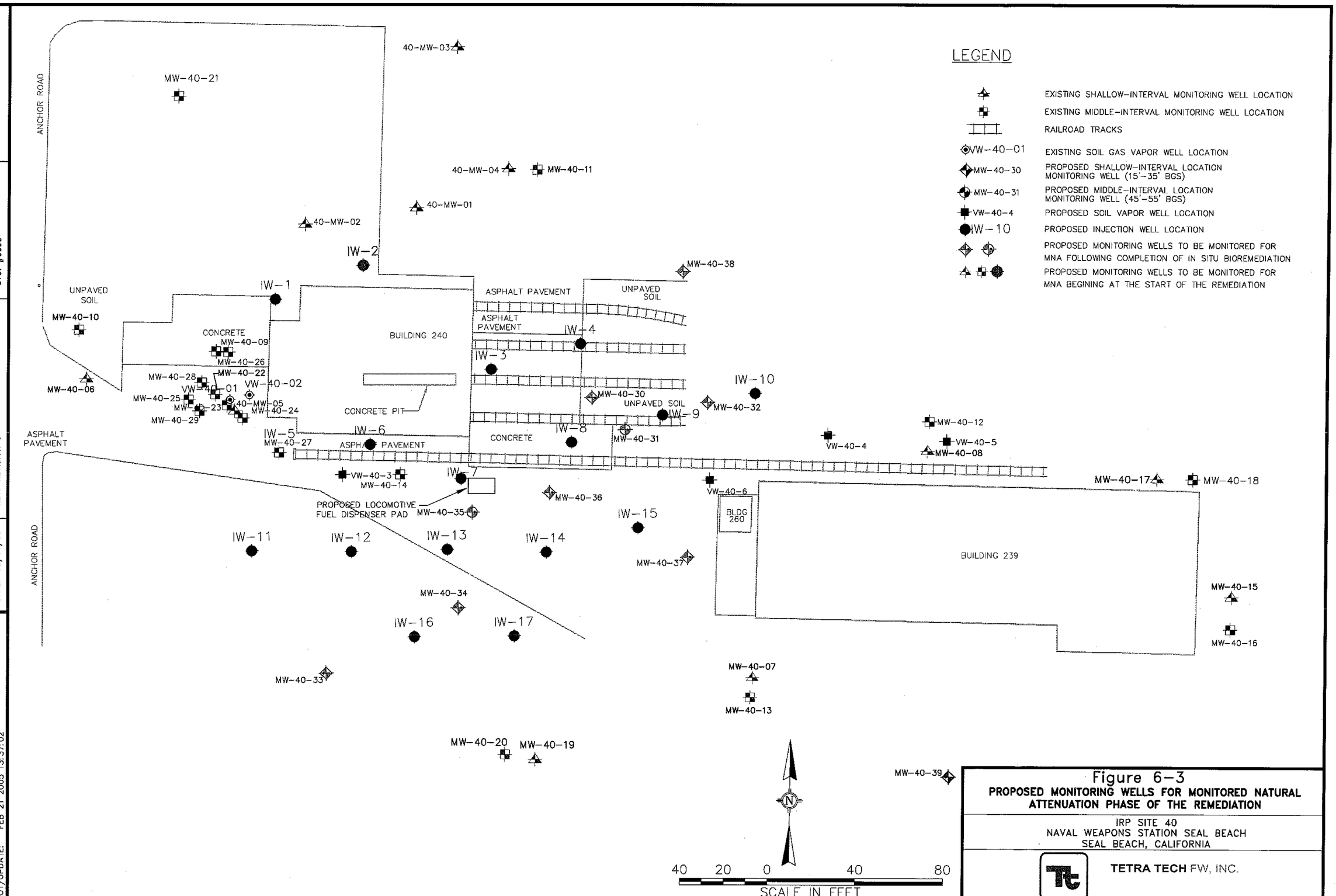

Figure 6-3
PROPOSED MONITORING WELLS FOR MONITORED NATURAL ATTENUATION PHASE OF THE REMEDIATION

IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC.

DRAWING NO: 05038063.DWG
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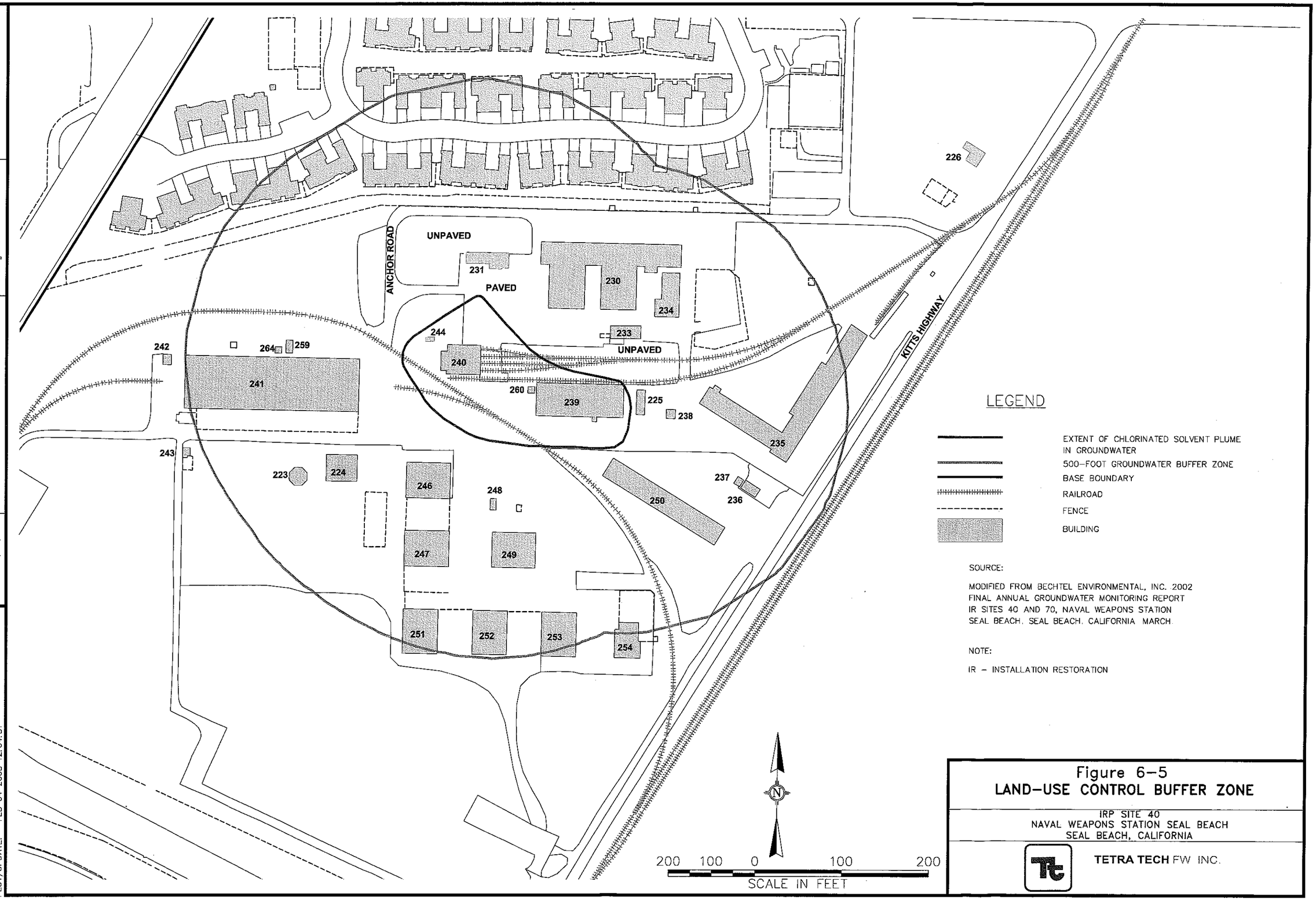

Figure 6-5
LAND-USE CONTROL BUFFER ZONE

IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW INC.

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DCN: FWSD-RAC-05-0380
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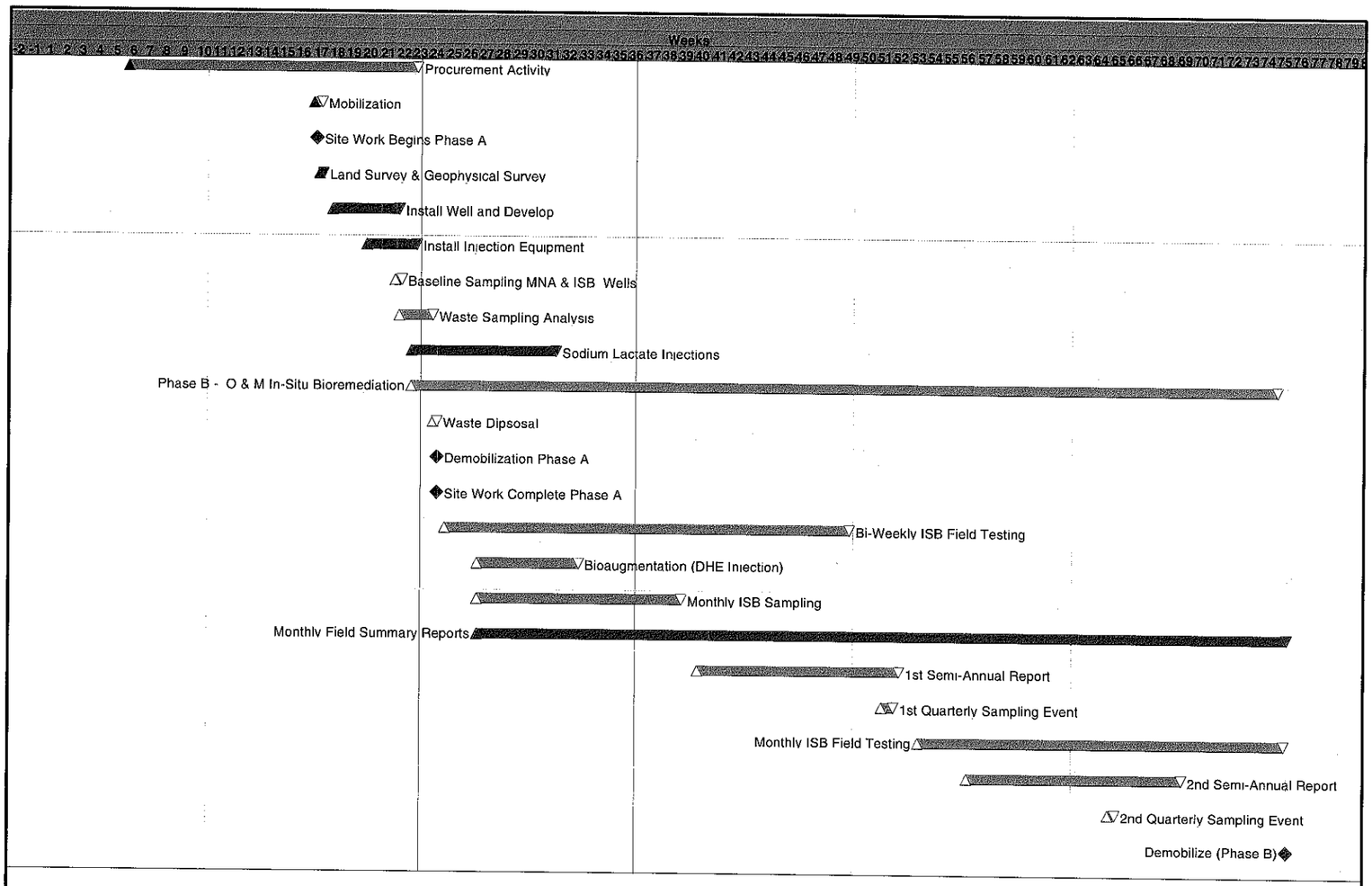

Early Bar
Progress Bar
Critical Activity

© Primavera Systems, Inc.

Figure 8-1
Proposed Project Schedule
In Situ Enhanced Bioremediation at IRP Site 40
Naval Weapons Station Seal Beach, California

Sheet 1 of 1

TETRA TECH FW, INC.

APPENDIX A

SAMPLING AND ANALYSIS PLAN

Southwest Division
Naval Facilities Engineering Command
Contracts Department
1220 Pacific Highway, Building 127, Room 112
San Diego, CA 92132-5190
CONTRACT NO. N68711-98-D-5713
CTO NO. 0090

APPENDIX A

FINAL

SAMPLING AND ANALYSIS PLAN

(Field Sampling Plan and Quality Assurance Project Plan)
Revision 0
February 24, 2005

ENHANCED IN SITU BIOREMEDIATION
INSTALLATION RESTORATION PROGRAM SITE 40
(CONCRETE PIT/GRAVEL AREA)
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

DCN: FWSD-RAC-05-0380

TETRA TECH FW, INC.
1230 Columbia Street, Suite 500
San Diego, CA 92101

Mark Cutler, R.G. 4487
Registered Geologist — Date: 2/22/05

REGISTERED GEOLOGIST
MARK CUTLER
No. 4487
STATE OF CALIFORNIA

Lisa Bienkowski
Program Chemist — Date: 2/22/05

Narciso A. Ancog
NFECSW Quality Assurance Officer — Date: 2/22/2005

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Figure A.3-2	Site Base Map and Well Locations
Figure A.7-1	Project Organization Chart

ABBREVIATIONS AND ACRONYMS

°C	degrees Celsius
%R	percent recovery
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
ASTM	American Society for Testing and Materials
BEI	Bechtel Environmental, Inc.
bgs	below ground surface
CCV	continuing calibration verification
COC	chain-of-custody
COD	chemical oxygen demand
CTO	Contract Task Order
DCE	dichloroethene
DHE	*Dehalococcoides ethenogenes*
DHS	Department of Health Services
DNA	deoxyribonucleic acid
DO	dissolved oxygen
DoD	Department of Defense
DON	Department of the Navy
DOT	Department of Transportation
DQO	data quality objective
DTSC	Department of Toxic Substances Control
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
EWI	Environmental Work Instruction
GC/FID	gas chromatograph/flame ionization detector
GC/MS	gas chromatograph/mass spectrometer
HCl	hydrochloric acid
HDPE	high-density polyethylene
HNO_3	nitric acid
IATA	International Air Transport Association

ABBREVIATIONS AND ACRONYMS
(Continued)

ICAL	initial calibration
ICP-AES	inductively coupled plasma-atomic emission spectrometer
IR	Installation Restoration
IRP	Installation Restoration Program
ISB	in situ bioremediation
L	liter
L/min	liters per minute
LCS	laboratory control sample
LTM	long-term monitoring
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mL	milliliter
mL/min	milliliters per minute
MNA	monitored natural attenuation
MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable
NA	not available
NAVWPNSTA	Navel Weapons Station
NE	none established
NFECSW	Southwest Division, Naval Facilities Engineering Command
NFESC	Naval Facilities Engineering Service Center
nM	nanomoles
ORP	oxidation/reduction potential
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCE	tetrachloroethene
PID	photoionization detector
pM	picomoles

ABBREVIATIONS AND ACRONYMS
(Continued)

ppbv	parts per billion by volume
ppmv	parts per million by volume
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
QED	QED Environmental Systems
Q-PCR	quantitative polymerase chain reaction
RAC	Remedial Action Contract
RL	reporting limit
ROICC	Resident Officer in Charge of Construction
RPD	relative percent difference
RPM	Remedial Project Manager
RWQCB	Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
Sch.	Schedule
SOP	standard operating procedure
STLC	Soluble Threshold Limit Concentration
SVOC	semivolatile organic compound
TBD	to be determined
TCE	trichloroethene
TCG	target cleanup goal
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solids
TO	Toxic Organics
TOC	total organic carbon
TtFW	Tetra Tech FW, Inc.
TTLC	Total Threshold Limit Concentration
VC	vinyl chloride
VOA	volatile organic analysis

ABBREVIATIONS AND ACRONYMS
(Continued)

VOC	volatile organic compound
WET	Waste Extraction Test

1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) has been prepared for the Department of the Navy (DON) by Tetra Tech FW, Inc. (TtFW) under Southwest Division, Naval Facilities Engineering Command (NFECSW) Remedial Action Contract (RAC) No. N68711-98-D-5713, Contract Task Order (CTO) No. 0090. The purpose of the SAP is to provide guidance on sampling, analysis, and quality assurance (QA) for groundwater monitoring for Installation Restoration Program (IRP) Site 40 at the Naval Weapons Station (NAVWPNSTA) Seal Beach, California. The DON has determined upon review of the site's operational history and site-specific groundwater investigative data that this site contains elevated concentrations of tetrachloroethene (PCE) and trichloroethene (TCE) in the groundwater, thus requiring a remedial action. The DON has initiated the remedial action for the impacted groundwater at IRP Site 40 to reduce any potential threats to human health and the surrounding environment. The planned remedial action is enhanced in situ bioremediation (ISB) and performance monitoring, monitored natural attenuation (MNA), and land use control. Enhanced ISB will consist of the injection of sodium lactate to stimulate the growth of indigenous microorganisms capable of biologically degrading chlorinated ethenes. Complete dechlorination will require the addition of microorganisms not found at the site followed by monitoring natural attenuation parameters. Throughout this process, groundwater monitoring will be performed at IRP Site 40 to monitor the enhanced ISB's effectiveness and natural attenuation.

The SAP will be used as a reference document by all field and laboratory personnel engaged in the sampling and analysis for this program. Included in this SAP are field sampling procedures, QA/quality control (QC) requirements, and data gathering methods that will be used during this project. Data quality objectives (DQOs) are also provided in this document. The QA elements of this SAP were prepared in accordance with the *EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5, QAMS* [U.S. Environmental Protection Agency (EPA), 2001] to ensure that all data collected are precise, accurate, representative, complete, and comparable to meet their intended use.

1.1 OBJECTIVES

The objectives of this SAP are to: 1) provide guidance for the field sampling activities at IRP Site 40; 2) describe and establish consistent field sampling procedures; 3) establish data gathering, handling, and documentation methods; and 4) define QA/QC measures to ensure consistency and confidence in the data obtained.

The primary objective is to collect groundwater and vapor samples to monitor progress of the enhanced ISB and the environmental impacts.

1.2 REGULATORY OVERSIGHT

The DON is the lead agency responsible for overseeing the progress of work at the base, with the state regulatory oversight provided by the California Department of Toxic Substances Control (DTSC) and the Regional Water Quality Control Board (RWQCB), Santa Ana Region

2.0 BACKGROUND

Site location and background are detailed in Section 2.0 of the Project Work Plan.

3.0 MAPS

The figures relevant to the site location are as follows:

- Figure A.3-1, Site Location Map
- Figure A.3-2, Site Base Map and Well Locations

4.0 SAMPLING STRATEGY

This section provides a brief description of the approach that will be used to collect samples at IRP Site 40.

4.1 GROUNDWATER SAMPLING

Groundwater at IRP Site 40 will be collected to assess the progress of the ISB process and its effectiveness. The overall monitoring approach is divided into three phases; ISB process, MNA phase, and long-term monitoring (LTM) phase. All groundwater sampling procedures will be performed as described in Section 6.1. The following will discuss the sampling approach to ISB process, MNA, and LTM.

4.1.1 IN SITU BIOREMEDIATION PROCESS

Ten proposed monitoring (MW-40-30 through MW-40-39) and 17 injection wells will be installed at IRP Site 40 for the enhanced ISB process. Table A.4-1 lists existing and proposed wells along with screen depth, and Figure A.3-2 shows the location of the wells (including existing monitoring wells). Dedicated QED Environmental Systems (QED) Well Wizard Model P1101S gas-operated bladder pumps or equivalent will be installed in the proposed monitoring wells as detailed in Section 5.5.5 of the Project Work Plan. The existing monitoring wells reportedly contain dedicated bladder pumps for sampling purposes. The injection wells will be sampled using portable bladder pumps or another low-flow sampling technique as dedicated bladder pumps are not feasible for an injection well. A suite of groundwater parameters will be analyzed throughout the enhanced ISB process using both field test methods and laboratory analyses. Table A.4-2 provides a list of these parameters and the recommended sampling frequency for each parameter. Groundwater sampling for this project will include the following:

- Prior to initiation of the enhanced ISB process, field test kits will be used to measure nitrate, sulfate, ferrous iron, carbon dioxide, alkalinity, and COD in the proposed and existing monitoring wells to establish baseline concentrations. A flow-through cell equipped with multiple monitoring probes will be used to collect pH, temperature, conductivity, oxidation/reduction potential (ORP), and dissolved oxygen (DO) readings. Groundwater samples will also be collected from proposed and existing monitoring wells to establish baseline concentrations. Table A.4-2 lists wells to be sampled. Baseline samples will be analyzed for chemical and biological parameters including volatile organic compounds (VOCs), dissolved gases, total dissolved solids (TDS), major anions and cations, alkalinity, chemical oxygen demand (COD), deoxyribonucleic acid (DNA), volatile fatty acids, phospholipid fatty acid, total organic carbon (TOC), and Title 22 metals.

- During the lactate injection period (approximately 9 weeks), groundwater will be collected from the proposed and existing monitoring wells for field testing of COD to assess migration of lactate. In addition, water levels will be collected during this time. COD and water levels will be collected at a frequency determined by the project scientist.

- Proposed monitoring wells (MW-40-14 and MW-40-30 through MW-40-38) and if necessary existing monitoring well 40-MW-02 will be selected for performance monitoring during the ISB phase. These wells will be located within the active treatment areas. Performance monitoring during the enhanced ISB active remediation will consist of field testing and laboratory analysis of groundwater, and groundwater level measurements.

  1. Field testing will be conducted biweekly during the active remediation period (approximately 6 months). Then field testing frequency may be reduced to monthly or modified as necessary after the first 6 months to eliminate analyses that are not providing useful information in a cost-effective manner. After the first year, field tests will be conducted on quarterly basis until the start of MNA. Table A.4-2 lists ISB field testing analysis and frequency. Field test kits will be used to measure nitrate, sulfate, ferrous iron, carbon dioxide, alkalinity, and COD. A flow-through cell equipped with multiple monitoring probes will be used to collect pH, temperature, conductivity, oxidation/reduction potential (ORP), and dissolved oxygen (DO) readings.

  2. During the ISB process, groundwater from the proposed wells will be submitted to an off-site laboratory for analysis. Groundwater will be sampled on a monthly basis for the first 3 months, then quarterly thereafter). The samples will be tested for VOC, dissolved gases, TDS, major anions and cations, alkalinity, COD, DNA testing, volatile fatty acids, phospholipid fatty acid, TOC, and Title 22 metals. Table A.4-2 lists ISB analysis and frequency for laboratory samples. If the proposed well(s) indicates that chemicals of concern have reached asymptotic levels for two consecutive quarters and if the chemicals of concern are less than 10 times their respective target cleanup goal (TCG), then the well(s) will be switched to monitoring for MNA as described in Section 4.1.2. Otherwise, the proposed wells will continue to be monitored on quarterly basis until the above criteria or the TCGs are met.

The TCGs for IRP Site 40 groundwater are based on federal Maximum Contaminant Levels (MCLs) for drinking water promulgated by EPA or California MCLs established by the Department of Health Services (DHS), whichever is lower for a given constituent (DON, 2004). Groundwater sampling frequency and measuring of field or analytical parameters may be altered during the course of the year based on review of the results to refine monitoring of the enhanced ISB process.

4.1.2 MONITORED NATURAL ATTENUATION

MNA will be implemented throughout the duration of ISB process using existing monitoring wells (MW-40-06, -07, -08, -10, -11, -13, -15, -17, -19, -20, -22, and -39) that were selected in order to confirm that natural attenuation processes are occurring and that the plume is stable and/or shrinking. In addition, proposed wells within the active treatment areas will be monitored for the MNA parameters when criteria described in Section 4.1.1 has been met.

During the MNA phase, field testing and groundwater sampling will be performed quarterly in the first year, then semiannually for maximum of 3 years. Field and analytical parameters are expected to include all or a portion of those used to assess the ISB process. Table A.4-2 provides a list of these parameters and the recommended sampling frequency.

4.1.3 LONG-TERM GROUNDWATER MONITORING

LTM will begin for the entire site when proposed and selected existing wells have reached TCGs for at least 1 year or have been monitored for MNA parameters for 3 years. Water levels and groundwater will be collected annually from wells MW-4-06, -07, -10, -13, -15, -16, -31, -32, -33, -34, -37, -39, IW-2, and IW-3. These are currently the proposed sampling wells for LTM, but may change after ISB and MNA laboratory data are reviewed. LTM will be conducted on an annual basis. During LTM, groundwater will be sampled and analyzed for VOCs only. LTM will continue until the remedial action objectives have been met and/or an agreement of "no further action" is reached for this site by all parties.

4.2 SOIL GAS SAMPLING

Four soil gas monitoring wells, ten vapor ports in the proposed groundwater monitoring wells, and 16 vapor ports in the injection wells will be installed to monitor dechlorination products (vinyl chloride and ethane) in the vapor phase (see Figure A.3-2). Soil gas will be monitored from the existing and proposed soil gas monitoring wells (VW-01 through VW-06) and the probes installed in the proposed injection and groundwater monitoring wells (IW-1, IW-3, IW-7, MW-40-31, and MW-40-34). Table A.4-2 lists soil gas monitoring frequency and analysis. Soil gas will be monitored as follows:

- Each time a well is opened, soil gas will be monitored for methane, oxygen, carbon dioxide, hydrogen sulfide, and total explosive gas using field instruments.
- Prior to initiation of the ISB process, soil gas samples will be collected and submitted to a laboratory for VOCs and fixed gases analysis to establish baseline concentration. In the first year, vapor samples will be collected on a monthly basis and analyzed for VOCs and fixed gases. After the first year, vapor samples will be collected quarterly for fixed gases analysis and semiannually for VOCs analysis.

All soil gas monitoring and sampling procedures will be performed as described in Section 6.2. Soil gas monitoring, sampling frequency, and measuring of field or analytical parameters may be altered during the course of the year based on review of the results to refine monitoring of the enhanced ISB process.

4.3 WASTE CHARACTERIZATION SAMPLING

Wastes generated during the enhanced ISB activities that will require sampling may include: 1) soil generated during drilling activities, 2) generated purged water, and 3) wastewater from decontamination. Wastes will be stored in appropriate containers.

Soil waste that is stored in containers on site will be sampled at a frequency determined in the field based on quantity and type of containers and analyzed for VOCs, semivolatile organic compounds (SVOCs), and Title 22 metals. The Soluble Threshold Limit Concentration (STLC) and Toxicity Characteristic Leaching Procedure (TCLP) will be added as applicable.

Wastewater generated during field activities will be stored on site in drums or tanks prior to sampling for disposal. One water sample per every third drum and one water sample per every tank will be collected. All wastewater samples will be analyzed, at a minimum, for VOCs, SVOCs, and Title 22 metals.

Additional analyses may be added based on disposal facility requirements. Waste characterization sampling procedures are detailed in Section 6.3.

5.0 REQUEST FOR ANALYSIS

This section describes the analytical methods, sample containers, and preservative requirements. Additionally, field QC samples to be collected for this project will be discussed in this section.

5.1 ANALYTICAL METHODS

The following EPA analytical methods [*Test Methods for Evaluating Solid Waste, Physical Chemical Methods, SW-846,* Third Edition and final updates (EPA, 1986); *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air,* Second Edition and final updates (EPA, 1999a); *Standard Practice for Analysis of Reformed Gas by Gas Chromatography* [American Society of Testing and Materials (ASTM), 2000)] will be used to analyze samples during this project:

Water Samples

The following laboratory analytical methods will be used for this project:

- VOCs by EPA Method 8260B
- Dissolved gases (methane, ethane, ethene, carbon dioxide) by RSK 175M
- Dissolved hydrogen sulfide by EPA Method 16-M
- Dissolved hydrogen by Microseeps Method AM20GAX
- TDS by EPA Method 160.1
- Major anions (sulfate, chloride, nitrate, nitrite) by EPA Method 300.0
- Major cations (calcium, iron, magnesium, potassium, sodium) by EPA Method 6010B
- Alkalinity by EPA Method 310.1
- COD by EPA Method 410.4
- DNA testing by Method quantitative polymerase chain reaction (Q-PCR)
- Volatile fatty acids by gas chromatograph/flame ionization detector (GC/FID)
- Phospholipid fatty acids by White et al., 1979
- TOC by EPA Method 9060
- Title 22 metals by EPA Method 6010B/7000
- SVOCs by EPA Method 8270C (for wastewater only)

Vapor Samples

- VOCs by Modified EPA Method Toxic Organics TO-15
- Fixed gases by ASTM D1946

Soil Waste Samples

- VOCs by EPA Method 8260B (EPA Method 5035/8260B for soil samples; if En Core™ samples for EPA Method 5035 are not able to be used due to the type of media, then EPA Method 5030B will be used)
- SVOCs by EPA Method 8270C
- Title 22 metals by EPA Method 6010B/7000
- STLC by California Waste Extraction Test (WET)
- TCLP by EPA Method 1311

Field test kits will be used for the following parameters:

- Nitrate
- Sulfate
- Ferrous iron
- Carbon dioxide
- Alkalinity
- COD

The following parameters will be collected using direct reading instruments in the field:

- pH, temperature, conductivity, ORP, and DO by flow-through cell
- Methane, oxygen, carbon dioxide, hydrogen sulfide, total explosive gas by multisensor gas meter

5.2 SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIMES

A list of the sample containers, preservatives, and holding time requirements for each analytical method is provided in Table A.5-1.

5.3 FIELD QUALITY CONTROL SAMPLES

Field QC samples will be collected and analyzed during the project to assess the consistency and performance of the sampling program. Field QC samples for this project may include field duplicates, equipment rinsates, source blanks, and trip blanks. Field QC samples are not applicable to the collection of waste characterization samples.

5.3.1 Field Duplicates

Field duplicates consist of two distinct samples (an original and a duplicate) of the same matrix collected at the same time and location to the extent possible and using the same sampling techniques. The purpose of field duplicates is to measure the consistency of field sampling. Field duplicates will be collected at a frequency of one for every ten samples taken and will be analyzed for the same analytes as the original sample. Field duplicates are uniquely identified so that the identity of the field duplicates is "blind" to the analytical laboratory. Exact locations of field duplicate samples and their identifications will be recorded in the field logbook.

5.3.2 Equipment Rinsate Samples

Equipment rinsate samples will be collected from sampling equipment that has been in direct contact with groundwater samples. Rinsate samples consist of organic-free, reagent-grade water collected from the final rinse of the equipment decontamination process. Rinsate samples will be collected directly from the sampling equipment, placed in appropriate pre-cleaned containers supplied by the analytical laboratory, and analyzed for the same analytes as the field samples under the same analytical conditions. Equipment rinsate samples, collected at a frequency of one per each day of sampling, will help determine the effectiveness of the decontamination procedure and potential for cross-contamination during sampling events.

5.3.3 Source Blank Samples

A source blank consists of analyte-free, reagent-grade water provided by the laboratory to be used for the collection of equipment rinsate samples as described in Section 5.3.2. In order to assure that the source blank is free of contamination, one of two courses of action will be followed before the source blank water is used. First, the laboratory will be asked to provide a certificate of analysis that the water provided for the equipment rinsate samples does not contain analytes above the project reporting limits (RLs) discussed in Section 8.2.2. If the laboratory cannot provide a certificate of analysis, then a sample of the laboratory water will be collected at the beginning of the project and analyzed for the same parameters as the equipment rinsate samples to verify that the results are not above the project RLs. Source blank samples will only be collected if equipment rinsate samples are to be collected for this project.

5.3.4 Trip Blanks

Trip blanks are hydrochloric acid-preserved, analyte-free, deionized water prepared by the laboratory in 40-milliliter (mL) volatile organic analysis (VOA) vials that will be carried to the field, stored with the samples, and returned to the laboratory for VOC analysis. Trip blanks will be used to determine if samples have been cross-contaminated with VOCs during sample transportation to the laboratory. One trip blank will be provided in each cooler, which contains samples for VOC analysis. Trip blanks will be prepared using the same type of containers, analyte-free, deionized water, and preservatives as the field samples.

6.0 FIELD METHODS AND SAMPLING PROCEDURES

The following sections provide the sampling procedures and sample handling protocols to be used for this project.

6.1 GROUNDWATER SAMPLING PROCEDURES

Low-flow purging and sampling procedures using dedicated bladder pumps will be used for this project for the proposed and existing groundwater monitoring wells. Portable bladder pumps or alternate low-flow techniques will be used for the injections wells, as dedicated bladder pumps are not feasible for injection wells.

The following steps summarize the procedures for measuring water level, purging wells, determining when water-quality parameters have stabilized, and collecting samples using the low-flow groundwater sampling technique.

1. Monitor the wellhead for organic vapors and explosive gases with a calibrated photoionization detector (PID) and an explosive gas meter. Record all readings on a groundwater sampling data sheet. The PID used will be calibrated daily according to manufacturers specifications using current (unexpired) standards. Calibration results will be documented on a field calibration form.
2. Sampling personnel will don a new pair of disposable nitrile gloves immediately before collecting depth-to-water measurements at each well.
3. Measure depth-to-water (to nearest 0.01 feet) relative to a known surveyed reference point.
4. Check and record the condition of the well box, well/piezometer, and well cap for any damage or evidence of tampering. Record all information on the groundwater sampling data sheet.
5. Connect the QED MicroPurge water-level meter to the water-level sounding tube on the well cap.
6. Connect pump controller to a compressed air source and to the air line fitting on the well cap.
7. Connect one end of discharge tube to the discharge line on the well cap and connect the other end to the inlet of QED MicroPurge flow-through cell. A 5-gallon bucket will be placed under the outlet of the flow-through cell to hold purged water.
8. Turn on the pump controller to start purging the well and adjust the flow rate to 100 to 500 milliliters per minute (mL/min). To determine the flow rate, measure the time to fill a know volume (graduated cylinder).
9. Confirm that drawdown on the water column is no more than 0.3 foot below initial depth to water through use of the drawdown meter or water-level indicator. The purge flow rate

will be reduced appropriately if the draw down at any time exceeds 0.3 feet below initial depth to water.

10. Use calibrated QED MicroPurge flow-through cell to monitor field parameters such as pH, temperature, conductivity, ORP, and DO. Record water level and field parameters every 3 to 5 minutes on the groundwater sampling data sheet.

11. When the pH is within 0.5 of the two previous measured values and measurements of temperature, conductivity, ORP, and DO have stabilized within 10 percent of the two previous measurements, purging will be considered adequate.

12. Discard gloves worn during purging activities and put on a new pair of nitrile gloves. Fill the appropriate sample bottles according to Table A.5-1 for the requested analyses from the discharge line on the well cap. Prior to filling VOA containers, maintain an approximate flow rate of 100 mL/min. Record the sampling rate on the groundwater sampling data sheet.

13. Fill VOA vials by initially tilting the vials, allowing the pump discharge to flow gently down the inside of the vial with minimal turbulence. Fill each vial until a positive meniscus is formed at the top of the VOA vial. After the vial is full, cap immediately, invert the vial, tap the side lightly, and check for the presence of air bubbles. If air bubbles are present, discard the sample, and resample using a new vial. When filling other containers, flow rate can be at 0.5 to 1 liter per minute (L/min).

14. Sample numbering, labeling, packaging, and documentation procedures will be followed as described in Section 6.5 through Section 6.8.

6.1.1 Field Test Kit Sampling Procedures

Collection of groundwater for COD measurements during the lactate injection period are considered instantaneous measurements. Therefore, groundwater sampling procedures described above are not applicable. Instead, groundwater will be collected by first purging 1 to 2 tubing volumes and then collecting a sample for the COD field test kit.

Biweekly groundwater samples for testing of field parameters will be collected as described above in Section 6.1. Field test kits and a flow-through cell will be used to collect field parameters.

6.2 SOIL GAS SAMPLING PROCEDURES

Soil gas will be monitored for methane, hydrogen sulfide, and total explosive gas using field instruments to establish baseline concentrations. The instruments will be used to collect direct reading measurements from the wells or vapor ports.

In addition, soil gas samples will be collected from wells or probes in Tedlar™ bags for VOC and fixed gas analyses using an oil-less vacuum/pressure pump. Approximately one well volume (air void volume in the screened interval) of gas will be purged from the well before sampling. A tracer compound (such as pentane, isopropanol, isobutene, propane, or butane) will be used as a

leak check compound during the soil gas sampling. The tracer will be placed near places where ambient air could enter the sampling system such as tubing connections. This tracer will be analyzed for along with the VOC and fixed gas analyses to determine if the sampling system is leaking. If the tracer is not detected after subsequent sampling events, then use of the tracer may be discontinued. Sample numbering, labeling, packaging, and documentation procedures will be followed as described in Section 6.5 through Section 6.8.

6.3 WASTE CHARACTERIZATION SAMPLING PROCEDURES

Soil and wastewater will be generated during field activities and will require proper disposal. Sampling of these materials will be performed as follows.

6.3.1 Waste Sampling Procedures

Waste samples will be collected as follows:

1. Sampling personnel will don a new pair of disposable nitrile gloves immediately before collecting samples.
2. The top of the drum or other approved container will be carefully opened.
3. A disposable scoop or similar device will be used to collect soil samples in a pre-cleaned glass jar. Samples for VOC analysis will be collected as described in Section 6.3.1.1.
4. Liquid samples will be collected using disposable bailers or similar device. Samples will be transferred from the bailers to pre-preserved, pre-cleaned sample containers using a bottom-emptying device. Samples for VOC analysis will be collected as described in Section 6.3.1.2.
5. Sample numbering, labeling, packaging, and documentation procedures will be followed as described in Section 6.5 through Section 6.8.

6.3.1.1 Waste Soil VOC Sampling Procedures

For VOC analysis, three En Core samplers will be collected as follows:

1. Holding the coring body, the plunger rod will be pushed down until the small o-ring rests against the tabs. This will ensure that the plunger will move easily.
2. The locking lever on the En Core T-handle will be depressed. The coring body, with the plunger end first, will be placed into the open end of the T-handle, aligning the slots of the coring body with the locking pins in the T-handle. The coring body will be twisted clockwise to lock the pins in the slots. The sampler will be checked to ensure that it is locked in place. The sampler will now be ready for use.

3. By holding the T-handle, the coring body will be pushed into the soil until the coring body is full. When full, the small o-ring will be centered in the T-handle viewing hole. The sampler will then be removed from the soil and any excess soil will be wiped from the coring body exterior.
4. The coring body will be capped while it is still on the T-handle. The cap should be pushed over the flat area of the ridge. To lock the cap in place, the cap will be pushed and twisted so that it seals the sampler.
5. The capped sampler will be removed by depressing the locking lever on the T-handle while twisting and pulling the sampler from the T-handle.
6. The En Core sampler will be placed in its aluminum sealed bag.
7. This procedure will be performed until three En Core samples are collected for each sample. All three En Core samples for VOCs may be placed in one aluminum bag for consolidation purposes.
8. Following completion of the sample label on the outside of the aluminum bag, the aluminum bag will be placed in a resealable bag, a custody seal will be placed over the resealable bag, that bag will be placed in another resealable bag, and then that bag will immediately be placed on ice.
9. If soil samples cannot be collected using the En Core samplers due to high percent moisture content, then the VOC analysis will be conducted from the glass jar.

6.3.1.2 Wastewater VOC Sampling Procedures

Water VOC samples will be collected as follows:

1. The water samples will be collected into 40-mL VOA vials carefully to minimize aeration.
2. The vial will be filled up to the lid until a positive meniscus is formed.
3. The vial will be capped immediately, but slowly.
4. The sample will be checked for the presence of air bubbles.
5. If an air bubble is present, the collected sample will be discarded and re-sampled using a new vial.
6. The previous steps will be repeated until an air bubble-free sample is collected.

6.4 DECONTAMINATION PROCEDURES

Decontamination of sampling equipment will be performed to prevent the introduction of extraneous material into samples and to prevent cross-contamination between samples. All sampling equipment will be decontaminated by steam cleaning or by washing with a nonphosphate detergent such as Liquinox® or equivalent. Decontamination water will be collected in approved Department of Transportation (DOT) containers.

The following steps will be followed for general decontamination of non-disposable sampling equipment:

1. **Wash with nonphosphate detergent and water solution** — This step will reduce the amount of cross-contamination from the equipment. Use of a bucket, approximately 75 percent full of solution, is suggested for this step. This detergent solution will be prepared by diluting nonphosphate detergent in potable water as directed by the manufacturer.
2. **Rinse with potable water** — This step will rinse all the detergent solution away from equipment. Use of a bucket, approximately 75 percent full of potable water, is suggested for this step. Periodic changing of this water is required.
3. **Rinse with deionized water** — This step will rinse the equipment of detergent solution and potable water residues. Use of a bucket or stainless steel Hudson-type sprayer or Nalgene™ squeeze bottle while holding equipment over a bucket is suggested for this step.
4. **Rinse with deionized water** — This step will be a final rinse of the equipment. Use of a bucket or stainless steel Hudson-type sprayer or Nalgene™ squeeze bottle while holding equipment over a bucket is suggested for this step.

If equipment rinsate samples are to be collected, laboratory reagent-grade water will be used as an additional rinse after Step 4. Water that is falling off the sampling equipment as is it being rinsed with the reagent-grade water will be collected in appropriate sample bottles and analyzed for the same parameters as the field samples.

6.5 SAMPLE NUMBER

Each sample will be identified by a 5-digit number (XX-YYY) as follows:

XX-: 2-character designation of the project number and CTO number (for example, 90)

YYY: 3-character designation of the consecutive sample number (for example, 004)

For example, in the sample identification number 90-004, "90" represents the CTO number, and "004" represents the fourth sample collected for the project.

The sample number will be recorded in the field logbook, on the labels, and chain-of-custody (COC) record at the time of sample collection. A complete description of the sample and sampling conditions will be recorded in the field logbook and referenced using the unique sample identification number.

6.6 SAMPLE LABELING

Sample labels are necessary to prevent misidentification of samples. Sample labels will be filled out in indelible black or blue ink and affixed to sample containers at the time of sample

collection. Each sample label will be covered with clear tape. Each sample container will be labeled with the following, at a minimum:

- Sample identification number
- Sample collection date (month/day/year)
- Time of collection (24-hour clock)
- Sampler's initials
- Analyses required
- Preservative (if any)

6.7 SAMPLE PACKAGING AND SHIPMENT

Sample packaging and shipment procedures for this project will be in accordance with DOT/International Air Transport Association (IATA) procedures as applicable for packaging.

6.7.1 Packaging and Shipment Procedures for Soil and Water Samples

Immediately after sample labeling, custody seals will be affixed to each sample container. For VOA vials and En Core samples, the custody seal will be placed on the outside of the first resealable bag; then the containers will be placed in a second resealable bag. This will prevent any contact with the adhesive from the custody seal and the samples. Other sample containers will be placed in double-resealable plastic bags to protect the samples from moisture and to prevent breakage and potential cross-contamination during transportation to the laboratory. All glass sample containers will be protected with bubble wrap first, then placed in resealable bags if transported by a commercial carrier. VOA vials should be wrapped with bubble wrap, then placed in a resealable bag, a custody seal placed over the bag, and then placed in another resealable bag.

Each cooler will be shipped with a temperature blank. A temperature blank is a container filled with tap water and stored in the cooler during sample collection and transportation. The temperature of the cooler will be recorded by the laboratory on the COC record immediately upon receipt of the samples.

Sample cooler drain spouts will be taped from the inside and outside of the cooler to prevent any leakage.

Samples transported by a laboratory-assigned courier will be packed in a sample cooler with sufficient ice to keep the samples cooled. Two custody seals will be taped across the cooler lid: one seal in the front and one seal in the back. The COC record will be completed and signed by the courier. The cooler(s) and the top two copies (white and pink) of the COC record will then be released to the courier for transportation to the laboratory.

Samples to be shipped by commercial carrier will be packed in a sample cooler lined with a plastic bag. Double-bagged ice will be added inside the plastic bag at the bottom of the cooler, one layer of sample containers will be placed on the ice, and more double-bagged ice will be placed on top of the containers. This will be repeated until the cooler is filled with ice as the top layer in the cooler. The COC record will include the airbill number, and the "Received By" box will be labeled with the commercial courier's name. The top two copies of the COC record will be sealed in a double-resealable bag and then taped to the inside of the sample cooler lid. The cooler will be taped shut with strapping tape. Two custody seals will be taped across the cooler lid: one seal in the front and one seal in the back. Clear tape will be applied to the custody seals to prevent accidental breakage during shipment. The pouch for the airbill will be placed on the cooler and secured with clear tape. The airbill will be completed for priority overnight delivery and placed in the pouch. If multiple coolers are being shipped, then the original airbill will be placed on the cooler with the COC record, and copies of the airbill will be placed on the other coolers. The number of packages should be included on each airbill (1 of 2, 2 of 2). Saturday deliveries should be coordinated with the laboratory in advance, and field sampling personnel or their designee must ensure that Saturday delivery stickers are placed on each cooler by the commercial courier. "Dangerous goods" declarations will also be completed as applicable.

6.7.2 Packaging and Shipment Procedures for Vapor Samples

After finish collecting vapor samples, Tedlar bags may be placed into cardboard box or empty cooler. The top two copies of the COC record will be placed inside cardboard box. The box will be taped shut with shipping tape. One custody seal will be taped across the top and bottom flaps. Clear tape will be applied to the custody seals. If shipping by commercial carrier, the airbill will be completed for priority overnight delivery.

6.8 FIELD DOCUMENTATION

In order to maintain the integrity and traceability of samples, all information pertinent to field sampling will be recorded in a field logbook. All samples will be properly labeled and custody-sealed prior to being transported to the laboratory and will be accompanied by completed COC documentation. All documentation will be recorded in a field logbook in indelible black or blue ink.

6.8.1 Chain-of-custody

To establish the documentation necessary to trace sample possession from the time of collection through analysis and disposal, a COC record will be completely filled out and will accompany every sample. Samples will be delivered to the laboratory for analysis as soon as practicable.

At a minimum, the following items will be recorded on the COC record:

- Project name

- Project location/Site ID
- Project number (1990 090D)
- Purchase order number
- Sample ID
- Sampler name
- Sampler signature
- Project contact
- Airbill number (if applicable)
- Date (of sample collection)
- Time (of sample collection to the nearest minute, 24-hour clock)
- Sample type (matrix)
- Turnaround time
- Sample location codes
- Sample depth in feet (start, end)
- QC type:

  REG: regular sample
  FD: field duplicate
  ER: equipment rinsate
  SMQC: source blank
  TB: trip blank
- Composite description (if applicable)
- Laboratory name
- Number of sample containers
- Laboratory ID
- Analyses required
- Comments
  - Matrix spike/matrix spike duplicate (MS/MSD) samples
  - Observations specific to sample
- Transfer signature (to relinquish samples)
  - The sampler will be the first person to relinquish sample possession
- Courier/laboratory representative signature (for commercial carrier, record airbill number here)
- Date/time (of custody transfer)

- Laboratory instructions
- Data package requirement (Level III or IV)

6.8.2 Custody Seals

Sample custody seals are used to detect unauthorized tampering of samples from the time of sample collection to the time of analysis.

The seals will be signed or initialed and dated by the sampler. The seals will be placed on the sample containers (except for Tedlar bags) and shipping containers in such a way that they must be broken in order to open the containers. Seals will be affixed to containers before the samples leave the custody of the sampling personnel.

6.8.3 Field Logbooks

A permanently bound field logbook with consecutively numbered pages, used for sampling activities only, will be assigned to this project. All entries will be recorded in indelible black or blue ink. At the end of each workday, the logbook pages will be signed by the responsible sampler, and any unused portions of the logbook pages will be crossed out, signed, and dated.

If it is necessary to transfer the logbook to another person, the person relinquishing the logbook will sign and date the last page used, and the person receiving the logbook will sign and date the next page to be used.

At a minimum, the logbook will contain the following information:

- Project name and site location
- Date and time
- Personnel in attendance
- General weather information
- Work performed
- Field observations
- Sampling performed, including specifics such as location, type of sample, type of analyses, and sample identification
- Field analyses performed, including results, instrument checks, problems, and calibration records for field instruments
- Descriptions of deviations from this SAP
- Problems encountered and corrective action taken
- Identification of field QC samples

- QC activities
- Verbal or written instructions
- Any other events that may affect the samples

6.8.4 Document Corrections

Changes or corrections on any project documentation will be made by crossing out the erroneous item with a single line and initialing (by the person performing the correction) and dating the correction. The original item, although erroneous, must remain legible beneath the cross-out line. The new information should be written clearly above the crossed-out item.

7.0 PROJECT ORGANIZATION

This section identifies the key individuals from the DON and TtFW who are responsible for the oversight and/or implementation of the proposed field activities. The project organization chart is shown in Figure A.7-1. The responsibilities of the team members associated with the sampling activities are presented in Table A.7-1.

7.1 POINTS OF CONTACT

The following is a list of the key contacts for the project:

Agency	Contact	Title
NFECSW 1220 Pacific Highway San Diego, CA 92132	Si T. Le (619) 532-1235	DON Remedial Project Manager (RPM)
Naval Weapon Station Seal Beach 800 Seal Beach Boulevard Building 110 Seal Beach, CA 90740	Pei-Fen Tamashiro (562) 626-7897	NAVWPNSTA Installation Restoration (IR) Program Coordinator
ROICC Los Angeles Naval Weapons Station Seal Beach Building 230 Seal Beach, CA 90740	David Crawley (562) 626-7964	Resident Officer in Charge of Construction (ROICC)
NFECSW 1220 Pacific Highway San Diego, CA 92132	Chris Leadon (619) 532-3878	Remedial Technical Manager
NFECSW 1220 Pacific Highway San Diego, CA 92132	Ann Garrett (619) 532-4261	Contracting Officer
NFECSW 1220 Pacific Highway San Diego, CA 92132	Narciso Ancog (619) 532-2540	Quality Assurance Officer
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Hamlet Hamparsumian (949) 756-7520	Project Manager
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Mark Losi (949) 756-7516	Project Scientist
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Mary Schneider (949) 756-7586	Quality Control Program Manager
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Lisa Bienkowski (949) 756-7592	Program Chemist

8.0 QUALITY ASSURANCE OBJECTIVES

The overall QA objectives of this SAP are to outline procedures for the collection and assessment of data that are within acceptable ranges of precision, accuracy, representativeness, completeness, and comparability (PARCC) to meet the project DQOs. The DQOs associated with environmental data are a function of the sampling plan rationale and the procedures used to collect the samples, as well as the analytical methods and instrumentation used. However, uncertainty cannot be eliminated entirely from environmental data.

8.1 DATA QUALITY OBJECTIVES

The DQO process is a seven-step planning approach based on scientific methods that are designed to ensure that the type, quantity, and quality of environmental data used for decision making are appropriate for the intended application. The DQO process, as defined by the EPA, consists of the following seven steps that are designed to provide a systematic approach to resolving issues that pertain to this remediation project (EPA, 2000):

- Stating the Problem
- Identifying the Decisions
- Identifying Inputs to the Decisions
- Defining the Boundaries
- Developing a Decision Rule
- Specifying Limits on the Decision Error
- Optimizing Sampling Design

The DQOs are presented in Table A.8-1.

8.2 ANALYTICAL DATA QUALITY OBJECTIVES

Analytical data will be obtained using published, standard methods in a state of California DHS-certified and Naval Facilities Engineering Service Center (NFESC)-evaluated laboratory. Some of the analytical methods listed in Section 5.1 are specialty testing (DNA testing, volatile fatty acids, and so forth) and do not require DHS-certification or NFESC evaluation. Analytical DQOs will be assessed through measures of PARCC parameters. The analytical methods used, project-required RLs, and project QC criteria are also detailed in this document. The analytical methods listed in this document are for laboratories to analyze by such method or similar methods established by the laboratory.

8.2.1 Quality Control Criteria

QC criteria definitions are as follows:

- **Precision**—A measure of the reproducibility of a set of replicate results or the agreement among repeat observations made under the same conditions. Analytical precision is the measurement of the variability associated with duplicate or replicate analyses. For this project, a laboratory control sample (LCS) will be used to determine the precision of the analytical method. Total precision is the measurement of the variability associated with the entire sampling and analysis process. It is determined by analysis of duplicate field samples and measures variability introduced by both the laboratory and field operations. Field duplicate, laboratory duplicate, and MSD samples will be used to assess field and analytical precision, and the precision measurement will be determined using the relative percent difference (RPD) between the duplicate sample results. The formula for calculating the RPD is as follows:

  RPD = 100 x 2 x (result - duplicate result)/(result + duplicate result)

- **Accuracy**—The nearness of a result or the mean of a set of results to the true or accepted value. Analytical accuracy is measured by comparing the percent recovery of analytes spiked into a LCS against a control limit. Surrogate compound recoveries are also used to assess accuracy and method performance for each sample analyzed. The formula for calculating accuracy uses the following equation to determine percent recovery (%R) of specific analytes.

  %R = 100 x (spiked sample result - unspiked sample result)/amount of spike added

- **Representativeness**—The degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter mostly concerned with the proper design of the sampling program.

- **Completeness**—The percentage of measurements made that are judged to be valid measurements. The completeness goal is to generate a sufficient amount of valid data to meet project needs. Completeness is calculated and reported for each method, matrix, and analyte combination. The number of valid results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set. For completeness requirements, valid results are all results not qualified with a rejected ("R") flag. The requirement of completeness is 95 percent for aqueous samples and 90 percent for soil samples and is determined using the following equation:

  % completeness = 100 x (number of valid analyte results/number of possible results)

- **Comparability**—A qualitative parameter expressing the confidence with which one data set can be compared with another. Sample data should be comparable with other measurements for similar samples and sample conditions. The objective for the QA/QC program is to produce data with the greatest possible degree of comparability. The number of matrices that are sampled and the range of field conditions encountered are considered in determining comparability. Comparability is

achieved by using standard methods for sampling and analysis, reporting data in standard units, normalizing results to standard conditions, and using standard and comprehensive reporting formats.

8.2.2 Project Reporting Limits

The RLs established for this project are presented in Table A.8-2.

8.2.3 Project Quality Control Limits

The precision and accuracy QC limits for each method are presented in Table A.8-3.

9.0 ANALYTICAL QUALITY CONTROL PROCEDURES

This section describes laboratory qualification, sample custody and documentation, QC procedures, QC samples, preventative maintenance, data review, and deliverables for the collection of samples for chemical analysis.

9.1 LABORATORY QUALIFICATION

The analytical laboratories selected to analyze samples for this project will be certified by the California DHS for all of the analytical methods required for the project. In addition, the laboratory must successfully complete the NFESC Laboratory Evaluation Program prior to sampling activities and maintain current status throughout the duration of the project. Some of the analytical methods listed in Section 5.1 are specialty testing (DNA testing, volatile fatty acids, and so forth) and do not require DHS-certification or NFESC evaluation.

The laboratory selected for the project must be capable of providing the required turnaround times, project QC, and data deliverables required by this SAP.

9.2 LABORATORY SAMPLE CUSTODY AND DOCUMENTATION

The integrity and traceability of samples from the time they are collected through the time data are reported are essential in any sampling and analysis program. The handling of the samples and transferring of custody must be well-documented given the evidentiary nature of the analytical data. A sample is considered to be in one's custody if it meets any of the following criteria:

1. In actual possession or in view of the person who collected the sample
2. Locked in a secure area
3. Placed in an area restricted to authorized personnel

The samples will be delivered to the person in the laboratory authorized to receive samples (referred to as the sample custodian). Upon receipt of a sample, the sample custodian will inspect the condition of the sample (including the temperature of the cooler) and the custody seal, reconcile the information on the sample label against that on the COC record, assign a unique laboratory tracking number, log the sample in the laboratory logbook, and store the sample in a secured sample storage room.

The TtFW Project Chemist will be informed immediately of any inconsistencies between the COC record and the sample containers received. Any deviations from accepted sample handling procedures will be documented, and the TtFW Project Chemist will be informed

9.2.1 Corrections to Custody Documentation

Changes or corrections on any project documentation will be made by crossing out the erroneous item with a single line initialing (by the person performing the correction) and dating the correction. The original item, although erroneous, must remain legible beneath the cross-out line. The new information will be written above the crossed-out item. Corrections must be written clearly and legibly with indelible black or blue ink.

9.3 LABORATORY QUALITY CONTROL PROCEDURES

The analytical laboratory must have written standard operating procedures (SOPs) defining the instrumentation, instrumentation maintenance, tuning, calibration, method detection and RLs, QC requirements, blank requirements, and step-by-step procedures for each analytical method. The SOPs must be available to the analysts performing the work. The SOPs must meet or exceed the requirements of the analytical methods cited in this SAP and in the *Quality Systems Manual for Environmental Laboratories* [Department of Defense (DoD), 2000]. The laboratory must maintain logs of all activities that have an impact on the quality of the laboratory results.

Any portion of the method that is subcontracted by the laboratory to another laboratory or sent to another facility of the same network of laboratories must have the prior approval of the TtFW Project Chemist.

The laboratory must maintain the instruments in working condition required by the methods specified for the analyses. Sufficient redundancy in equipment must be available in the laboratory to handle downtime situations.

Method substitution because of instrumental failure will not be permitted without approval from the TtFW Project Chemist.

9.4 LABORATORY QUALITY CONTROL SAMPLES

The following subsections describe in detail the laboratory QC samples required by this project.

9.4.1 Calibration

All instruments and equipment must be calibrated in accordance with the specified methods, unless different instructions are included in this document. Each instrument must be calibrated with the standard solutions appropriate to the type of instrument and the calibration range established for the method.

Initial calibrations (ICALs) are performed when the method is first used and again whenever the continuing calibrations fail to meet their respective acceptance criteria. In addition, if the instrument undergoes significant maintenance, the ICAL must be repeated.

Continuing calibrations verify that the instrument performance has remained within the limits set at the time of the ICAL. The frequency of continuing calibrations is specified in referenced methods.

9.4.2 Instrument/Calibration Blanks

Instrument blanks are run to ensure that analytes from previous runs are out of the system and do not contaminate succeeding runs. Instrument blanks must be run following calibration runs, before sample analyses are performed, and after samples containing high concentrations of potentially interfering materials are found.

Target analytes must not appear in the instrument blanks at concentrations greater than half the required RLs. If the laboratory consistently observes contaminants in the instrument blanks, the laboratory must investigate the source of the contamination and eliminate it, if possible.

9.4.3 Method Blanks

Method blanks are prepared in the same manner as the samples, using the same reagents and glassware used for samples. The purpose of the method blank is to ensure that the equipment and reagents used in preparing the samples are free of contaminants that could interfere with the analysis. The method blank must be prepared and analyzed for each batch of 20 project samples or less per matrix (aqueous and solid) type.

The method blank must not exhibit analytes at concentrations greater than half the required RLs. If contaminants are found that either contribute to the apparent concentration of a particular target analyte or interfere with the analysis, the analysis must be stopped, the source of contamination identified and corrected, and the analysis repeated. Contamination in the method blank above half the RLs will require that the entire associated batch of extracts or digestates be reprepared and reanalyzed. Hence, it is very important to make sure that no such contamination is present.

9.4.4 Laboratory Control Samples

LCSs are purchased samples containing known concentrations of specific target analytes. LCSs can also be prepared by spiking known amounts of target analytes into a well-characterized blank matrix. The matrix will be organic-free, laboratory reagent-grade water for water samples and clean sand or equivalent for soil samples.

The LCS is prepared and run at a frequency of one per 20 project samples per matrix with the associated samples, using the same reagents and volumes. If insufficient quantity of sample is available for the MS/MSD, the LCS will be prepared and analyzed in duplicates. All analytes in

the LCS must meet recovery criteria. If the criteria are not met, the entire batch of samples must be reprepared, together with a new LCS, and reanalyzed.

9.4.5 Matrix Spike and Matrix Spike Duplicate

The MS/MSD serves to determine whether matrix effects are affecting recoveries. For inorganic analysis, only a single MS may be performed per batch. A MS/MSD is prepared by spiking a known amount of solution to two portions of a sample being run in a batch. Once the spike is added to the MS/MSD samples, these samples are carried through the complete sample preparation process along with the other samples in the batch. The MS/MSD recoveries are compared against each other and against the known amount of the spike. From this data, both accuracy and precision can be determined The laboratory will perform a MS/MSD at a frequency of one per 20 project samples per matrix. To prepare a project-specific MS/MSD, field personnel will collect additional sample volumes as necessary at a frequency of one per 20 samples. Field personnel will designate samples for MS/MSD analysis on the COC record.

9.4.6 Duplicates

Two types of duplicates, field and laboratory, will be performed. Field duplicates are two samples that are duplicates of each other. The purpose of field duplicates is to measure the consistency of field sampling. However, due to the heterogeneous nature of soils, results will be used to determine sampling variability rather than sampling precision. The field duplicate is treated the same as the other field samples, and identification is withheld from the laboratory.

The laboratory duplicate is created by the laboratory, where two aliquots are intentionally taken from the same sample and analyzed in parallel. This analysis serves to measure the precision of laboratory operations. Duplicate analyses will be applied only for inorganic analyses.

9.5 PREVENTIVE MAINTENANCE

All instruments must be maintained in accordance with the manufacturers' recommended procedures. The laboratory must define in its QA plan the frequency and type of maintenance for each instrument. The laboratory must also record all maintenance activities in an instrument logbook.

In addition to preventive maintenance, the laboratory must keep a sufficient supply of replacement parts on hand for those parts known to require frequent changes due to wear and tear or contamination.

Whenever preventive or corrective maintenance is applied to an instrument, the laboratory must demonstrate the instrument's return to operating conditions and must recalibrate the instrument prior to resumption of sample analyses.

9.6 DATA REVIEW

All data reported by the laboratory must be reviewed in accordance with the SOPs and as described in the following subsections.

9.6.1 Analyst Review

Each analyst that generates a data set is responsible for ensuring that 100 percent of the data comply with the method- and project-specific requirements and that any deviations or failure to meet criteria are documented for the project file.

9.6.2 Peer Review

One hundred percent of all data sets must be reviewed by an independent peer analyst. Peer reviews must be performed by an analyst that is qualified to perform the subject analytical method. The peer review must be comprehensive and include the following:

- Check 100 percent of manual entries for transcription errors
- Check 100 percent of manual calculations for accuracy
- Spot-check computer calculations to verify program validity
- Check for compliance with method- and project-specific QC requirements
- Check for completeness of raw data or supporting materials
- Confirm spectral assignments
- Check descriptions of deviations from method or project requirements
- Check for appropriate use of significant figures and rounding
- Check reported values for dilutions
- Evaluate reasonableness of results

9.6.3 Technical Review

Technical reviews by the responsible supervisor or designated alternate must be performed on 100 percent of reported data. The same individual may not perform peer and technical reviews on the same data set. The technical review must include the following:

- Check for compliance with method- and project-specific requirements
- Check the completeness of the reported information
- Check the information in the report narrative
- Evaluate the reasonableness of the results

If the responsible supervisor is the only qualified peer reviewer for a method, the requirement for the technical review is waived.

9.6.4 Management Review

One hundred percent of all data must receive management approval prior to release. The scope and content of management's review is at the laboratory's discretion. Authority to release data may be delegated to a technical supervisor or other party, if the term of the delegated authority is documented in the QA program file.

9.6.5 Quality Assurance Review

QA reviews of data from each section of the laboratory must be conducted on a routine basis. Annually, at least 10 percent of data reports generated using each analytical method must be reviewed by a member of the QA staff. The QA reviews must include the following:

- Check for compliance with required QC practices
- Check for compliance with approved SOPs
- Check for compliance with method and project requirements

QA data reviews may be conducted after the subject data have been reported to TtFW.

9.7 DELIVERABLES

The following sections describe the deliverable documents that will be submitted to TtFW by the analytical laboratory.

9.7.1 Hard-copy Deliverables

Two copies of the hard-copy data will be submitted to TtFW by the laboratory. The report pages will be sequentially numbered. The report will contain a table of contents referencing individual sections in the data package, original white copy of COC records, a copy of all corrective action reports, and a narrative documenting the resolution of all corrective actions and nonconformances. All TtFW samples will be cross-referenced to the associated QC samples. When revisions to data reports are required, the revised pages will be stamped with the notation "amended or revised report."

To allow third-party validation, two types of data packages will be required. They will be referred to as EPA Level III-equivalent or IV-equivalent packages. For this project, TtFW will request that 90 percent of the data be submitted in an EPA Level III-equivalent data package and 10 percent submitted in an EPA Level IV-equivalent data package. (For waste characterization samples, 100 percent of the data will be submitted in an EPA Level III-equivalent data package.) All data packages will be assembled in the following sequence:

- Cover page (with laboratory service identification number, TtFW project name, and TtFW project number)

- Original COC records (including cooler temperature and sample condition)
- Sample receipt forms
- Cross-reference table
- Case narrative
- Organic raw data sequence (by test):
  - Sample result forms, including method blanks
  - Sample raw data after each result form (EPA Level IV only)
  - Surrogate summaries (surrogate results may appear on the sample result forms)
  - QC summaries
  - Tune data [gas chromatograph/mass spectrometer (GC/MS) only]
  - ICAL
  - Daily calibration checks, including related continuing calibration verifications (CCVs)
  - Resolution check standards (GC/MS and pesticides) (if applicable)
  - QC (LCS, MS/MSD) raw data (EPA Level IV only)
  - Instrument run log
  - Sample preparation log
- Inorganic raw data sequence:
  - Sample results forms, including method blanks
  - Sample raw data (EPA Level IV only)
  - QC summaries
  - ICAL
  - Daily calibration checks, including all related CCVs
  - Calibration blanks, including all related continuing calibration blanks
  - Interference check standards A and B for inductively coupled plasma-atomic emission spectrometer (ICP-AES) only
  - QC raw data (EPA Level IV only)
  - Post-digestion spike results
  - Analytical spike results
  - Method of standard additions
  - ICP-AES serial dilutions
  - Instrument run log
  - Sample preparation log

9.7.2 Electronic Deliverables

The electronic data deliverable (EDD) will be in ASCII format. This will be compatible with the Navy Environmental Data Transfer Standard. The laboratory will verify that the EDD and the hard-copy reports are identical. Both the EDD and the hard-copy report will present results to two or three significant figures. For organic results, two significant figures will be used for all results. For inorganic results, two significant figures will be used for results less than 10, and three significant figures will be used for results greater than 10. Results for QC analyses (method blanks, MS/MSD, LCS, and duplicates) will be reported up to three significant figures. The EDD for each sample delivery group is due at the same time as the hard-copy report, 21 calendar days after the last sample of the sample delivery group has been delivered to the laboratory.

10.0 DATA QUALITY MANAGEMENT

10.1 DATA MANAGEMENT

The following sections describe the requirements for the management of hard-copy data and electronic data for samples collected for chemical analysis.

10.1.1 Hard-copy Report

All relevant raw data and documentation, including, but not limited to, logbooks, data sheets, electronic files, and final reports, will be maintained by the laboratory for at least 7 years. TtFW will be notified 30 days before disposal of any relevant laboratory records.

TtFW will maintain copies of all COC records. Laboratory reports will be logged in upon receipt and filed in chronological order. The second copy of the report will be sent for third-party data validation.

10.1.2 Electronic Data

Field information (date and time collected, sample identification, and so forth) will be entered directly into the main database from the COC records or uploaded from electronic files generated in the field.

Upon receipt by the TtFW Data Manager, electronic data will be uploaded into a Microsoft Access database. The uploaded data will be processed to compare the fields against a list of required values. If any errors are returned by the program, the file will be manually edited or regenerated by the laboratory. The laboratory database will be merged with the field database, and reports will be generated from the merged database.

10.2 DATA VALIDATION

All chemical sample data will be validated by an independent data validation company except for waste characterization samples. Data will be validated at 90 percent EPA Level III and 10 percent EPA Level IV. The validation will be in accordance with the Contract Laboratory Program *National Functional Guidelines for Organic Data Review, EPA 540/R-99/008* (EPA, 1999b), Contract Laboratory Program *National Functional Guidelines for Inorganic Data Review, EPA 540/R-94/013* (EPA, 2004), *Environmental Work Instruction (EWI) #1, 3EN2.1, Chemical Data Validation* (NFECSW, 2001a), and the QC criteria specified in the referenced methods and in this SAP. Data not meeting method and/or SAP specifications will be flagged as estimated ("J") or rejected ("R").

The data validation company will have the following qualifications:

1. A minimum of 5 years of experience in the environmental data validation business
2. Prior experience on DON RAC or Comprehensive Long-term Environmental Action projects
3. DON data validation experience
4. Active peer review program

Personnel must have the following qualifications:

1. Data Reviewer:
   - Bachelor of science degree or higher in chemistry or a physical science
   - Five years of combined experience with approximately 2 years in data validation and 3 years conducting laboratory analysis in an environmental laboratory using the EPA-approved methods being validated
2. Peer Reviewer:
   - Bachelor of science degree or higher in chemistry or a physical science
   - Five years of combined experience with approximately 2 years in data validation and 3 years conducting laboratory analysis in an environmental laboratory using the EPA-approved methods being validated

10.3 DATA EVALUATION

Following third-party validation, data will be further evaluated by the TtFW Project Chemist. During this process, the Project Chemist will determine which of the advisory data qualifiers provided by the independent data validator will be retained or removed. The evaluation of data will be based on method requirements and the results of the QC samples, the level of contamination of samples indicated by the method blanks analysis, and the overall indication of interference due to contamination. The following data qualifiers will be used in the report:

J - Result is estimated
U - Analyte is not detected at or above the stated RL
R - Data are rejected
UJ- Analyte is not detected, but there is an uncertainty about the RL

Data qualifying will be used to alert end users to uncertainties associated with the data. The evaluation flags will be entered into a special field in the electronic database. Thus, when data processing is complete, the data for each analyte will have the flag designated by the laboratory and the flag designated by the evaluator, as appropriate.

11.0 QUALITY ASSURANCE OVERSIGHT

QA oversight for this project will include system audits of field activities and of the laboratory subcontracted by the DON to perform the analysis.

11.1 FIELD AUDITS

The TtFW and NFECSW QA Officers may schedule audits of field activities at any time to evaluate the execution of sample collection, identification, and control in the field. The audit will also include observations of COC procedures, field documentation, instrument calibrations, and field measurements.

Field documents and COC records will be reviewed to ensure that all entries are printed or written in indelible black or blue ink, dated, and signed.

Sampling operations will be reviewed and compared to this SAP and other applicable SOPs. The auditor will verify that the proper sample containers are used, the preservatives are added or are already present in the container, and the documentation of the sampling operation is adequate.

Field measurements will be reviewed by random spot-checking to determine that the instrument is within calibration, the calibration is done at the appropriate frequency, and that the sensitivity range of the instrument is appropriate for the project.

11.1.1 Corrective Action

Nonconformance identified during the field audit will be recorded on a Nonconformance Report. All nonconformance and corrective actions will be processed in accordance with TtFW Procedure QC-3. This procedure is presented in Attachment 5 of the *Final Contractor Quality Control Program Plan* (TtFW, 2004).

The TtFW QC Program Manager will monitor corrective action documentation, verify implementation of the corrective action, track and analyze the corrective action, and closeout corrective action documentation upon completion of the corrective action.

11.2 LABORATORY AUDITS

Laboratories selected to perform the analyses are required to have successful completion of the NFESC laboratory evaluation process throughout the project. Some of the analytical methods listed in Section 5.1 are specialty testing (DNA testing, volatile fatty acids, and so forth) and do not require NFESC evaluation. This process consists of a laboratory QA plan review, performance evaluation samples, a data package review, and an on-site audit. Because of this requirement, TtFW will not perform an on-site audit or visit, unless it is deemed necessary.

Laboratory oversight by TtFW will include a thorough review of the preliminary report and hard-copy data packages. The information that may be obtained from the data packages consists of the following:

- Correctness of COC procedures
- Adherence to method holding times
- Project RLs
- Spiking levels, frequency, and recovery
- Accuracy of analytical methods through the LCSs and surrogates

11.2.1 Corrective Action

The laboratory will have a QA/QC and corrective action program that addresses all out-of-control situations. Following completion of analyses, laboratory personnel will verify compliance with the minimum QC requirements of the project and the laboratory QA/QC plan. If any of the parameters fall outside the control limits, corrective action will be implemented.

Initial corrective action is to verify that no obvious calculation errors have occurred. If appropriate, reanalysis will be performed. If the reanalysis confirms the initial out-of-control limits result, the chemist will notify the laboratory supervisor, who will initiate the corrective action process. Corrective actions may include, but are not limited to, the following:

- Verification of dilution factors
- Examination of sample for nonhomogeneity
- Verification of sample preparation
- Checking of standard preparation logbook
- Verification of instrument performance
- Checking of reagent-grade water purity
- Monitoring chemist's method performance for procedure verification

Notification and prompt involvement of the TtFW Project Chemist in the corrective action process are absolutely necessary in determining an appropriate resolution. Corrective action records will document all steps taken in the corrective action process, beginning with a description of the problem and ending with a final resolution. A copy of the corrective action report will be sent to the TtFW Project Chemist immediately and will be maintained in the project files at TtFW.

All corrective action reports will be maintained by the laboratory in a project file and delivered to TtFW as part of the hard-copy deliverable.

12.0 SAP REVISION OR AMENDMENT

When circumstances arise that impact the original project DQOs, such as a significant change in work scope, this SAP will be revised or amended. The modification process will be based on EPA guidelines, direction from the DON and QA Officer, and will be in conjunction with *Environmental Work Instruction (EWI) #2, 3EN2.2, Review, Approval, Revision, and Amendment of Sampling and Analysis Plans (SAPs)* (NFECSW, 2001b).

13.0 REFERENCES

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TABLES

TABLE A.4-1

EXISTING AND PROPOSED MONITORING WELL AND INJECTION WELL LIST

Well ID	Construction Date	Casing Diameter (inches)	Casing Material	Slot Size (inches)	Borehole Diameter (inches)	Top of Casing (feet bgs)	Top of Filter Pack (feet bgs)	Screen Interval (top) (feet bgs)	Screen Interval (bottom)	Well Depth (feet bgs)
EXISTING WELLS										
VW-40-01	3/19/2003	2	Sch. 40 PVC	0.01	8	0.3	2	2.5	7.5	8
VW-40-02	3/19/2003	2	Sch. 40 PVC	0.01	8	0.3	2	2.5	7.5	8
40-MW-01	12/22/1992	2	Sch. 40 PVC	0.01	8	NA	4.0	6.5	16.5	20.0
40-MW-02	12/21/1992	2	Sch. 40 PVC	0.01	8	NA	4.0	6.0	16.0	20.0
40-MW-03	12/21/1992	2	Sch. 40 PVC	0.01	8	0.3	4.0	6.5	16.5	19.0
40-MW-04	12/22/1992	2	Sch. 40 PVC	0.01	NA	0.4	4.0	6.0	16.0	18.0
40-MW-05	10/30/1995	2	Sch. 40 PVC	0.01	10	0.5	6.0	9.5	25.0	26.0
MW-40-06	8/26/1997	4	Sch. 40 PVC	0.01	10	0.4	16.3	20.3	30.3	34.0
MW-40-07	9/15/1997	4	Sch. 40 PVC	0.01	12	0.5	15.0	20.0	30.0	34.0
MW-40-08	9/12/1997	4	Sch. 40 PVC	0.01	12	0.4	13.5	20.0	30.0	34.0
MW-40-09	8/27/1997	4	Stainless Steel	0.01	12	0.3	40.0	45.0	55.0	57.0
MW-40-10	8/28/1997	4	Sch. 40 PVC	0.01	10	0.7	40.0	45.0	55.0	59.0
MW-40-11	9/5/1997	4	Stainless Steel	0.01	12	0.4	40.0	45.0	55.0	57.0
MW-40-12	9/11/1997	4	Sch. 40 PVC	0.01	12	0.6	40.0	45.0	55.0	59.0
MW-40-13	9/15/1997	4	Sch. 40 PVC	0.01	12	0.4	40.0	45.0	55.0	58.0
MW-40-14	9/8/1997	4	Sch. 40 PVC	0.01	12	0.2	25.0	30.0	40.0	59.0
MW-40-15	9/16/1997	4	Sch. 40 PVC	0.01	12	0.4	17.0	20.0	30.0	33.5
MW-40-16	9/16/1997	4	Sch. 40 PVC	0.01	12	0.3	34.0	42.3	52.3	57.5
MW-40-17	4/11/2000	4	Sch. 40 PVC	0.01	10	0.2	17.0	20.0	30.0	32.0
MW-40-18	4/12/2000	4	Sch. 40 PVC	0.01	10	0.0	47.0	50.0	60.0	62.0
MW-40-19	4/12/2000	4	Sch. 40 PVC	0.01	10	-1.5	197.0	19.8	29.8	32.0
MW-40-20	4/13/2000	4	Sch. 40 PVC	0.01	10	-1.8	47.0	49.7	59.7	62.0
MW-40-21	4/11/2000	4	Sch. 40 PVC	0.01	10	-1.8	47.0	50.5	60.5	62.0
MW-40-22	7/6/2001	4	Sch. 40 PVC	0.01	11	0.4	12	15.3	35.5	35.7
MW-40-23	7/9/2001	4	Sch. 40 PVC	0.01	11	0.4	10.5	15.1	35.1	35.5
MW-40-24	7/9/2001	4	Sch. 40 PVC	0.01	11	0.2	12.9	15.1	35.1	35.5

TABLE A.4-1

EXISTING AND PROPOSED MONITORING WELL AND INJECTION WELL LIST

Well ID	Construction Date	Casing Diameter (inches)	Casing Material	Slot Size (inches)	Borehole Diameter (inches)	Top of Casing (feet bgs)	Top of Filter Pack (feet bgs)	Screen Interval (top) (feet bgs)	Screen Interval (bottom)	Well Depth (feet bgs)
MW-40-25	7/9/2001	4	Sch. 40 PVC	0.01	11	0.6	13	15.3	35.3	35.7
MW-40-26	7/6/2001	4	Sch. 40 PVC	0.01	11	0.2	12.5	15.2	35.2	35.6
MW-40-27	7/9/2001	4	Sch. 40 PVC	0.01	11	0.5	12.6	15.1	35.1	35.5
MW-40-28	7/9/2001	4	Sch. 40 PVC	0.01	11	0.6	11	15.0	35.0	35.4
MW-40-29	3/19/2003	4	Sch. 40 PVC	0.01	10	0.7	13	15.0	35.0	35.5
PROPOSED WELLS										
IW-1	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-2	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-3	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-4	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-5 Existing Monitoring Well MW-40-27	7/9/2001	4	Sch. 40 PVC	0.01	11	0.5	12.6	15.1	35.1	35.5
IW-6	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-7	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-8	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-9	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-10	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-11	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-12	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-13	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-14	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-15	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-16	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
IW-17	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
MW-40-30	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
MW-40-31	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	35.0	55.0	55.0
MW-40-32	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0

TABLE A.4-1

EXISTING AND PROPOSED MONITORING WELL AND INJECTION WELL LIST

Well ID	Construction Date	Casing Diameter (inches)	Casing Material	Slot Size (inches)	Borehole Diameter (inches)	Top of Casing (feet bgs)	Top of Filter Pack (feet bgs)	Screen Interval (top) (feet bgs)	Screen Interval (bottom)	Well Depth (feet bgs)
MW-40-33	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
MW-40-34	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
MW-40-35	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	35.0	55.0	55.0
MW-40-36	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
MW-40-37	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
MW-40-38	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	15.0	35.0	35.0
MW-40-39	TBD	4	Sch. 40 PVC	0.01	12	TBD	TBD	20.0	30.0	30.0
VW-40-3	TBD	2	Sch. 40 PVC	0.01	10	TBD	TBD	2.0	9.0	10.0
VW-40-4	TBD	2	Sch. 40 PVC	0.01	10	TBD	TBD	2.0	9.0	10.0
VW-40-5	TBD	2	Sch. 40 PVC	0.01	10	TBD	TBD	2.0	9.0	10.0
VW-40-6	TBD	2	Sch. 40 PVC	0.01	10	TBD	TBD	2.0	9.0	10.0

Notes:

bgs – below ground surface

NA – not available

PVC – polyvinyl chloride

Sch. – schedule

TBD - to be determined

TABLE A.4-2

ANALYTICAL TESTING PARAMETERS AND FREQUENCY

Analyte	Frequency	Proposed Sampling Well
BASELINE		
Field nitrate, sulfate, ferrous iron, carbon dioxide, alkalinity, COD, pH, temperature, conductivity, ORP, DO and water level	Once	MW-40-30 through MW-40-39, 40-MW-01, -02, MW-40-06, -07, -08, -10, -11, -13, -14, -15, -17, -19, -20, and -22
Laboratory • VOCs • Dissolved gases (methane, ethane, ethene, carbon dioxide, hydrogen sulfide, hydrogen) • TDS • Major anions (sulfate, chloride, nitrate, nitrite) • Major cations (Ca, Fe, Mg, Mn, K, Na) • Alkalinity • COD • DNA testing • Volatile fatty acids • Phospholipid fatty acid • TOC • Title 22 Metals	Once	MW-40-30 through MW-40-39, 40-MW-02, MW-40-06, -07, -08, -10, -11, -13, -14, -15, -17, -19, -20, and -22
Lactate Injection Period		
Field[a] COD and water level	Frequency determined by project scientist	MW-40-30 through MW-40-39, 40-MW-02, MW-40-06, -07, -08, -10, -11, -13, -14, -15, -17, -19, -20, and -22
ISB Process[b]		
Field[a] nitrate, sulfate, ferrous iron, carbon dioxide, alkalinity, COD, pH, temperature, conductivity, ORP, DO and water level	Biweekly – first 6 months Monthly – after 6 months Quarterly – after first year	40-MW-02, MW-40-14 and MW-40-30 through MW-40-38[c]

TABLE A.4-2

ANALYTICAL TESTING PARAMETERS AND FREQUENCY

Analyte	Frequency	Proposed Sampling Well
Laboratory[a] • VOCs • Dissolved gases (methane, ethane, ethene, carbon dioxide, hydrogen sulfide, hydrogen) • TDS • Major anions (sulfate, chloride, nitrate, nitrite) • Major cations (Ca, Fe, Mg, Mn, K, Na) • Alkalinity • COD • DNA testing • Volatile fatty acids • Phospholipid fatty acid • TOC • Title 22 Metals	Monthly – First 3 months Quarterly – After 3 months	40-MW-02, MW-40-14 and MW-40-30 through MW-40-38[c]
MNA[b]		
Field[a] pH, temperature, conductivity, ORP, DO and water level	Quarterly – for the first year Semiannually after first year for maximum of 3 years	MW-40-06*, -07*, -08*, -10**, -11**, -13**, -15*, -17*, -19*, -20**, –22*, and –39*.
Laboratory[a] • VOCs • Dissolved gases (methane, ethane, ethene, carbon dioxide, hydrogen sulfide, hydrogen) • TDS • Major anions (sulfate, chloride, nitrate, nitrite) • Major cations (Ca, Fe, Mg, Mn, K, Na) • Alkalinity • COD • DNA testing • Volatile fatty acids • Phospholipid fatty acid • TOC • Title 22 Metals	Quarterly – for the first year Semiannually after first year for maximum of 3 years	MW-40-06*, -07*, -08*, -10**, -11**, -13**, -15*, -17*, -19*, -20**, –22*, and –39*.

TABLE A.4-2

ANALYTICAL TESTING PARAMETERS AND FREQUENCY

Analyte	Frequency	Proposed Sampling Well
	LTM[b]	
Field pH, temperature, conductivity, ORP, DO and water level	Annually for 5 years	MW-40-06 *, -7 *, -10 **, -13 **, -15 *, -16 **, -31 **, -32 *, -33 *, -34 *, -37 *, -38 *, -39 *, IW-2 *, and IW-3 *.
Laboratory VOCs	Annually for 5 years	MW-40-06 *, -7 *, -10 **, -13 **, -15 *, -16 **, -31 **, -32 *, -33 *, -34 *, -37 *, -38 *, -39 *, IW-2 *, and IW-3 *.
	Soil Vapor Monitoring[b]	
Field Methane, oxygen, carbon dioxide, hydrogen sulfide, and toxic explosive gas	Each time the wells are opened	VW-1 through VW-6, IW-1, IW-3, IW-7, MW-40-31, and MW-40-34.
Laboratory VOCs	Once – Baseline Monthly – first year Semiannually – after first year	VW-1 through VW-6, IW-1, IW-3, IW-7, MW-40-31, and MW-40-34.
Laboratory Fixed gases (methane, ethane, ethane)	Once – Baseline Monthly – first year Quarterly – after first year	VW-1 through VW-6, IW-1, IW-3, IW-7, MW-40-31, and MW-40-34.

Notes:

a – Some of the analysis listed may be reduced in frequency or eliminated if deemed appropriate by the lead scientist.

b – These are currently the proposed sampling wells, but may change based on evaluation of field and laboratory data.

c – Sampling may follow MNA analytes and frequency when chemical of concern reach asymptotic levels for 2 consecutive quarters and if the chemicals of concern are less than 10 times their respective target cleanup goal (TCG). Otherwise, the proposed wells will continue to be monitored on quarterly basis until the above criteria or the TCGs are met.

* Shallow Interval Wells (screened from about 15 – 35 feet bgs).

** Middle-Interval Wells (screened from about 45 – 60 feet bgs).

bgs – below ground surface
Ca – calcium
COD – chemical oxygen demand
DNA – deoxyribonucleic acid
DO – dissolved oxygen
Fe – iron
ISB – in situ bioremediation
K – potassium
LTM - long term monitoring
Mg – magnesium
Mn – manganese
MNA – Monitor Natural Attenuation
Na – sodium
ORP – oxidation/reduction potential
TDS – total dissolved solids
TOC – total organic carbon
VOC – volatile organic compound

TABLE A.5-1

SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIME REQUIREMENTS

Analyte	Analytical Method	Container	Preservative	Holding Time
WATER SAMPLES				
VOCs	EPA Method 8260B	Three 40-mL VOA vials	pH ≤ 2 w/ HCl Cool, 4±2°C	14 days
Dissolved Gases	RSK 175M	Three 40-mL VOA vials	Cool, 4±2°C	48 hours
Dissolved Hydrogen Sulfide	EPA Method 16-M	Three 40-mL VOA vials	Cool, 4±2°C	None
Dissolved Hydrogen	Microseeps Method AM20GAX	One 20-mL air-tight vial	None	30 days
Total Dissolved Solids	EPA 160.1	One 250-mL HDPE	Cool, 4±2°C	7 days
Anions	EPA Method 300.0	One 1-L HDPE	Cool, 4±2°C	48 hours
Cations	EPA Method 6010B	One 500-mL HDPE	pH ≤ 2 w/ HNO_3	6 months
Alkalinity	EPA Method 310.1	One 250-mL HDPE	Cool, 4±2°C	48 hours
Chemical Oxygen Demand	EPA Method 410	One 125-mL HDPE	pH ≤ 2 w/ H_2SO_4 Cool, 4±2°C	28 days
DNA	Q-PCR	One 1-L HDPE	Cool, 4±2°C	24 hours
Volatile Fatty Acids	GC/FID	Three 40-mL VOA vials	Cool, 4±2°C	24 hours
Phospholipid Fatty Acids	White 1979	One 1-L HDPE	Cool, 4±2°C	24 hours
Total Organic Carbon	EPA Method 9060	One 250-mL HDPE	pH ≤ 2 w/ H_2SO_4 Cool, 4±2°C	28 days
SVOCs	EPA Method 8270C	Two 1-L amber	None	7 days to extract; 40 days to analyze
Title 22 metals	EPA Method 6010B/7000	One 500-mL HDPE	pH ≤ 2 w/ HNO_3	6 months, except for mercury which is 28 days

TABLE A.5-1

SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIME REQUIREMENTS

Analyte	Analytical Method	Container	Preservative	Holding Time
VAPOR SAMPLE				
VOCs	Modified EPA Method TO-15	1 to 3-L Tedlar™ bag	None	72 hours
Fixed Gases	ASTM D1946	1 to 3-L Tedlar™ bag	None	72 hours
SOIL SAMPLES (WASTE CHARACTERIZATION)				
VOCs	EPA Method 5035/8260B[1]	Three En Core™ samples	Cool, 4±2°C	48 hours for analysis or laboratory preservation for En Core samples; analysis within 14 days of preservation
SVOCs	EPA Method 8270C	One 8-ounce glass jar	Cool, 4±2°C	14 days to extract; 40 days to analyze
Title 22 Metals	EPA Method 6010B/7000	One 8-ounce glass jar	Cool, 4±2°C	6 months, except for mercury which is 28 days

Notes:

[1] If solid samples cannot be collected with the En Core™ samples, then EPA Method 5035 will be replaced with EPA Method 5030B, and the liner or jars will be used for volatile analysis.

°C – degrees Celsius
ASTM – American Society for Testing Materials
DNA – deoxyribonucleic acid
EPA – U.S. Environmental Protection Agency
GC/FID – gas chromatograph/flame ionization detector
HCl – hydrochloric acid
HDPE – high-density polyethylene
HNO_3 – nitric acid
L – liter
mL – milliliter
Q-PCR – quantitative polymerase chain reaction
SVOC – semivolatile organic compound
VOA – volatile organic analysis
VOC – volatile organic compound

TABLE A.7-1

PERSONNEL AND RESPONSIBILITIES

Key Position	Responsibility
NFECSW Quality Assurance Officer	• Provides governmental oversight of the TtFW QA Program • Provides quality-related directives through Contracting Officer Representative • Provides technical and administrative oversight of TtFW surveillance audit activities • Acts as point of contact for all matters concerning QA and the DON's Laboratory QA Program • Prepares governmental budget estimates for all QA functions included in TtFW contracts • Coordinates training on matters pertaining to generation and maintenance of quality of data • Authorizes the suspension of project execution if QA requirements are not adequately followed
Project Chemist	• Develops Sampling and Analysis Plan • Evaluates and selects qualified subcontract laboratories • Implements chemical data QC procedures and performs auditing of field performance • Reviews laboratory data prior to use • Coordinates data validation of laboratory data • Reviews data validation reports • Prepares and supports report preparation
RPM	• Performs project management from client perspective • Fulfills scope of work • Oversees cost and schedule • Acts as lead interface with agencies

TABLE A.7-1

PERSONNEL AND RESPONSIBILITIES

Key Position	Responsibility
Project Manager	• Executes all phases of a specific project and efficiently applies the full resources of the TtFW RAC Team • Manages all technical, quality, financial, and administrative aspects of the project • Identifies and completes documents appropriate to work assignments • Approves and maintains qualification records for all project personnel • Ensures and verifies that the project team completes all work tasks and QA/QC requirements of planning documents • Logs all variances to planning documents and ensures timely follow-up and approval by the DON
ROICC	• Oversees the technical and QA of the field activities • Provides governmental monitoring of the field health and safety program • Acts as DON liaison for base activities, such as security, permits, and communications

Notes:

DON – Department of the Navy
NFECSW – Southwest Division, Naval Facilities Engineering Command
QA – quality assurance
QC – quality control
RAC – Remedial Action Contract
ROICC – Resident Officer in Charge of Construction
RPM – Remedial Project Manager
TtFW – Tetra Tech FW, Inc

TABLE A.8-1

SUMMARY OF DATA QUALITY OBJECTIVES

STEP 1 Statement of Problem	STEP 2 Decisions	STEP 3 Inputs to the Decisions	STEP 4 Boundaries of the Study	STEP 5 Decision Rules	STEP 6 Limits on Decision Errors	STEP 7 Optimize the Sampling Design
Previous site investigation indicated that PCE, TCE, and DCE-impacted groundwater at IRP Site 40 at levels exceeding state and federal MCLs, thus requiring remedial action. An ISB pilot test was performed and indicated that by adding nutrient and a proprietary microorganism to groundwater, the existing microorganisms can accelerate the degradation of PCE, TCE, and DCE. Due to success of pilot test, a full-scale ISB was recommended for IRP Site 40. Therefore, groundwater monitoring will be performed to evaluate progress and effectiveness of ISB at the site. During pilot test, vapor samples were also collected to evaluate dechlorination products in the vapor phase. The result indicated presence of methane, hydrogen	1. Does the COD monitoring data indicate lactate distribution to the appropriate zones? 2. Are conditions within the treatment zone suitable for introduction of DHE? 3. Is DHE naturally present in the treatment zone? 4. Are the chlorinated volatile organic compounds (PCE, TCE, DCE, and VC) being dechlorinated? 5. Are chlorinated intermediates accumulating in the treatment zone? 6. When should the active ISB system be switched to the MNA phase?	Previous investigation data from the pilot test. Groundwater and vapor data collected during this project from field measurements and laboratory analysis. Groundwater analysis will include: VOCs, dissolved gases, dissolved hydrogen sulfide, dissolved hydrogen, TDS, major anions (sulfate, chloride, nitrate, nitrite), major cations (calcium, iron, magnesium, potassium, sodium), alkalinity, COD, DNA, volatile fatty acids, TOC, and Title 22 metals. Vapor analysis for: VOCs and fixed gases. Groundwater field measurements will include: nitrate, sulfate, ferrous iron, carbon dioxide, alkalinity, COD, pH, temperature, conductivity, ORP, and DO.	Proposed injection, monitoring, and soil gas wells will be installed to monitor remediation progress. The locations of the wells are shown in Figure A.3-2. In addition, well depths and screened intervals are listed in Table A.4-1. ISB process will continue to be monitored through selected ISB wells until PCE, TCE, DCE, and VC are below TCGs or reaches asymptotic levels for a period of three quarters. Once these conditions are met, MNA phase will begin for the ISB wells and continue for maximum of 3 years. When all the wells are detected below TCGs for at least one year or have been monitoring for MNA for 3 years, groundwater samples will be collected annually for VOCs analysis only for up to 5 years.	ISB monitoring data will be assessed throughout this project to confirm that conditions in the groundwater are favorable for the degradation of PCE, TCE, and DCE. 1. If COD is not detected above background, then distribution of lactate will be considered inadequate and additional sodium lactate will be injected. COD will continue to be monitored and lactate injected until COD is detected. Once COD is detected in all wells, then monitoring parameters such as sulfate, DNA, lactate breakdown products, ORP, pH, and others will be evaluated to assess whether conditions are suitable for introduction of DHE. 2. If conditions are not suitable for introduction of DHE, then additional sodium lactate will be injected and parameters will continue to be monitored. If conditions are suitable, then naturally occurring DHE presence will be assessed. 3. If DHE is not naturally-occurring or at low concentrations in any or all wells, then DHE will be introduced in the treatment zone. Once DHE presence is confirmed, then water will be pumped from well to well to distribute the DHE. 4. If dechlorination of the chlorinated volatile organic compounds (PCE, TCE, DCE, and VC) is not occurring, then system-operating parameters will be adjusted to optimize reductive dechlorination. If dechlorination is occurring, then the buildup or increase in concentration of DCE will be assessed.	Statistically derived limits on sampling design error are not quantifiable because a judgmental sampling design is being followed. The number and location of samples were determined based on the results of pilot test. To limit decision errors, analytical method requirements and project-specific DQOs were established. Published analytical method and laboratory-specific performance requirements are the primary determiners of DQOs for precision and accuracy.	Baseline groundwater samples will be collected from eight proposed monitoring wells prior to injection activities. During lactate injection period, groundwater will be collected from the injection wells and the proposed and existing monitoring wells for COD and water level field analysis at a frequency determined by the project scientist. During the ISB process, groundwater will be collected biweekly for the first 6 months, monthly after 6 moths, then quarterly after first year from wells MW-40-30 through MW-40-38, -14, and selected injection wells for field parameter readings listed in Table A.4-2. In addition, groundwater will also be submitted for laboratory analysis, monthly for the first 3 months then quarterly after that. MNA phase will be conducted in conjunction with ISB phase. During

TABLE A.8-1

SUMMARY OF DATA QUALITY OBJECTIVES

STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	STEP 6	STEP 7
Statement of Problem	**Decisions**	**Inputs to the Decisions**	**Boundaries of the Study**	**Decision Rules**	**Limits on Decision Errors**	**Optimize the Sampling Design**
sulfide, VC, and ethene gas in vadose zone. Methane gas was present at a potentially explosive level and appears to be migrating under Building 240. Therefore, vapor samples will be collected during this project to evaluate the distribution and fate of dechlorination products (VC and ethane) in the vapor phase.	7. During the MNA phase, are the concentrations of chlorinated volatile organic compounds (PCE, TCE, DCE, and VC) in an individual well less than the TCGs for 1 year? 8. Are the concentrations of the chlorinated volatile organic compounds (PCE, TCE, DCE, and VC) in all wells that have been monitored for MNA less than the TCGs for at least one year? 9. Have the TCGs been met during the LTM program and/or an agreement of "no further action" is reached for this site by all parties?	Vapor field measurements will include: methane, oxygen, carbon dioxide, hydrogen sulfide, and total explosive gases.		5. If DCE is accumulating, then DHE –laden groundwater will be redistributed or additional fresh culture will be introduced to promote further dechlorination to VC and eventually to ethene. Once DCE and VC (if observed) concentrations are decreasing, and ethene is observed, then chlorinated volatile organic compound concentrations will be evaluated to determine whether the ISB process is complete and the MNA phase can begin. 6. If concentrations of the chlorinated volatile organic compounds (PCE, TCE, DCE, and VC) have not reached asymptotic levels for two quarters, and are not less than 10 times the TCGs, then the ISB process will be continued along with quarterly monitoring. If concentrations of the chlorinated volatile organic compounds (PCE, TCE, DCE, and VC) reach asymptotic levels for two quarters and are less than 10 times the TCGs, then the MNA phase will begin. 7. If concentrations of the chlorinated volatile organic compounds (PCE, TCE, DCE, and VC) are not less than the TCGs for 1 year, then the MNA phase will continue up to 3 years. If the concentrations are less than the TCGs for 1 year, then that well will be monitored on an annual basis. 8. If the concentrations of the chlorinated volatile organic compounds (PCE, TCE, DCE, and VC) in all wells that have been monitored for MNA are not less than the TCGs for at least one year, then MNA monitoring will continue up to 3		MNA, groundwater will be sampled quarterly for the first year then semiannually after first year for maximum of 3 years. Field analysis will be pH, temperature, conductivity, ORP, DO and water level. Groundwater will also be submitted for laboratory analysis, quarterly for the first year, semiannually after first year for maximum of 3 years. When all the wells reach TCG for at least 1 year or have been monitored for MNA for 3 years, LTM will be conducted for 5 years. During LTM phase, groundwater will be sampled annually and analyzed for only VOCs. If after 5 years, COCs are detected above TCGs, then a 5-year review report will be submitted to agencies to request further action to achieve TCGs. Four proposed soil gas monitoring wells, two existing soil gas monitoring

TABLE A.8-1

SUMMARY OF DATA QUALITY OBJECTIVES

STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	STEP 6	STEP 7
Statement of Problem	**Decisions**	**Inputs to the Decisions**	**Boundaries of the Study**	**Decision Rules**	**Limits on Decision Errors**	**Optimize the Sampling Design**
				years after which the LTM program will begin. If the concentrations of the chlorinated volatile organic compound (PCE, TCE, DCE, and VC) in all wells are less than the TCGs for at least 1 year, then the LTM program will begin. 9. If the TCGs have not been met during the LTM program and/or all parties do not reach an agreement of "no further action" for this site, further system evaluation will be conducted, and an appropriate course of action will be pursued. If the TCGs have been met and/or an agreement of "no further action" is reached for this site by all parties, then IRP Site 40 will be considered a "no further action" site.		wells, probes installed in the proposed injection and groundwater monitoring wells will be monitored prior to initiation of the ISB process and MNA phase. Soil vapor will be monitored with field instrument each time the well is opened. In addition, soil vapor samples will be collected and submitted to laboratory for analysis monthly in the first year, then after first year semiannually for VOCs and quarterly for fixed gases.

Notes:

COD – chemical oxygen demand
DCE – dichloroethene
DHE – *Dehalococcoides ethenogenes*
DNA – deoxyribonucleic acid
DQO – data quality objective
IRP – Installation Restoration Program
ISB – in situ bioremediation
LTM – Long-Term Monitoring
MCL – Maximum Contaminant Level
MNA – Monitored Natural Attenuation
PCE – tetrachloroethene
ppmv – parts per million by volume
TCE – trichloroethene
TCGs – target cleanup goals
TDS – total dissolved solids
TOC – total organic carbon
VC – vinyl chloride
VOC – volatile organic compound

TABLE A.8-2

PROJECT REPORTING LIMITS

Parameter/Method	Analyte	Water[a]		
		RL	Unit	TCGs
VOCs EPA Method 8260B	1,1,1-Trichloroethane	1	µg/L	N/A
	1,1,2,2-Tetrachloroethane	1	µg/L	N/A
	1,1,2-Trichloroethane	1	µg/L	N/A
	1,1-Dichloroethane	1	µg/L	N/A
	1,1-Dichloroethene	1	µg/L	N/A
	1,2-Dichloroethane	1	µg/L	N/A
	1,2-Dichloropropane	1	µg/L	N/A
	2-Hexanone	50	µg/L	N/A
	Acetone	50	µg/L	N/A
	Benzene	0.5	µg/L	N/A
	Bromodichloromethane	1	µg/L	N/A
	Bromoform	1	µg/L	N/A
	Bromomethane	1	µg/L	N/A
	Carbon tetrachloride	1	µg/L	N/A
	Chlorobenzene	1	µg/L	N/A
	Chloroethane	1	µg/L	N/A
	Chloroform	1	µg/L	N/A
	Chloromethane	1	µg/L	N/A
	cis-1,2-Dichloroethene	1	µg/L	6[d]
	cis-1,3-Dichloropropene	1	µg/L	N/A
	Dibromochloromethane	1	µg/L	N/A
	Ethylbenzene	0.5	µg/L	N/A
	Methyl ethyl ketone (MEK)	50	µg/L	N/A
	Methyl tert-butyl ether (MTBE)	1	µg/L	N/A
	Methylene chloride	1	µg/L	N/A
	Methyl isobutyl ketone (MIBK)	50	µg/L	N/A
	Styrene	1	µg/L	N/A
	Tetrachloroethene	1	µg/L	5[d]
	Toluene	0.5	µg/L	N/A
	trans-1,2-Dichloroethene	1	µg/L	10[d]
	trans-1,3-Dichloropropene	1	µg/L	N/A
	Trichloroethene	1	µg/L	5[d]
	Vinyl acetate	50	µg/L	N/A
	Vinyl chloride	0.5	µg/L	0.5[b,d]
	Xylenes (Total)	1	µg/L	N/A
Dissolved gases RSK 175M	Ethane	1	µg/L	N/A
	Ethene	1	µg/L	N/A
	Methane	1	µg/L	N/A
	Carbon dioxide	1,000	µg/L	N/A
Dissolved hydrogen sulfide EPA Method 16-M	Dissolved hydrogen sulfide	1	µg/L	N/A
Dissolved hydrogen Microseeps Method AM20GAX	Dissolved hydrogen	0.1	nM	N/A
TDS EPA Method 160.1	TDS	10	mg/L	N/A
Anions EPA Method 300.0	Sulfate	100	µg/L	N/A
	Chloride	100	µg/L	N/A
	Nitrate	100	µg/L	N/A
	Nitrite	100	µg/L	N/A

TABLE A.8-2

PROJECT REPORTING LIMITS

Parameter/Method	Analyte	Vapor	
		RL	Units
VOCs EPA Method TO-15	Dichlorodiflouromethane (F-12)	0.20	ppbv
	Chloromethane	0.40	ppbv
	1,2-Dichloro-1,1,2,2-tetrafluoroethane (F-114)	0.20	ppbv
	Vinyl chloride	0.20	ppbv
	Vinyl acetate	1.0	ppbv
	Bromomethane	0.20	ppbv
	Chloroethane	0.40	ppbv
	Trichlorofluoromethane (F-11)	0.40	ppbv
	1,1-Dichloroethene	0.20	ppbv
	1,1,2-Trichloro-1,2,2-trifluoroethane	0.40	ppbv
	cis-1,2-Dichloroethene	0.20	ppbv
	trans-1,2-Dichloroethene	0.20	ppbv
	Dibromochloromethane	0.20	ppbv
	Chloroform	0.20	ppbv
	1,1,1,-Trichloroethane	0.20	ppbv
	Carbon Tetrachloride	0.20	ppbv
	Benzene	0.20	ppbv
	1,2-Dichloroethane	0.20	ppbv
	Trichloroethene	0.20	ppbv
	1,2-Dichloropropane	0.20	ppbv
	cis-1,3-Dichloropropene	0.20	ppbv
	Toluene	0.30	ppbv
	trans-1,3-Dichloropropene	0.20	ppbv
	1,1,2-Trichloroethane	0.20	ppbv
	Tetrachloroethene	0.20	ppbv
	1,2-Dibromoethane	0.20	ppbv
	Methylene chloride	0.20	ppbv
	Carbon disulfide	1.0	ppbv
	Acetone	0.80	ppbv
	1,1-Dichloroethane	0.20	ppbv
	2-Butanone (Methyl ethyl ketone)	1.0	ppbv
	Bromodichloromethane	0.20	ppbv
	4-Methyl-2-Pentanone (Methyl isobutyl ketone)	0.80	ppbv
	2-Hexanone (Methyl butyl ketone)	0.40	ppbv
	Chlorobenzene	0.20	ppbv
	Ethylbenzene	0.20	ppbv
	1,4- and 1,3-(p,m)Xylenes	0.50	ppbv
	Bromoform	0.20	ppbv
	1,2-(otho)Xylene	0.20	ppbv
	Styrene	0.20	ppbv
	1,1,2,2-Tetrachloroethane	0.20	ppbv
	4-Ethyltoluene	0.40	ppbv
	1,3,5-Trimethylbenzene	0.40	ppbv
	1,2,4-Trimethylbenzene	0.40	ppbv
	1,3-Dichlorobenzene	0.20	ppbv
	1,4-Dichlorobenzene	0.20	ppbv
	1,2-Dichlorobenzene	0.20	ppbv
	1,2,4-Trichlorobenzene	0.80	ppbv
	Hexachlorobutadiene	0.40	ppbv

TABLE A.8-2

PROJECT REPORTING LIMITS

Parameter/Method	Analyte	Vapor	
		RL	Units
Fixed Gases ASTM D1946	Methane	10	ppmv
	Ethane	10	ppmv
	Ethene	10	ppmv
	Carbon dioxide	100	ppmv

TABLE A.8-2

PROJECT REPORTING LIMITS

Parameter/Method	Analyte	Soil[c]		
		RL	TTLC Action Level	Unit
VOCs EPA Method 5035/8260B	1,1,1-Trichloroethane	5	NE	µg/kg
	1,1,2,2-Tetrachloroethane	5	NE	µg/kg
	1,1,2-Trichloroethane	5	NE	µg/kg
	1,1-Dichloroethane	5	NE	µg/kg
	1,1-Dichloroethene	5	NE	µg/kg
	1,2-Dichloroethane	5	NE	µg/kg
	1,2-Dichloropropane	5	NE	µg/kg
	2-Hexanone	50	NE	µg/kg
	Acetone	100	NE	µg/kg
	Benzene	5	NE	µg/kg
	Bromodichloromethane	5	NE	µg/kg
	Bromoform	5	NE	µg/kg
	Bromomethane	5	NE	µg/kg
	Carbon tetrachloride	5	NE	µg/kg
	Chlorobenzene	5	NE	µg/kg
	Chloroethane	5	NE	µg/kg
	Chloroform	5	NE	µg/kg
	Chloromethane	5	NE	µg/kg
	cis-1,2-Dichloroethene	5	NE	µg/kg
	cis-1,3-Dichloropropene	5	NE	µg/kg
	Dibromochloromethane	5	NE	µg/kg
	Ethylbenzene	5	NE	µg/kg
	Methyl ethyl ketone (MEK)	50	NE	µg/kg
	Methyl tert-butyl ether (MTBE)	10	NE	µg/kg
	Methylene chloride	5	NE	µg/kg
	Methyl isobutyl ketone (MIBK)	50	NE	µg/kg
	Styrene	5	NE	µg/kg
	Tetrachloroethene	5	NE	µg/kg
	Toluene	5	NE	µg/kg
	trans-1,2-Dichloroethene	5	NE	µg/kg
	trans-1,3-Dichloropropene	5	NE	µg/kg
	Trichloroethene	5	2,040,000	µg/kg
	Vinyl acetate	50	NE	µg/kg
	Vinyl chloride	5	NE	µg/kg
	Xylenes (Total)	15	NE	µg/kg
SVOCs EPA Method 8270C	1,2,4-Trichlorobenzene	330	NE	µg/kg
	1,2-Dichlorobenzene	330	NE	µg/kg
	1,3-Dichlorobenzene	330	NE	µg/kg
	1,4-Dichlorobenzene	330	NE	µg/kg
	2,4-Dinitrotoluene	330	NE	µg/kg
	2,4,5-Trichlorophenol	1600	NE	µg/kg
	2,4,6-Trichlorophenol	330	NE	µg/kg
	2,4-Dichlorophenol	330	NE	µg/kg
	2,4-Dimethylphenol	330	NE	µg/kg
	2,4-Dinitrophenol	1600	NE	µg/kg
	2,6-Dinitrotoluene	330	NE	µg/kg
	2-Chloronaphthalene	330	NE	µg/kg
	2-Chlorophenol	330	NE	µg/kg

TABLE A.8-2

PROJECT REPORTING LIMITS

Parameter/Method	Analyte	Soil[c]		
		RL	TTLC Action Level	Unit
SVOCs EPA Method 8270C	2-Methylphenol	330	NE	µg/kg
	2-Nitroaniline	1600	NE	µg/kg
	2-Nitrophenol	330	NE	µg/kg
	3-Nitroaniline	1600	NE	µg/kg
	3,3'-Dichlorobenzidine	330	NE	µg/kg
	3/4-Methylphenol	330	NE	µg/kg
	4,6-Dinitro-2-methylphenol	1600	NE	µg/kg
	4-Chloro-3-methylphenol	330	NE	µg/kg
	4-Bromophenyl phenyl ether	330	NE	µg/kg
	4-Chloroaniline	330	NE	µg/kg
	4-Chlorophenyl phenyl ether	330	NE	µg/kg
	4-Nitroaniline	1600	NE	µg/kg
	4-Nitrophenol	1600	NE	µg/kg
	Bis (2-chloroethoxy) methane	330	NE	µg/kg
	Bis (2-chloroethyl) ether	330	NE	µg/kg
	Bis (2-chloroisopropyl) ether	330	NE	µg/kg
	Bis (2-ethylhexyl) phthalate	330	NE	µg/kg
	Butyl benzylphthalate	330	NE	µg/kg
	Di-n-butylphthalate	330	NE	µg/kg
	Di-n-octylphthalate	330	NE	µg/kg
	Dibenzofuran	330	NE	µg/kg
	Diethyl phthalate	330	NE	µg/kg
	Dimethyl phthalate	330	NE	µg/kg
	Hexachlorobenzene	330	NE	µg/kg
	Hexachlorobutadiene	330	NE	µg/kg
	Hexachlorocyclopentadiene	330	NE	µg/kg
	Hexachloroethane	330	NE	µg/kg
	N-Nitrosodiphenylamine	330	NE	µg/kg
	N-Nitrosodi-n-propylamine	330	NE	µg/kg
	Nitrobenzene	330	NE	µg/kg
	Pentachlorophenol	330	17,000	µg/kg
	Phenol	330	NE	µg/kg
	Acenapthene	330	NE	µg/kg
	Acenaphthylene	330	NE	µg/kg
	Anthracene	330	NE	µg/kg
	Benzo[a]anthracene	330	NE	µg/kg
	Benzo[a]pyrene	330	NE	µg/kg
	Benzo[b]fluoranthene	330	NE	µg/kg
	Benzo[g,h,i]perylene	330	NE	µg/kg
	Benzo[k]fluoranthene	330	NE	µg/kg
	Chrysene	330	NE	µg/kg
	Dibenz[a,h]anthracene	330	NE	µg/kg
	Fluoranthene	330	NE	µg/kg
	Fluorene	330	NE	µg/kg
	Indeno[1,2,3-cd]pyrene	330	NE	µg/kg
	Naphthalene	330	NE	µg/kg
	Phenanthrene	330	NE	µg/kg
	Pyrene	330	NE	µg/kg

TABLE A.8-2

PROJECT REPORTING LIMITS

Parameter/Method	Analyte	Soil[c]		
		RL	TTLC Action Level	Unit
Title 22 Metals EPA Method 6010B/7000	Antimony	5	500	mg/kg
	Arsenic	10	500	mg/kg
	Barium	1	10,000	mg/kg
	Beryllium	1	75	mg/kg
	Cadmium	1	100	mg/kg
	Chromium	2	2,500	mg/kg
	Cobalt	3	8,000	mg/kg
	Copper	2	2,500	mg/kg
	Lead	10	1,000	mg/kg
	Mercury	0 2	20	mg/kg
	Molybdenum	3	3,500	mg/kg
	Nickel	4	2,000	mg/kg
	Selenium	5	100	mg/kg
	Silver	2	500	mg/kg
	Thallium	10	700	mg/kg
	Vanadium	2	2,400	mg/kg
	Zinc	2	5,000	mg/kg

Notes:

[a] Water samples include groundwater, equipment rinsate (as applicable), and wastewater samples collected for characterization.

[b] Value listed is not the California MCL for vinyl chloride Value was proposed by the DON in the Record of Decision (NFECSW, 2004).

[c] Action levels for waste characterization samples are based on the TTLC values.

[d] TCGs are only listed for the chemicals of concern as determined by historical data Additional compounds listed will only be analyzed for consistency with historical data for the site and therefore will not be compared to their associated TCGs.

µg/kg – micrograms per kilogram
µg/L – micrograms per liter
ASTM – American Society for Testing and Materials
COD – chemical oxygen demand
DNA – deoxyribonucleic acid
DON – Department of the Navy
EPA – U.S. Environmental Protection Agency
GC/FID – gas chromatograph/flame ionization detector
MCL – Maximum Contaminant Level
mg/kg – milligrams per kilogram
mg/L – milligrams per liter
N/A – not applicable
NFECSW – Southwest Division, Naval Facilities Engineering Command
NE – none established
nM – nanomoles
pM – picomoles
ppbv – parts per billion by volume
ppmv – parts per million by volume
Q-PCR – quantitative polymerase chain reaction
RL – reporting limit
SVOC – semivolatile organic compound
TCG – target cleanup goal
TDS – total dissolved solids
TO – Toxic Organics
TOC – total organic carbon
TTLC – Total Threshold Limit Concentration
VOC – volatile organic compound

TABLE A.8-3

QUALITY CONTROL ACCEPTANCE CRITERIA

Method	Analyte	Accuracy Water (%R)	Precision Water (% RPD)
EPA Method 8260B	1,1-Dichloroethene	75–125	≤ 20
	Benzene	75–125	≤ 20
	Chlorobenzene	75–125	≤ 20
	Trichloroethene	75–125	≤ 20
	Toluene	75–125	≤ 20
	Surrogates:		
	Toluene-d_8	75–125	N/A
	4-Bromofluorobenzene	75–125	N/A
	1,2-dichloroethane-d_4	75–125	N/A
RSK 175M	Methane	50-150	≤ 30
	Ethane	50-150	≤ 30
	Ethene	50-150	≤ 30
	Carbon dioxide	50-150	≤ 30
EPA Method 16-M	Dissolved hydrogen sulfide	NE	NE
Microseeps AM20GAX	Dissolved hydrogen	75-125	≤ 20
EPA Method 160.1	Total dissolved solids	80-120	≤ 20
EPA Method 300.0	Anions	80-120	≤ 20
EPA 6010B	Cations	80-120	≤ 20
EPA Method 310.1	Alkalinity	80-120	≤ 20
EPA Method 410.4	Chemical oxygen demand	80-120	≤ 20
Q-PCR	DNA	NE	NE
Phospholipid fatty acid	Phospholipid fatty acid	NE	NE
Volatile fatty acids	Lactate	NE	NE
	Acetate	NE	NE
	Butyrate	NE	NE
	Propionate	NE	NE
EPA Method 9060	Total organic carbon	80-120	≤ 20
EPA Method 8270C	1,2,4-Trichlorobenzene	44-142	≤ 30
	1,4-Dichlorobenzene	30-125	≤ 30
	2,4-Dinitrotoluene	39-139	≤ 30
	Acenaphthene	49-125	≤ 30
	2-Chlorophenol	41-125	≤ 30
	n-Nitrosodi-n-propylamine	37-125	≤ 30
	4-Chloro-3-methyl phenol	44-125	≤ 30
	4-Nitrophenol	25-131	≤ 30
	Pentachlorophenol	28-136	≤ 30
	Phenol	25-125	≤ 30
	Pyrene	47-136	≤ 30

TABLE A.8-3

QUALITY CONTROL ACCEPTANCE CRITERIA

Method	Analyte	Accuracy Water (%R)	Precision Water (% RPD)
EPA Method 8270C (continued)	***Surrogates:***		
	2,4,6-Tribromophenol	25-134	N/A
	2-Fluorbiphenyl	43-125	N/A
	2-Fluorophenol	25-125	N/A
	Nitrobenzene-D5	32-125	N/A
	Phenol-D5	25-125	N/A
	Terphenyl-D14	42-126	N/A
EPA Method 6010B/7000	Antimony	75-125	≤ 30
	Arsenic	75-125	≤ 30
	Barium	75-125	≤ 30
	Beryllium	75-125	≤ 30
	Cadmium	75-125	≤ 30
	Chromium	75-125	≤ 30
	Cobalt	75-125	≤ 30
	Copper	75-125	≤ 30
	Lead	75-125	≤ 30
	Mercury	75-125	≤ 30
	Molybdenum	75-125	≤ 30
	Nickel	75-125	≤ 30
	Selenium	75-125	≤ 30
	Silver	75-125	≤ 30
	Thallium	75-125	≤ 30
	Vanadium	75-125	≤ 30
	Zinc	75-125	≤ 30

TABLE A.8-3

QUALITY CONTROL ACCEPTANCE CRITERIA

Analyses	Parameter	Accuracy Vapor (% R)	Precision Vapor (% RPD)
EPA Method TO-15	1,1-Dichloroethene	70-130	≤ 30
	Methylene chloride	70-130	≤ 30
	Trichloroethene	70-130	≤ 30
	Toluene	70-130	≤ 30
	1,1,2,2-Tetrachloroethane	70-130	≤ 30
ASTM D1946	Methane	70-130	≤ 30
	Carbondioxide	70-130	≤ 30

TABLE A.8-3

QUALITY CONTROL ACCEPTANCE CRITERIA

Analyses	Parameter	Accuracy Soil (% R)	Precision Soil (% RPD)
EPA Method 5035/8260B	1,1-Dichloroethene	65-135	≤ 30
	Benzene	65-135	≤ 30
	Chlorobenzene	65-135	≤ 30
	Trichloroethene	65-135	≤ 30
	Toluene	65-135	≤ 30
	Surrogates		
	Toluene-D8	65-135	N/A
	4-Bromofluorobenzene	65-135	N/A
	1,2-Dichloroethane-D4	65-135	N/A
EPA Method 8270C	1,2,4-Trichlorobenzene	34-152	≤ 30
	1,4-Dichlorobenzene	25-135	≤ 30
	2,4-Dinitrotoluene	29-149	≤ 30
	Acenaphthene	39-135	≤ 30
	2-Chlorophenol	31-135	≤ 30
	n-Nitrosodi-n-propylamine	27-135	≤ 30
	4-Chloro-3-methyl phenol	34-135	≤ 30
	4-Nitrophenol	25-141	≤ 30
	Pentachlorophenol	38-146	≤ 30
	Phenol	25-135	≤ 30
	Pyrene	37-146	≤ 30
	Surrogates		
	2,4,6-Tribromophenol	25-144	N/A
	2-Fluorbiphenyl	34-135	N/A
	2-Fluorophenol	25-135	N/A
	Nitrobenzene-D5	25-135	N/A
	Phenol-D5	25-135	N/A
	Terphenyl-D14	32-136	N/A

TABLE A.8-3

QUALITY CONTROL ACCEPTANCE CRITERIA

Analyses	Parameter	Accuracy Soil (% R)	Precision Soil (% RPD)
EPA 6010B/7000	Antimony	75-125	≤ 30
	Arsenic	75-125	≤ 30
	Barium	75-125	≤ 30
	Beryllium	75-125	≤ 30
	Cadmium	75-125	≤ 30
	Chromium	75-125	≤ 30
	Cobalt	75-125	≤ 30
	Copper	75-125	≤ 30
	Lead	75-125	≤ 30
	Mercury	75-125	≤ 30
	Molybdenum	75-125	≤ 30
	Nickel	75-125	≤ 30
	Selenium	75-125	≤ 30
	Silver	75-125	≤ 30
	Thallium	75-125	≤ 30
	Vanadium	75-125	≤ 30
	Zinc	75-125	≤ 30

Notes:

%R – percent recovery
ASTM – American Society for Testing and Materials
DNA – deoxyribonucleic acid
EPA – U.S. Environmental Protection Agency
N/A – not applicable
NE – none established
Q-PCR – quantitative polymerase chain reaction
RPD – relative percent difference
TO – Toxic Organics

FIGURES

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PLOT/UPDATE: FEB 03 2005 10:41:44

DRAWN BY: MD	CHECKED BY: HH	APPROVED BY: HH	DCN: FWSD-RAC-05-0380	DRAWING NO:
DATE: 02/11/05	REV: REVISION 0		CTO: #0090	05038012.DWG

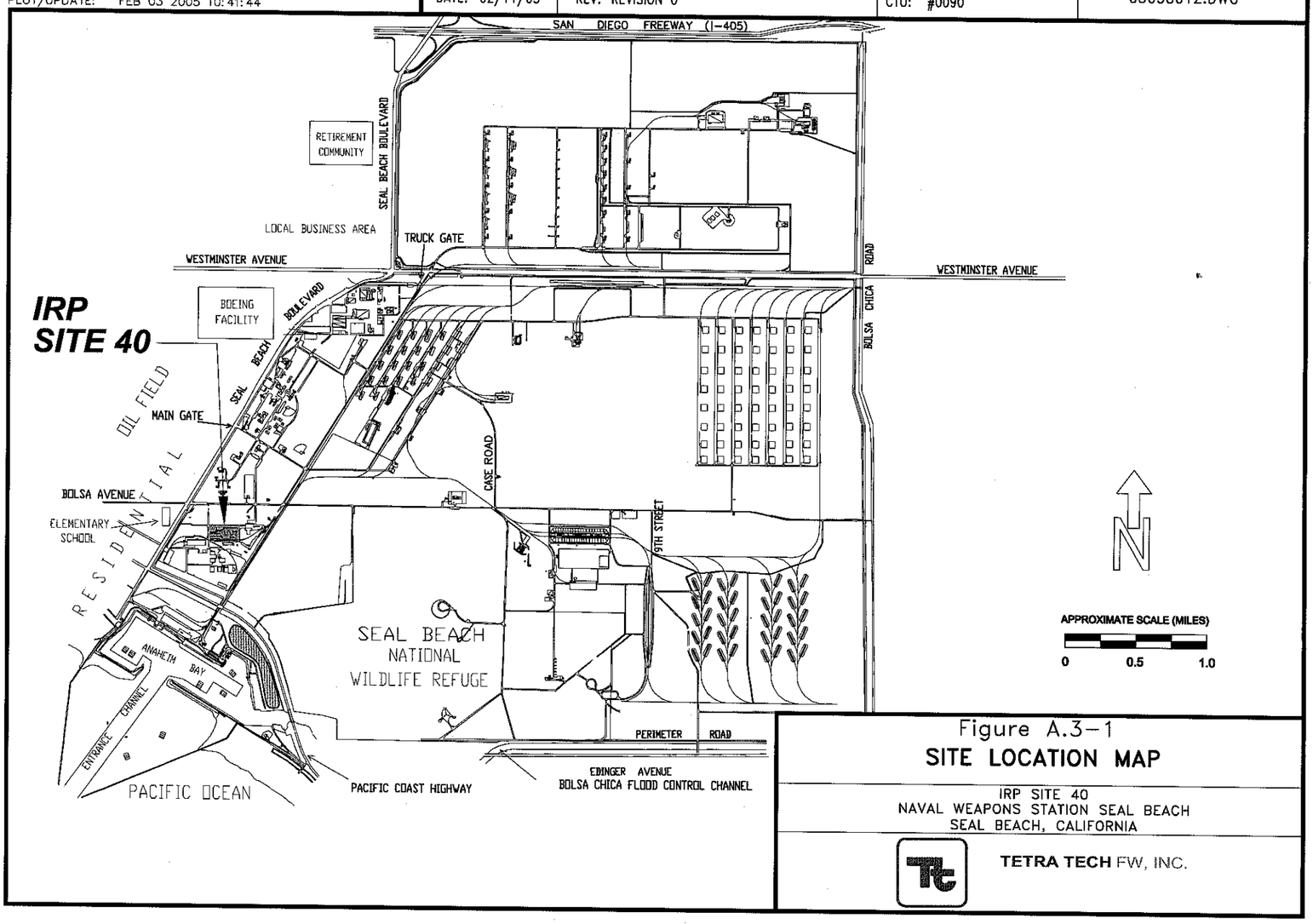

Figure A.3-1
SITE LOCATION MAP

IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC.

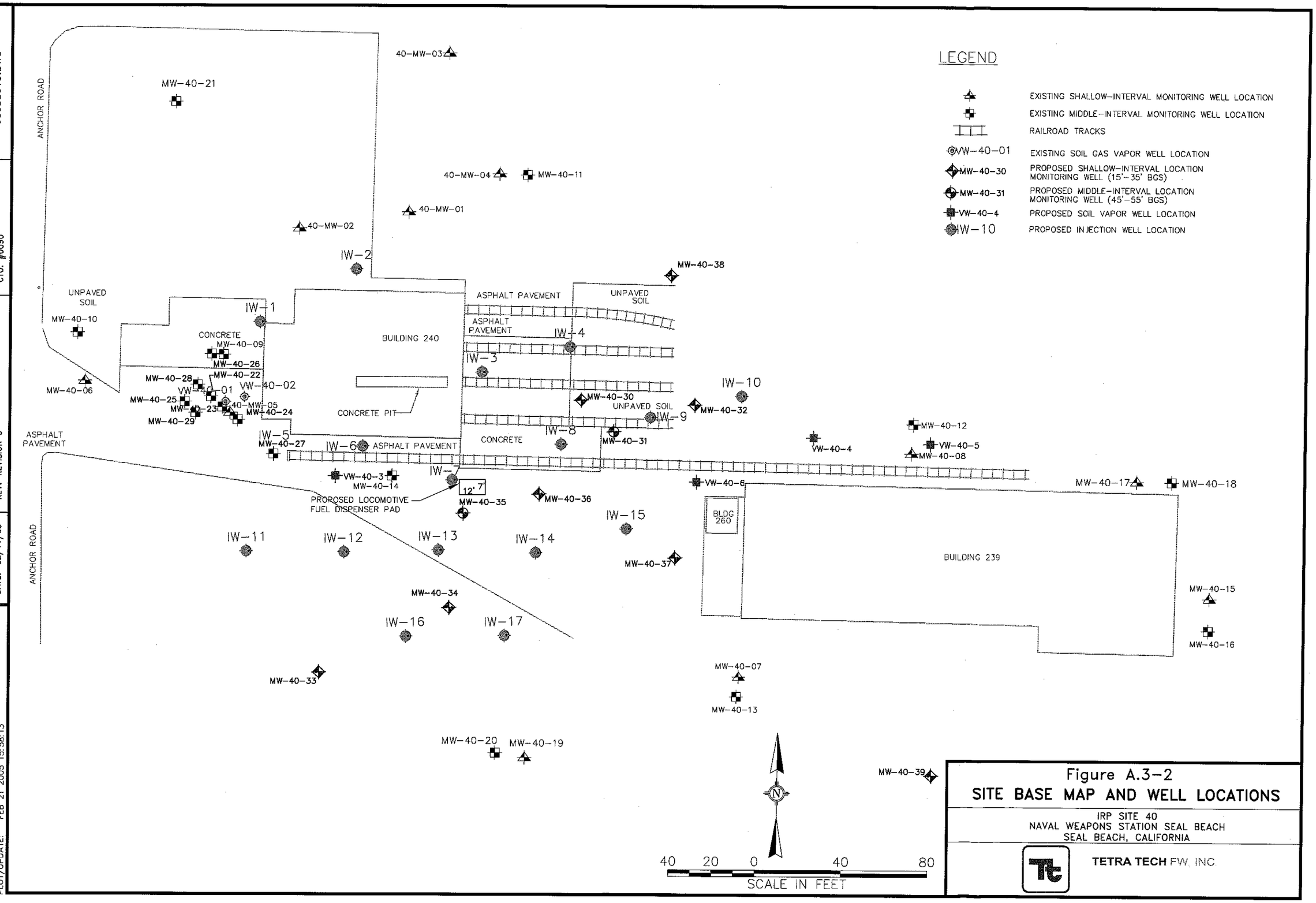

Figure A.3-2
SITE BASE MAP AND WELL LOCATIONS

IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC.

DRAWING NO: 05038013.DWG
DCN: FWSD-RAC-05-0380
CTO: #0090
APPROVED BY: HH
CHECKED BY: MT
REV: REVISION 0
DRAWN BY: MD
DATE: 02/11/05

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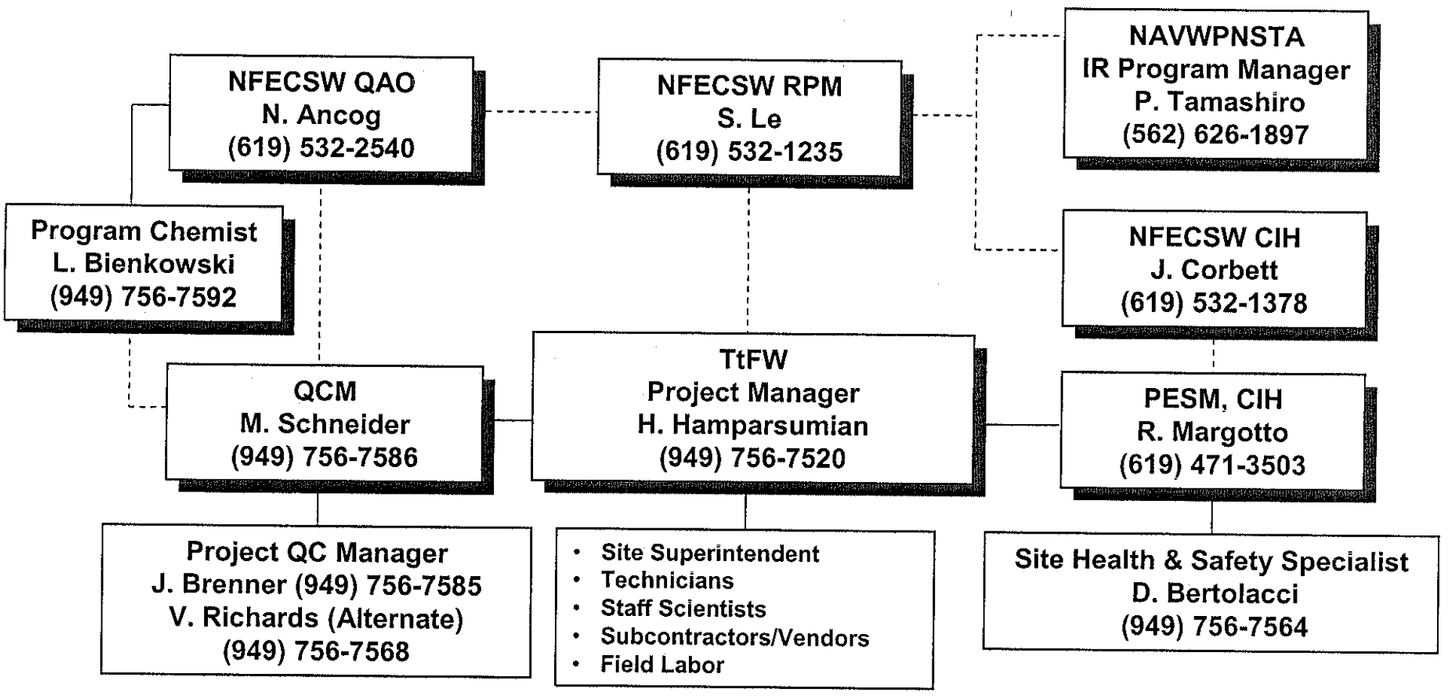
Figure A.7-1

Project Organization Chart



Legend
- - - - - = In regular contact and coordination
——— = Directly reports to above

APPENDIX B

PROJECT CONTRACTOR QUALITY CONTROL PLAN

Southwest Division
Naval Facilities Engineering Command
Contracts Department
1220 Pacific Highway, Building 127, Room 112
San Diego, California 92132-5190

CONTRACT NO. N68711-98-D-5713
CTO NO. 0090

APPENDIX B

FINAL

PROJECT CONTRACTOR QUALITY CONTROL PLAN

Revision 0
February 24, 2005

ENHANCED IN SITU BIOREMEDIATION
INSTALLATION RESTORATION PROGRAM SITE 40
(CONCRETE PIT/GRAVEL AREA)
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

DCN: FWSD-RAC-05-0380

Prepared by:

TETRA TECH FW, INC.
1230 Columbia Street, Suite 500
San Diego, CA 92101

Hamlet H. Hamparsumian
Project Manager

Mary Schneider
Quality Control Program Manager

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ABBREVIATIONS AND ACRONYMS

AHA	Activity Hazard Analysis
BRAC	Base Realignment and Closure
CAD	computer-assisted drafting
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CPR	Contractor Production Report
CQC	Contractor Quality Control
CQCR	Contractor Quality Control Report
CTO	Contract Task Order
DCN	Design Change Notice
DFW	definable feature of work
DON	United States Department of the Navy
ER,N	Environmental Restoration, Navy
FCR	Field Change Request
IR	Installation Restoration
IRP	Installation Restoration Program
ISB	in situ bioremediation
LUC	land-use control
MNA	monitored natural attenuation
NAVWPNSTA	Naval Weapons Station
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NCR	Nonconformance Report
NFECSW	Southwest Division, Naval Facilities Engineering Command
NFGS	Naval Facilities Guide Specification
PESM	Program Environmental Safety Manager
PjM	Project Manager
PQCM	Project Quality Control Manager
QA	Quality Assurance
QC	quality control
QCM	Quality Control Program Manager
RAC	Remedial Action Contract

ABBREVIATIONS AND ACRONYMS
(Continued)

RD/WP	Remedial Design/Work Plan
ROICC	Resident Officer in Charge of Construction
RPM	Remedial Project Manager
SAP	Sampling and Analysis Plan
SD	submittal description
SDS	Spatial Data Standard
SHSP	Site-Specific Health and Safety Plan
SHSS	Site Health and Safety Specialist
SOW	Scope of Work
TSDF	treatment, storage, and disposal facility
TtFW	Tetra Tech FW, Inc.
USACE	United States Army Corps of Engineers

1.0 INTRODUCTION

This Project Contractor Quality Control (CQC) Plan establishes the procedures and methods to be implemented for the remediation of groundwater at Installation Restoration Program (IRP) Site 40, Naval Weapons Station (NAVWPNSTA) Seal Beach, California. The Project CQC Plan combines the requirements of Southwest Division, Naval Facilities Engineering Command (NFECSW) Remedial Action Contract (RAC) No. N68711-98-D-5713 with the Tetra Tech FW, Inc. (TtFW) quality control (QC) system.

This site-specific Project CQC Plan for Contract Task Order (CTO) No. 0090 is an addendum to the *Final Contractor Quality Control Program Plan* (TtFW, 2004).

1.1 PURPOSE

The United States Department of the Navy (DON), NFECSW, directs this remedial action in accordance with requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The DON has determined upon review of the site's operational history and site-specific groundwater investigative data that this site contains elevated concentrations of tetrachloroethene and trichloroethene in groundwater, thus requiring a response action. The DON has initiated the remedial action for the impacted groundwater at IRP Site 40 to reduce any potential threats to human health and the surrounding environment.

A Remedial Design/Work Plan (RD/WP) has been prepared by TtFW for remediation of groundwater contaminated with chlorinated solvents at IRP Site 40. The planned remedial action for the impacted groundwater at IRP Site 40 is enhanced in situ bioaugmentation (ISB) and performance monitoring, monitored natural attenuation (MNA), and land-use control (LUC).

The Project CQC Plan provides an effective QC system to ensure the quality of all work performed by TtFW and its subcontractor personnel. The major activities include: land surveying to mark the planned well locations (groundwater monitoring wells, groundwater injection wells, and soil vapor monitoring wells); a geophysical survey of areas where intrusive activities will be performed; drilling, well installation, and well development; installation of dedicated well pumps and equipment; injecting sodium lactate into the subsurface at a specified number of groundwater injection wells (biostimulation to degrade chlorinated ethenes) and monitoring of the biostimulation process; introducing non-indigenous microorganisms to the groundwater (bioaugmentation to complete the dechlorination process) and monitoring of the bioaugmentation process; and groundwater and soil vapor monitoring.

1.2 SCOPE

This Project CQC Plan is applicable to all field operations and will be available in the project field office. All work activities will be conducted in accordance with the RD/WP, which includes a Sampling and Analysis Plan (SAP), this Project CQC Plan, and a Site-Specific Health and Safety Plan (SHSP).

The Project CQC Plan will be implemented for the following activities:

- Mobilization of equipment, materials, and personnel
- Land survey to mark the planned well locations (groundwater monitoring wells, groundwater injection wells, and soil vapor monitoring wells)
- Geophysical survey of areas where intrusive activities will be performed
- Drilling, installation, and development of 17 groundwater injection wells
- Drilling, installation, and development of eight groundwater monitoring wells
- Drilling and installation of four soil vapor monitoring wells
- Land survey (post-construction) to verify the locations of the wells
- Construction of the sodium lactate delivery system
- Installation of dedicated well pumps and equipment
- Injection of sodium lactate into the subsurface at a specified number of groundwater injection wells (biostimulation to degrade chlorinated ethenes) and monitoring of the biostimulation process
- Introducing non-indigenous microorganisms to the groundwater (bioaugmentation to complete the dechlorination process) and monitoring of the bioaugmentation process
- Long-term groundwater monitoring
- Health and safety monitoring (soil vapor monitoring and indoor air monitoring)
- Transportation and disposal of waste
- Demobilization of equipment, materials, and personnel

2.0 ORGANIZATION AND RESPONSIBILITIES

This section describes the organization and authority for project personnel performing construction operations, including subcontractors. The organizational structure, functional responsibilities, personnel qualifications, levels of authority, and lines of communication are established within the organization to ensure proper QC documentation and recordkeeping for the work performed. The project organization chart showing the reporting lines for each individual is provided in Figure B.2-1.

All personnel assigned to this project will be qualified and experienced. The responsibilities and authorities of the key project personnel are described in the following paragraphs.

2.1 CONTRACT TASK ORDER PROJECT MANAGER

The CTO Project Manager (PjM), Mr. Hamlet H. Hamparsumian, is responsible for the direction, execution, and successful completion of project tasks to achieve overall project goals. The PjM has responsibility and authority to perform the following quality-affecting activities related to the project:

- Coordinate work activities of subcontractors and TtFW personnel and ensure that all personnel adhere to the administrative and technical requirements of the project.
- Monitor and report the progress of work and ensure that project deliverables are completed on time and within project budget.
- Ensure adherence to the quality requirements of the contract, project scope of work, and the Project CQC Plan.
- Ensure that all contract work will meet the requirements of the specifications and applicable codes.
- Ensure that all work activities are conducted in a safe manner in accordance with the SHSP, *United States Army Corps of Engineers* [USACE] *Safety and Health Manual* (USACE EM-385-1-1) (1996), and all applicable Occupational Safety and Health Administration regulations.
- Serve as the primary contact between DON personnel and TtFW for actions and information related to the work.
- Coordinate satisfactory resolution and completion of evaluation and acceptance reports for Nonconformance Reports (NCRs).

2.2 QUALITY CONTROL PROGRAM MANAGER

The Quality Control Program Manager (QCM), Ms. Mary Schneider, is responsible for the oversight of program QC, including chemical data acquisition. The duties of the QCM include:

- Establish and maintain the Quality Program.
- Work directly with the Program Manager, Neil Hart, and the DON to ensure implementation of the Program QC Plan.
- Be the focal point for coordination of quality matters across all projects and resolving quality concerns.
- Provide quality directions and training to the Project Quality Control Manager (PQCM) and others performing quality functions.
- Suspend project activities if quality standards are not maintained.
- Interface with the DON, including the NFECSW Quality Assurance (QA) Officer on quality-related issues.
- Perform reviews of audits and surveillance reports.
- Implement the DON technical directives relating to quality.

2.3 CONSTRUCTION MANAGER (PROJECT SUPERINTENDENT)

The Construction Manager/Project Superintendent reports to the PjM and is responsible for coordinating, directing, implementing, and supervising site-specific activities. Specific duties of the Project Superintendent include:

- Implement site-specific activities in accordance with the RD/WP.
- Direct field leaders, support personnel, and subcontractors.
- Administer site access.
- Maintain worksite, vehicles, and equipment.
- Coordinate and maintain logistics of all components of on-site tasks, including all personnel and equipment.
- Prepare daily Contractor Production Reports (CPRs) and monthly summary reports, and estimate future scheduling needs.
- Coordinate, prepare, and complete all required field reports.
- Ensure that all safety requirements are met, enforced, and documented.
- Ensure compliance with applicable regulations, including contractual requirements, and health and safety requirements.
- Maintain the current 2-week look-ahead schedule of field activities.
- Recommend changes to improve project efficiency and effectiveness.

- Verify that field personnel are trained and qualified to complete assigned tasks.
- Attend QC meetings.
- Coordinate work efforts with the PQCM and Site Health and Safety Specialist (SHSS).
- Provide technical justification for change orders.
- Maintain site security.

2.4 PROJECT QUALITY CONTROL MANAGER

The PQCM is responsible for overall management of project QC and reports to the QCM. The PQCM will be on site at all times during construction. The PQCM has the authority to stop work on site-related issues affecting the quality of the work performed and to direct the correction of all nonconforming work. The resume and delegation of authority letter for the PQCM and the Alternate PQCM are included as Attachments 1 and 2, respectively. QC forms related to the PQCM duties are included in Attachment 3.

The duties of the PQCM as they apply to this project include:

- Providing and maintaining an effective QC system for all site activities.
- Monitoring QC activities to ensure conformance with authorized policies, procedures, contract specifications, required standards, sound practices, and methods of quality construction.
- Maintaining sufficient staff to perform all QC activities to ensure QC for all work phases, work shifts, and work crews.
- Preparing the daily Contractor Quality Control Reports (CQCRs).
- Maintaining the Testing Plan and Log (Table B.2-1).
- Performing and coordinating the three phases of inspection (preparatory, initial, and follow-up) and making sure they are implemented for all definable features of work (DFWs) (Table B.2-2).
- Issuing and enforcing NCRs.
- Ensuring that all on-site inspections, testing, and sampling are performed in accordance with the plans, specifications, and applicable codes.
- Ensuring that all required tests and inspections are performed and results are documented.
- Conducting weekly QC meetings.
- Attending required meetings, including the coordination and mutual understanding meeting (pre-construction conference or kickoff meeting), pre- and post- construction site inspections, and other scheduled meetings.
- Providing inspection of testing and sampling.

- Coordinating and maintaining the Submittal Register (Attachment 4), photograph log sheet, requests for engineering information and requests for information, and the NCR log.
- Reviewing and maintaining records of approved submittals, Design Change Notices (DCNs) for construction activities, and Field Change Requests (FCRs).
- Reviewing Scopes of Work (SOWs) for subcontractor work to be performed to ensure compliance with the plans, specifications, and applicable codes.
- Inspecting material delivery, handling, and storage to ensure compliance with technical specifications.
- Reviewing and approving submittals and shop drawings and/or forwarding submittals for record/approval.
- Issuing compliance notices on material, equipment, work-in-place, and workmanship.
- Reviewing project plans and procedures for quality-related issues.
- Identifying the need for corrective action and initiate, recommend, and coordinate solutions for project quality-related problems.
- Performing submittal reviews and reviewing approvals/certifications.
- Directing the removal of work, material, and equipment that is not in compliance with plans and specifications.
- Identifying the need for corrective action and initiating, recommending, and coordinating solutions for quality-related problems.
- Immediately stopping any segment of work that does not comply with the specifications and drawings.

2.5 FIELD ENGINEER

The Field Engineer is responsible for implementing, directing, and supervising engineering activities on site. The Field Engineer will notify the PjM of any design changes. Field engineering will include or conduct survey control, inspection and testing, and implementation of the project technical specifications and contract drawings. The duties of the Field Engineer include:

- Ensuring that all engineering work activities are performed in accordance with the TtFW corporate engineering procedures, technical specifications and contract drawings, RD/WP, and applicable professional standards.
- Providing oversight of engineering work activities performed by subcontractors.
- Implementing engineering design requirements.
- Conducting field engineering inspections and tests required by the project technical specifications and contract drawings.
- Ensuring the quality of survey control data.

- Inspecting the work performed each day for compliance with the RD/WP and technical specifications.
- Preparing engineering documents in accordance with the technical specifications and drawings.
- Coordinating with the PQCM regarding FCRs, DCNs, and NCRs.
- Preparing SOWs for subcontractor work to be performed.

2.6 SITE HEALTH AND SAFETY SPECIALIST

The SHSS ensures that all elements of the approved SHSP are implemented and enforced on site. The SHSS reports directly to the Program Environmental Safety Manager (PESM), Mr. Roger Margotto, and will assist in implementing and enforcing the SHSP in the field. The SHSS has full authority to issue stop work orders or evacuation orders where work operations or noncompliance(s) may threaten the health and safety of site workers or the public.

Duties and responsibilities for the SHSS include the following:

- Ensuring enforcement of the SHSP through daily site inspections.
- Coordinating site health and safety requirements with the Project Superintendent and PjM.
- Ensuring maintenance of all health and safety monitoring and personal protective equipment and directing site monitoring activities.
- Reporting all health and safety monitoring results to the PESM.
- Coordinating daily field activities with the Project Superintendent.
- Coordinating site safety and emergency response duties, and verifying site communications systems with site personnel.
- Implementing periodic safety inspections of equipment and supplies.
- Performing inspection of safety equipment.
- Coordinating with the PESM and Resident Officer in Charge of Construction (ROICC).
- Maintaining recordkeeping and reporting systems.
- Initiating necessary revisions or changes to the SHSP.
- Maintaining site control procedures.
- Maintaining current certification for first aid and cardiopulmonary resuscitation.

2.7 SUBCONTRACTORS AND VENDORS

Qualified subcontractors will be procured to provide services for this project. Subcontractors and vendors will comply with the requirements of the contract specifications, drawings, Project CQC Plan, and applicable codes and regulations. The subcontractors are responsible for field inspection of their operating activities. The PQCM ensures that this is accomplished.

Subcontractor personnel are responsible for maintaining a daily log of the project activities they perform and for providing information needed to complete the daily CQCR for the PQCM. All inspection records, including inspection reports, deficiency reports, and re-inspections of corrective actions, will be documented by the PQCM.

3.0 SUBMITTALS

This section describes the review and approval process for submittals. In addition, the PQCM will institute and maintain a submittal register to track submittals from issue to approval. A list of required submittals is included as Attachment 4. This list will be revised as necessary.

Submittals will be scheduled, reviewed, certified, and managed in accordance with the latest edition of the Naval Facilities Guide Specification (NFGS)-01330E submittals.

Required submittals may consist of the following types:

- **Shop Drawings**—Drawings, schedules, diagrams, and other data prepared specifically for this contract to illustrate a portion of work. These can be prepared directly by the contractor (TtFW), or prepared for the contractor by a subcontractor, manufacturer, supplier, distributor, or other lower tier contractor.
- **Product Data**—Pre-printed material such as illustrations, standard schedules, performance charts, instructions, brochures, diagrams, manufacturer's descriptive literature, catalog data, and other data to illustrate a portion of work, but not prepared exclusively for this contract.
- **Sample**—Physical examples of products, materials, equipment, assemblies, or workmanship that are physically identical to a portion of work, illustrating a portion of work, or establishing standards for evaluating appearance of finished work.
- **Administrative Submittals**—Data presented for review and approval to ensure that administrative requirements of projects are adequately met, but not to ensure directly that work is in accordance with design concepts or in compliance with contract documents.

3.1 SUBMITTAL DESCRIPTIONS

Submittal descriptions (SDs) are as follows:

- **SD-01, Pre-construction Submittals**—Submittals which provide calculations, descriptions, or other documentation regarding the work (RD/WP, SAP, SHSP, and Project CQC Plan).
- **SD-02, Shop Drawings**—Submittals which graphically show relationships of various components of the work, schematic diagrams of systems, details of fabrication, layout of particular elements, connections, and other relational aspects of the work.
- **SD-03, Product Data**—Data composed of catalog cuts, illustrations, schedules, diagrams, performance charts, instructions, and brochures illustrating size, physical appearance, and other characteristics of materials or equipment for some portion of the work.

- **SD-04, Samples**—Samples, including both fabricated and unfabricated physical examples of materials, products, and units of work either as complete units or as portions of units of work.

- **SD-05, Design Data**—Design calculations, mix designs, analyses, or other written data pertaining to a part of work.

- **SD-06, Test Reports**—Reports signed by an authorized official of a testing laboratory stating that a material, product, or system identical to the material, product, or system to be provided has been tested in accordance with requirements specified by naming the test method and material. Test reports must state that the test was performed in accordance with test requirements, state test results, and indicate whether the material, product, or system has passed or failed test. Testing must have been conducted within 3 years of the date of award of this contract.

  A written report which includes the findings of a test made at the job site, in vicinity of the job site, or on a sample taken from job site, on a portion of work during or after installation. The report must be signed by an authorized official of the testing laboratory or agency and must state that the test was performed in accordance with the test requirements, state the test results, and indicate whether material, product, or system has passed or failed the test.

- **SD-07, Certificates**—Statements signed by responsible officials of the manufacturer of the product, system, or material attesting that the product, system, or material meets the specified requirements. Statements must be dated after award of this contract, must name the project, and must list the specific requirements that they are intended to address.

  Documentation required of the contractor, or of a supplier, installer, or subcontractor through the contractor, the purpose of which is to further the quality of orderly progression of a portion of the work by documenting procedures, acceptability of methods, or personnel qualifications.

- **SD-08, Manufacturer's Instructions**—Pre-printed material describing the installation of a product, system, or material, including special notices and Material Safety Data Sheets concerning impedances, hazards, and safety precautions.

- **SD-09, Manufacturer's Field Reports**—Documentation of the testing and verification actions taken by the manufacturer's representative to confirm compliance with the manufacturer's standards or instructions. Also includes factory test reports.

- **SD-10, Operation and Maintenance Data**—Data that is furnished by the manufacturer, or the system provider, to the equipment operating and maintenance personnel. This data is needed by operating and maintenance personnel for the safe and efficient operation, maintenance, and repair of the item.

- **SD-11, Closeout Submittals**—Documentation to ensure compliance with administrative requirements or to establish an administration mechanism.

3.2 SUBMITTAL REQUIREMENTS

Submittal requirements will be in accordance with the project technical specifications and RD/WP. The following requirements apply to all submittals:

- Each submittal will be complete and in sufficient detail to allow determination of compliance with the plans, specifications, and applicable codes.
- Each submittal will be reviewed by the PQCM or an approved reviewer.
- A Catalog Cut/Shop Drawing Transmittal and Approval form (Attachment 3) certifying compliance with all contract requirements will accompany each submittal in accordance with the technical specifications.
- Proposed deviation from the contract requirements will be clearly identified.
- Submittals will include items such as applicable drawings, descriptive literature, test reports, samples, certifications, and warranties.
- All spatial data, including computer-assisted drafting (CAD) drawings, will conform to the Tri-Service Spatial Data Standard (SDS) and be submitted as DOS AutoCAD version 13 or Microstation version 5.0, or later, compatible format.
- Geographic Information System data will conform to the Tri-Service SDS and be submitted as ARCInfo Export Format or MGE Export format.
- The State Plane Coordinate System, North American Datum 83, and Lambert Zones 1 through 6 will be used.
- The vertical reference elevation is mean sea level, with the relevant control data provided.

3.3 REVIEW OF SUBMITTALS

Submittals will be reviewed to ensure completeness, accuracy, and contract compliance. All items will be checked and approved by the PQCM or designated representative. Any submittals requiring modifications or changes will be returned to the originating organization for correction and then resubmitted for review and approval by the PQCM, prior to acceptance. Approval by the PQCM of the submittal will be indicated by stamping, signing, or initialing, in addition to dating the submittal form. The PQCM or designee will perform a check to ensure that all materials and equipment have been tested, submitted, and approved during the preparatory phase of the QC inspections. No construction activities will be performed prior to the required approval of applicable submittals.

3.4 SUBMITTAL PROCESS

The PQCM will provide all submittals to the ROICC and to the required DON personnel. Each submittal will have a unique document control number. Submittal schedules will include the allotted approval time as specified in the RAC specifications. However, with DON approval, some submittals may require accelerated processing to maintain the site activities schedule.

The PQCM will update the submittal register regularly. A transmittal and approval form (Attachment 3) will accompany each submittal. Each transmittal and submittal will be identified by including the following information on each component:

- Project title and location.
- Contract number and CTO number.
- Name, address, and phone number of subcontractor, supplier, manufacturer, and any other second tier contractor associated with the submittal.
- Date of the submittal.
- SD number of each component of the submittal.
- Product identification and location in project.
- Description of item being submitted, including reference to specification section and SD number.
- Approval of submitting organization indicating conformance to the requirements.
- Submittals will be reviewed by the PQCM or an approved reviewer. The submittal will indicate that it either does or does not conform to contract requirements.

Administrative submittals will be formatted as follows:

- When a submittal includes a document, which is to be used in a project or become part of project record, other than as a submittal, do not apply the contractor's approval stamp to document, but to a separate sheet accompanying document.

3.5 REVIEW AND PROCESSING OF SUBMITTALS THAT DO NOT REQUIRE DON APPROVAL

The submittal will be reviewed by the PQCM or an approved reviewer. The submittal will indicate that it either does or does not conform to the contract requirements. The PQCM will advise the submitter of the results of the review. The submittal log will be updated to indicate status.

Conforming submittals will be certified by the PQCM for approval and forwarded to the required DON personnel as an information-only submittal.

Nonconforming submittals will be returned to the submitter for correction, resolution of comments, and re-submittal.

3.6 REVIEW AND PROCESSING OF SUBMITTALS THAT REQUIRE DON APPROVAL

Submittals will be reviewed by the PQCM or an approved reviewer. The submittal will indicate that it either does or does not conform to the contract requirements. Reviewed and certified submittals will be forwarded to the contracting officer using the transmittal and approval form

(Attachment 3). Each form will indicate the item transmitted, the date and signature of the PQCM and submittal reviewer (when applicable), and QC-certifying statement. The QC-certifying statement is as follows:

> "I hereby certify that the (equipment) (material) (article) shown and marked in this submittal is that proposed to be incorporated with Contract Number N68711-98-D-5713, is in compliance with the contract drawings and specifications, can be installed in the allocated spaces, and is submitted for Government approval."

Upon completion of review, the ROICC (or ROICC's Representative) may return the transmittal sheet to the PQCM for further action.

The PQCM will advise the submitter of the results of the review in writing and include any comments. The submittal log will be updated to indicate status.

Nonconforming submittals may be returned to the submitter for correction, resolution of comments, and re-submittal, if required. No work will begin until submittals for that work have been returned as "Approved" or "Approved as Noted".

3.7 REVISED SUBMITTALS

Re-submission of submittals will be logged, reviewed, and processed in a manner consistent with the initial submittal. When re-submitting disapproved transmittals or transmittals noted for re-submittal, a copy of the previously submitted transmittal, including all reviewer comments (for use by approving authority), will be provided.

The submittal number used for the original submittal will be used for each re-submittal followed by a sequential alpha suffix to indicate re-submission.

4.0 TESTING (OTHER THAN CHEMICAL SAMPLING AND ANALYSIS)

The PQCM shall ensure the performance of all tests specified or required by the project specifications and drawings to verify that control measures are adequate to provide a product conforming to contract specifications. General requirements for testing procedures to be implemented for this project will be included in the RD/WP. The type, number, and frequency of required tests is specified in the Testing Plan and Log (Table B.2-1). If additional testing requirements are identified during field activities, an FCR will be submitted. The PQCM is responsible for conducting or coordinating the required tests. For all testing activities, the PQCM shall:

- Verify that testing procedures comply with contract requirements.
- Verify that facilities and testing equipment are available and comply with testing standards.
- Check test instrument calibration data against certified standards.
- Verify that recording forms and the test identification control number system have been prepared.

4.1 DOCUMENTATION

All test results, both passing and failing, will be recorded on the CQCR for the day the results are obtained. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test will be given. The actual test reports may be submitted later to the DON Remedial Project Manager (RPM), the NAVWPNSTA Installation Restoration (IR) Program Coordinator, and ROICC. A copy of all test results for tests performed by off-site facilities will be provided directly to the PjM or designee.

4.2 LABORATORY SERVICES

An independent testing laboratory will provide laboratory services as needed. The laboratory will be selected and qualified in accordance with recognized industry standards and applicable project requirements and accredited/certified as described in Sections 4.2.1 and 4.2.2. The laboratory name and proof of accreditation will be submitted after procurement has been completed and prior to the field activities.

4.2.1 Accreditation for Non-environmental Projects

Acceptable accreditation programs for non-environmental projects are the National Institute of Standards and Technology, National Voluntary Laboratory Accreditation Program, the American Association of State Highway and Transportation Officials Program, and the American Association for Laboratory Accreditation Program.

A copy of the certificate of accreditation, scope of accreditation, and latest directory of the accrediting organization for accredited laboratories will be submitted to the Contracting Officer or designated representative. The scope of the laboratory's accreditation shall include the test methods required by the project. Any deviation from these requirements must be approved in writing by the ROICC and the RPM.

4.2.2 Accreditation for Environmental Projects

Laboratories performing IRP work funded by Environmental Restoration, Navy (ER,N) (formerly Defense Environmental Restoration Account) or Base Realignment and Closure (BRAC) (ER,N eligible in the absence of BRAC funding) must successfully complete the Navy Laboratory Evaluation Program. Unless otherwise specified, sampling and analysis shall be performed using current U. S. Environmental Protection Agency procedures and QC. Any deviation from the above requirements must be approved in writing by the NFECSW QA Officer.

On-site chemical analysis by mobile laboratories must be performed by laboratories certified by the California Department of Health Services through the Environmental Laboratory Accreditation Program.

5.0 FIELD INSPECTION PLAN

The Project CQC Plan is the instrument by which TtFW ensures that all field activities, including that of subcontractors and suppliers, comply with the requirements of the contract. The DFWs establish the measures required to verify both the quality of work performed and compliance with specified requirements, which include inspection of materials and workmanship before, during, and after each DFW. The definable features for this project are:

- Mobilization of equipment, materials, and personnel
- Land survey to mark the planned well locations (groundwater monitoring wells, groundwater injection wells, and soil vapor monitoring wells)
- Geophysical survey of areas where intrusive activities will be performed
- Drilling, installation, and development of 17 groundwater injection wells
- Drilling, installation, and development of eight groundwater monitoring wells
- Drilling and installation of four soil vapor monitoring wells
- Land survey (post-construction) to verify the locations of the wells
- Construction of the sodium lactate delivery system
- Installation of dedicated well pumps and equipment
- Injection of sodium lactate into the subsurface at a specified number of groundwater injection wells (biostimulation to degrade chlorinated ethenes) and monitoring of the biostimulation process
- Introducing non-indigenous microorganisms to the groundwater (bioaugmentation to complete the dechlorination process) and monitoring of the bioaugmentation process
- Long-term groundwater monitoring
- Health and safety monitoring (soil vapor monitoring and indoor air monitoring)
- Transportation and disposal of waste
- Demobilization of equipment, materials, and personnel

Detailed descriptions of each DFW are presented in Table B.2-2.

The controls defined shall be adequate to cover all construction operations and are keyed to the proposed construction sequence. Project CQC includes implementing the following three control phases for all aspects of the work specified:

- Preparatory phase
- Initial phase
- Follow-up phase

Attachment 3 contains inspection forms for each phase. Inspection requirements specific to this project are discussed in the remainder of this section.

5.1 COORDINATION AND MUTUAL UNDERSTANDING MEETING

Prior to start of site work, the ROICC will conduct a pre-construction kickoff meeting with the RPM and NAVWPNSTA IR Program Coordinator, as well as the TtFW PjM, Construction Manager/Project Superintendent, and PQCM. The purpose of the meeting is to discuss the QC program required by this contract and to develop a mutual understanding of the QC details, including forms to be used; administration of on-site and off-site work; and coordination of the field activities, production, and PQCM duties. Minutes of the meeting shall be prepared by the PQCM and submitted to all attendees for concurrence.

5.2 QC MEETINGS

After the start of field activities, the PQCM will conduct QC meetings once every week (or as required by the ROICC). The meetings will be held at the project site or, if necessary, an alternate location determined by the ROICC or the NAVWPNSTA IR Program Coordinator. The meeting will be attended by the TtFW PjM, Project Superintendent, RPM, and ROICC. The PQCM will notify the ROICC at least 48 hours in advance of each meeting. One copy of the QC meeting minutes will be sent to all attendees within 2 calendar days of the meeting. The following will be accomplished at each meeting:

- Review the minutes of the previous meeting.
- Review the schedule and the status of work.
  - Work, inspection, or testing accomplished since last meeting
  - Rework items identified since last meeting
  - Rework items completed since last meeting
- Review the status of submittals.
  - Submittals reviewed and approved since last meeting
  - Submittals required in the near future
- Review the work to be accomplished in the next 2 weeks and documentation required. Schedule the three phases of control and testing.
  - Establish completion date for rework items
  - Preparatory phases required
  - Initial phases required
  - Follow-up phases required
  - Testing required
  - Status of off-site work or testing
  - Documentation required

- Discuss upcoming Activity Hazard Analyses (AHAs)

- Resolve QC and production problems.
- Address items that may require revisions to the CQC Plans.
  - Changes in QC organization personnel
  - Changes in procedures

5.3 PREPARATORY PHASE INSPECTION

The PQCM will conduct preparatory phase inspections prior to starting the DFW. These inspections shall include:

- A review of each paragraph of applicable specifications.
- A review of the contract plans and drawings.
- A check to ensure that all materials and/or equipment have been tested, submitted, and approved.
- A check to ensure that provisions have been made to provide required control inspection and testing.
- An examination of the work area to ensure that all required preliminary work has been completed and is in compliance with the contract.
- A physical examination of required materials, equipment, and sample work to ensure that they are on hand, conform to approved shop drawings or submitted data, and are properly stored.
- A review of the appropriate AHA to ensure that safety requirements are met.
- A discussion of procedures for constructing the work, including repetitive deficiencies.
- Documentation of construction tolerance and workmanship standards for that phase of work.
- A check to ensure that the portion of the Project CQC Plan for the work to be performed has been accepted by the DON.
- Confirm that all necessary training and/or health and safety certifications for personnel performing the activity are on file on the project site.

The ItFW PjM, Construction Manager/Project Superintendent, RPM, NAVWPNSTA IR Program Coordinator, and ROICC shall be notified at least 2 workdays in advance of each preparatory phase activity. This phase includes a meeting conducted by the PQCM and will be attended by other responsible construction personnel, as applicable.

The preparatory phase meetings will be documented by item on the Inspection Checklist and will be reported on the CQCR with the Preparatory Inspection Checklist included as an attachment.

The PQCM will direct personnel performing work activities as to the acceptable level of workmanship required.

5.4 INITIAL PHASE INSPECTION

An initial inspection will be performed at the beginning of a DFW and will include:

- A check of preliminary work to ensure that it is in compliance with contract requirements
- A review of the Initial Inspection Checklist documenting results of the preparatory meeting
- Verification of full contract compliance, including required control inspection and testing
- Establishment of the required level of workmanship, and verification to ensure that work meets minimum acceptable standards
- Resolution of all differences
- A check of safety requirements to include compliance with and upgrading of the SHSP and AHA
- A review of the AHA with project personnel

The PjM, the RPM, the NAVWPNSTA IR Program Coordinator, and the ROICC will be notified at least 2 workdays in advance of any initial phase activity. The PQCM will document initial inspections for each item using the Initial Inspection Checklist and attach it to the CQCR. The exact location of the initial phase inspection will be indicated for future reference and comparison with follow-up inspections.

An initial phase inspection will be conducted each time a new crew arrives on site or any time acceptable specified quality standards are not being met.

5.5 FOLLOW-UP PHASE INSPECTION

During the completion of a particular work feature, follow-up inspections will be conducted to ensure continued compliance with contract requirements. The frequency of the follow-up inspections will depend on the extent of the work being performed on each particular feature. Each follow-up inspection will be documented on the CQCR. A final follow-up check will be conducted on any completed work phase prior to the commencement of a subsequent phase. Any deficiencies will be corrected prior to starting additional phases of work or will be identified on a list of items that do not conform to the specified requirements or are incomplete.

5.6 ADDITIONAL PREPARATORY AND INITIAL PHASES

The PQCM may conduct additional preparatory and initial inspections on the same DFWs under the following circumstances: 1) if the quality of ongoing work is unacceptable as determined by the PQCM, PjM or designee, the ROICC, the NAVWPNSTA IR Program Coordinator, or RPM, 2) if there are changes in the staff, on-site supervision, or work crew, 3) if work on a definable feature is resumed after a substantial period of inactivity, or 4) if other problems develop.

5.7 COMPLETION INSPECTION

Completion inspections will be performed as summarized in this section.

5.7.1 Quality Control Completion Inspections

The PQCM or designated TtFW QC inspection personnel will conduct a detailed inspection prior to the pre-final inspection, when all of the work or an increment of work is deemed to be substantially complete. The PjM, the RPM, the NAVWPNSTA IR Program Coordinator, and the ROICC may also participate and will be notified in advance of the inspection date. The work will be inspected for conformance to plans, specifications, quality, workmanship, and completeness. The PQCM will prepare an itemized list of work not properly completed, inferior workmanship, or work that does not conform to plans and specifications. The list will also include outstanding administrative items, such as record (as-built) drawings. The list will be included in the QC documentation and submitted to the PjM or designee, the ROICC, the NAVWPNSTA IR Program Coordinator, and the RPM within 5 workdays following the inspection and will specify an estimated date for correction of each deficiency.

5.7.2 Pre-final Completion Inspection

The PjM or designee will conduct the pre-final inspection, and the ROICC, TtFW QC inspection personnel, the PQCM, or other primary management representative, as applicable, will attend. The PjM or designee will schedule the pre-final inspection in response to notification from the PQCM prior to the planned inspection date. The PQCM is required to verify at this time that all specific items previously identified to TtFW as being unacceptable, along with all remaining project work, will be complete and acceptable by the date scheduled for the pre-final inspection. At this inspection, the PjM or designee will develop a specific list of incomplete and/or unacceptable work performed under the contract and will provide this list to TtFW.

5.7.3 Final Completion Inspection

The PjM will schedule the final completion inspection based on notification from the PQCM of readiness. The inspection will include the QC inspection personnel, PQCM, or other primary management personnel, the PjM, the RPM, the NAVWPNSTA IR Program Coordinator, and the ROICC. Notification will be provided prior to the planned final completion inspection date. The notification must include verification that all specific items previously identified as being

unacceptable, along with all remaining work performed under the contract, will be complete and acceptable by the date scheduled for the final completion inspection.

5.8 INSPECTION DOCUMENTATION

The PQCM is responsible for the maintenance of the inspection records. Inspection records will be legible and clearly written to provide all necessary information to verify that the items or activities inspected conform to the specified requirements or, in the case of nonconforming conditions, provide evidence that the conditions were brought into conformance or otherwise accepted by TtFW. All inspection records will be made available to the DON.

6.0 DOCUMENTATION

Preparation, review, approval, and issuance of documents affecting quality will be controlled to the extent necessary to determine that the documents meet specified requirements. Project documents to be controlled include:

- Meeting Minutes, Conference Notes, and Confirmation Notes
- Submittal Register
- Inspection Documentation
- CQCR
- Survey Logs
- Testing Plan and Log
- NCRs
- DCNs
- FCRs
- Project Plans
- Record (As-built) Drawings

6.1 CONTRACTOR QUALITY CONTROL REPORT

The PQCM is responsible for maintenance of current records of QC operation, activities, and tests performed, including the work of subcontractors and suppliers. The records will include factual evidence that required QC activities and tests were performed A CQCR will be completed to document construction activities covered by the Project CQC Plan and will include:

- Record inspection and/or testing performed
- Identification and location of each DFW and its current phase (preparatory, initial, follow-up) of completion
- Results of inspections/testing
- Location and description of deficiencies
- Deficiencies corrected as of the date of the report
- Rework items
- Deviations from plans, difficulties, and resolution
- Test and/or control activities performed with results and references to specifications/ plan requirements, including the control phase (preparatory, initial, and follow-up) and deficiencies (along with corrective action)

- Material received, with statement as to its acceptability and storage
- Submittals reviewed with contract reference, by whom, and action taken

The records will indicate a description of trades working on the project, the number of personnel working, weather conditions encountered, and any delays encountered. Both conforming and nonconforming features will be covered with a statement that equipment and materials incorporated in the work and workmanship comply with the contract. The original of this report shall be furnished to the ROICC on the first workday following the date covered by the report, except that reports need not be submitted for days during which no work is performed. At a minimum, one report shall be prepared and submitted for every 7 days of no work and on the last day of a no-work period. All calendar days shall be accounted for throughout the life of the contract. The first report following a day of no work will summarize work for that day only. Reports will be signed and dated by the PQCM and other appropriate personnel, including subcontractors responsible for completion of activities. The report will include copies of test reports and copies of reports prepared by all subordinate QC personnel.

6.2 CONTRACTOR PRODUCTION REPORT

The Contractor Production Report will be prepared for each day the work is performed and will be attached to the daily CQCR prepared for the same day. The Contractor Production Report will be prepared, signed, and dated by the Project Superintendent and will contain the following information:

- Contractor and subcontractor and their area of responsibility
- Location and description of work performed
- Trades working on the project that day and number of personnel
- Operating equipment, with hours worked, idle, or down for repair
- Work performed that day giving location, description, weather conditions, and by whom work was done
- Any delays encountered
- Site visitors/purpose
- Job safety evaluations stating what was checked, results, and instructions or corrective actions
- A list of instructions given/received and conflicts in plans and/or specifications
- Contractor's verification statement

6.3 CONFERENCE NOTES AND CONFIRMATION NOTES

In addition to other required documentation, the PQCM is responsible for taking notes and preparing the reports of all conferences. Conference notes will be typed and the original report furnished to the DON within 5 days after the date of the conference for concurrence and subsequent distribution to all attendees. At a minimum, this report will include:

- Date and place the conference was held
- List of attendees, including name, organization, and telephone number
- Written comments presented by attendees attached to each report with the conference action noted: "A" for an approved comment, "D" for a disapproved comment, "W" for a comment that has been withdrawn, and "E" for a comment that has an exception noted
- Comments made during the conference and decisions affecting criteria changes
- Conference notes that augment the written comments

The PjM, or his designee, is also responsible for providing a record of all discussions, verbal directions, telephone conversations, and so forth, in which TtFW personnel or their representatives participate on matters relating to this contract and work. These records, entitled "Confirmation Notices" will be numbered sequentially and will fully identify participating personnel, subject discussed, and any conclusions reached. The PjM, or his designee, will forward a reproducible copy of the confirmation notices to the RPM, or designee, and the ROICC within 5 workdays.

6.4 TESTING PLAN AND LOG

As tests are performed, the PQCM will record on the Testing Plan and Log (Table B.2-1), the date the test was conducted, the date the test results were forwarded to the ROICC, and remarks and acknowledgement that an accredited testing laboratory was used. The updated Testing Plan and Log will be attached to the last daily CQCR of each month.

6.5 REWORK ITEMS LIST

The PQCM will maintain a list of work that does not comply with the contract, identifying what items need to be reworked, the date the item was originally discovered, the date the item will be corrected by, and the date the item was corrected. A rework item that is corrected the same day it is discovered will not be reported. The Rework Item List (Attachment 3) will be attached to the last daily CQCR of each month.

7.0 NONCONFORMANCES

The PQCM documents any work or materials not conforming to the technical specifications or project/contract requirements on an NCR. The NCR will detail the nonconforming condition, the recommended corrective action(s), and the disposition of the corrective action(s). Qualified representatives from engineering, QA, and construction will review the NCR and either accept or reject the recommended corrective action or disposition. The NCR will remain open until the nonconforming condition has been satisfactorily resolved and verified by QC inspection staff and PQCM. Upon receipt of notification of detected nonconformance, NCRs for each item will be completed.

7.1 IDENTIFICATION OF NONCONFORMING ITEMS

Items identified as nonconforming will be documented on an NCR that will include the following information:

- Description of nonconforming item or activity
- Detailed description of nonconformance
- Referenced criteria
- Recommended disposition and corrective action to prevent recurrence, as applicable
- Affected organization

Deficient conditions have been divided into three categories:

- In-process deficiencies
- Installed deficiencies
- Conditions that require Stop Work

7.1.1 In-process Deficiencies

In-process deficiencies are those conditions discovered during the course of QC inspections that are intended to be corrected or brought into conformance with requirements. In-process deficiencies will be noted briefly on the CQCR and detailed on the Deficiency Punch List (Attachment 3). Items on the punch list that cannot be corrected will be considered installed deficiencies.

7.1.2 Installed Deficiencies

Installed deficiencies are those conditions discovered during the course of QC inspection of completed work that do not meet established acceptance criteria or requirements and are not intended to or cannot be brought into conformance. These conditions will be noted on a Rework Item List (Attachment 3) in addition to a Construction Deficiency Report for evaluation and disposition. The PQCM will issue the Construction Deficiency Report summarizing discrepancies within 24 hours of discovery.

In the event a Construction Deficiency Report is not resolved within 7 calendar days after issuance, a notice of non-response will be issued to the PjM. Each report will be consecutively numbered, logged, and updated by the PQCM. Resolution of installed deficient conditions will be approved by the PjM. Copies of completed reports will be sent to the DON representative.

7.1.3 Condition Requiring Stop Work

If corrective actions are insufficient, resolution cannot be reached, or results of prior work are indeterminate, work may be stopped. A Stop Work Order can only be issued by the Project Superintendent and the PQCM in writing. If there is a disagreement between the PQCM and the PjM, the difference will be brought to the attention of the QCM until resolution is achieved.

The conditions of the Stop Work Order will be described in detail on a Rework Item List in addition to the Construction Deficiency Report to allow evaluation of the problem(s) and proper corrective action(s). Work will not continue until the Stop Work Order has been rescinded by the individual who authorized it.

7.1.4 NCR Log

The PQCM will maintain a NCR log, which provides the NCR number, a brief description of the nonconforming condition, date of issue, point of contact to resolve, date of anticipated corrective action, and date closed.

7.2 NONCONFORMING ITEMS

The nonconforming items will be controlled to prevent inadvertent use. All items noted as nonconforming will be clearly identified and segregated from acceptable items when practical.

7.3 DISPOSITION

The disposition of NCRs will include the necessary actions required to bring the nonconforming condition to an acceptable condition and may include reworking, replacing, retesting, or re-inspecting. Implementation of the disposition may be done in accordance with the original procedural requirements, a specific instruction, or a FCR.

7.3.1 Field Change Requests and Design Change Notices

Site personnel shall document changes to the approved plans in the field through the FCR form. At a minimum, the following information will be documented on the FCR form:

- Project name
- CTO number
- FCR number
- Documents to which a change is requested (including revision number if applicable)
- Description of the item or condition for which the change is requested
- Reason for the change
- Recommended disposition
- Cost and schedule implication of the change, if any
- Approval of disciplines if changes involve risk-sensitive items in that discipline
- Approval of the PjM, Site Superintendent, PESM, and QCM

7.4 CORRECTIVE ACTIONS

Upon detection of a nonconforming condition, the PQCM will immediately take corrective action. In addition to resolving identified nonconforming conditions, corrective action records will also address the initial cause of adverse conditions and establish methods and controls to prevent recurrence of the same or similar types of nonconformances. The PQCM will monitor the corrective actions to verify that they were properly implemented and accepted and that the NCR was closed out.

8.0 QUALITY MANAGEMENT

In addition to the required QC field inspections, the TtFW Quality Program requires a quality management overview of the site QA/QC Program implementation. The PQCM will perform regular internal QC checks on the site implementation of the QA/QC Program. Reports of any deficiencies will be reported to the PjM for corrective action.

Inspections will be performed and checked for the following:

- Possession and use of approved procedures, standards, and project specifications
- Conformance with appropriate procedures, standards, and instructions
- Thoroughness of performance
- Identification and completeness of documentation generated during performance

9.0 REFERENCES

Tetra Tech FW, Inc. (TtFW). 2004. *Final Contractor Quality Control Program Plan.*

United States Army Corps of Engineers (USACE). 1996. *United States Army Corps of Engineers Safety and Health Requirements Manual.* USACE EM-385-1-1. September 3.

TABLES

TABLE B.2-1

TESTING PLAN AND LOG

CONTRACT NUMBER	PROJECT TITLE AND LOCATION	CONTRACTOR
N68711-98-D-5713, CTO No. 0090	Enhanced In Situ Bioremediation, IRP Site 40, NAVWPNSTA Seal Beach, Seal Beach, California	Tetra Tech FW, Inc.

SPECIFICATION SECTION AND PARAGRAPH NUMBER	ITEM OF WORK	TEST REQUIRED	ACCREDITED/ APPROVED LAB		SAMPLED BY	TESTED BY	LOCATION OF TEST		FREQUENCY	DATE COMPLETED	DATE FORWARDED TO CONTR. OFF.	REMARKS
			YES	NO			ON SITE	OFF SITE				
		Backflow preventer	X				X		Start of project, quarterly thereafter			
		Sodium lactate delivery system - flow rate		X			X		Every well, each day of operation at startup			Flow rate of solution to each well

TABLE B.2-2

DEFINABLE FEATURES OF WORK

ACTIVITY	PREPARATORY	DONE	INITIAL	DONE	FOLLOW-UP	DONE
Mobilization	• Verify that the ROICC has been notified. • Verify that the approved final RD/WP and SHSP are available on-site. • Verify that the NFECSW QA Officer has signed the Sampling and Analysis Plan. • Verify that SHSP has been approved. • Verify that all site personnel, including contractors, have submitted health and safety and qualification documentation. • Verify that TtFW internal Operational Readiness Review has been conducted and that all "punch list" items have been completed. • Verify that project kick-off meeting was held per Section 5.3 of the RD/WP and minutes have been issued. • Review lists of equipment, facilities, and materials to be delivered to the project site. • Verify that location of equipment, facilities, and materials staging areas have been approved by ROICC. • Review traffic control procedure. • Review NAVWPNSTA Seal Beach requirements for connecting to station utilities and verify that all permits and/or notifications have been made.		• Verify that work is being performed in compliance with vendor SOWs, station requirements, and all applicable regulations. • Verify that delivery trucks are using approved route. • Inspect all equipment, facilities, and materials upon arrival at the site. • Inspect preparation of work zones (support zone, contaminant reduction zone, and exclusion zone). • Verify that equipment received is clean. • Verify that health and safety awareness training has been completed by all site personnel. • Check for compliance with the SHSP and with task AHA(s).		• Verify that work has been performed in compliance with the Work Plan, vendor SOWs, station requirements, permit requirements, and all applicable regulations. • Verify that documentation for any utility hook-up work has been submitted. • Verify that all required equipment, facilities, and materials have been delivered to the project site.	

TABLE B.2-2

DEFINABLE FEATURES OF WORK

ACTIVITY	PREPARATORY	DONE	INITIAL	DONE	FOLLOW-UP	DONE
Mobilization (continued)	• Verify that vendor SOWs provided to utility connection vendors meet NAVWPNSTA Seal Beach requirements and all applicable regulations. • Review AHA(s) for this activity.					
Land survey to mark the planned well locations	• Verify that the ROICC has been notified. • Verify that the surveyor is licensed in the state of California. • Review survey SOW. • Review survey area and planned well locations in Section 5.5.1 of the RD/WP. • Review AHA(s) for this activity.		• Confirm that the survey crew understands the survey area and what specific locations need to be surveyed. • Verify that the California State Plane Coordinate system is used. • Check for compliance with the SHSP and with task AHA(s).		• Verify that survey area and well locations are correct. • Verify that deliverables are received as required in the survey SOW.	
Geophysical survey for underground utility identification	• Verify that the ROICC has been notified. • Notify Underground Service Alert at least 5 business days prior to geophysical survey. • Review as-built drawings or subsurface utility plats, if available. • Mark out work areas to delineate geophysical survey areas and locations for clearance. • Perform on-site visual identification of any utilities that may intersect the work area. • Review AHA(s) for this activity.		• Ensure that the parties contacted by Underground Service Alert respond to their notifications. • Ensure that as-built drawings, if available, are provided to geophysical subcontractor. • Check for compliance with the SHSP and with task AHA(s).		• Prior to engaging in intrusive activities, ensure that drawings generated by geophysical survey contractor are received, reviewed, and understood by the on-site project staff. • Ensure that permit is kept current during drilling and earthwork operations.	

TABLE B.2-2

DEFINABLE FEATURES OF WORK

ACTIVITY	PREPARATORY	DONE	INITIAL	DONE	FOLLOW-UP	DONE
Drilling, installation, and development of groundwater injection wells	• Verify that the ROICC has been notified. • Verify that the necessary well installation permits have been obtained from the County of Orange Department of Environmental Health. • Review Sections 5.5.3 and 5.5.4 of the RD/WP and permit requirements relevant to the placement of wells. • Review results of geophysical survey and check against proposed well locations. • Review AHA(s) for this activity.		• Check well construction materials against permit requirements, Sections 4.2.1 and 5.5.6 of the RD/WP and vendor SOW to ensure that they are in compliance. • Check that wells are being installed per Sections 4.2.1 and 5.5.6 of the RD/WP. • Verify that there is adequate equipment and materials to decontamination drilling equipment as necessary. • Check for compliance with the SHSP and with task AHA(s).		• Verify that work has been performed in compliance with the RD/WP, vendor SOW, and permit requirements.	
Drilling, installation, and development of groundwater monitoring wells	• Verify that the ROICC has been notified. • Verify that the necessary well installation permits have been obtained from the County of Orange Department of Environmental Health. • Review Sections 5.5.3 and 5.5.4 of the RD/WP and permit requirements relevant to the placement of wells. • Review results of geophysical survey and check against proposed well locations. • Review AHA(s) for this activity.		• Check well construction materials against permit requirements, Sections 4.2.5 and 5.5.5 of the RD/WP and vendor SOW to ensure that they are in compliance. • Check that wells are being installed per Sections 4.2.5 and 5.5.5 of the RD/WP. • Verify that there is adequate equipment and materials to decontaminate drilling equipment as necessary. • Check for compliance with the SHSP and with task AHA(s).		• Verify that work has been performed in compliance with the RD/WP, vendor SOW, and permit requirements.	

TABLE B.2-2

DEFINABLE FEATURES OF WORK

ACTIVITY	PREPARATORY	DONE	INITIAL	DONE	FOLLOW-UP	DONE
Drilling and installation of soil vapor wells	• Verify that the ROICC has been notified. • Verify that the necessary well installation permits have been obtained from the County of Orange Department of Environmental Health. • Review sections 5.5.3 and 5.5.4 of the RD/WP and permit requirements relevant to the placement of wells. • Review results of geophysical survey and check against proposed well locations. • Review AHA(s) for this activity.		• Check well construction materials against permit requirements, RD/WP and vendor SOW to ensure that they are in compliance. • Check that wells are being installed per Section 4.2.7 of the RD/WP. • Verify that there is adequate equipment and materials to decontaminate drilling equipment as necessary. • Check for compliance with the SHSP and with task AHA(s).		• Verify that work has been performed in compliance with the RD/WP, vendor SOW, and permit requirements.	
Land Survey (post-construction) to document the well locations	• Verify that the ROICC has been notified. • Verify that the surveyor is licensed in the state of California. • Review survey SOW. • Review AHA(s) for this activity.		• Confirm that the survey crew understands the survey area and what specific locations need to be surveyed. • Verify that the California State Plane Coordinate system is used. • Check for compliance with the SHSP and with task AHA(s).		• Verify that all wells are included in the survey. • Verify that deliverables are received as required in the survey SOW.	
Construction of the sodium lactate delivery system	• Verify that the ROICC has been notified. • Review Section 5.5.6 of the RD/WP, vendor SOW, and subcontractor submittals for construction of the system. • Verify that field engineer has reviewed and approved submittals for construction of the system. • Review Base requirements for connecting to NAVWPNSTA Seal Beach water service (flow meter and/or backflow preventer) and verify that all permits have been obtained and/or notifications have been made.		• Verify that materials and equipment for the system meet requirements of Section 5.5.6 of the RD/WP, vendor SOW, and match subcontractor submittals. • Ensure that subcontractor has understanding of work to be performed and that they maintain a current set of design drawings. • Check that system is being installed per Section 5.5.6 of the RD/WP.		• Verify that work has been performed in compliance with the RD/WP, vendor SOW, and permit requirements. • Ensure that subcontractor provides as-built drawings and all manufacturers' data for component pieces of the system.	

TABLE B.2-2

DEFINABLE FEATURES OF WORK

ACTIVITY	PREPARATORY	DONE	INITIAL	DONE	FOLLOW-UP	DONE
Construction of the sodium lactate delivery system (continued)	• Verify that SOW provided to vendor for connecting to NAVWPNSTA Seal Beach water service meet NAVWPNSTA Seal Beach requirements and all applicable regulations. • Review AHA(s) for this activity.		• Check for compliance with the SHSP and with task AHA(s).			
Installation of dedicated well pumps and associated equipment	• Verify that the ROICC has been notified. • Review Section 5.5.5 of the RD/WP, vendor SOW, and subcontractor submittals for installation of dedicated well pumps and associated equipment. • Verify that field engineer has reviewed and approved submittals for installation of dedicated well pumps and associated equipment. • Review AHA(s) for this activity.		• Verify that materials and equipment meet the requirements of Section 5.5.5 of the RD/WP, vendor SOW, and match subcontractor submittals. • Ensure that subcontractor has understanding of work to be performed and that they maintain a current set of design drawings. • Check that installation of dedicated well pumps and associated equipment is being installed per Section 5.5.5 of the RD/WP. • Check for compliance with the SHSP and with task AHA(s).		• Verify that work has been performed in compliance with the RD/WP, vendor SOW, and permit requirements. • Ensure that subcontractor provides as-built drawings and all manufacturers' data for component pieces of the system.	

TABLE B.2-2

DEFINABLE FEATURES OF WORK

ACTIVITY	PREPARATORY	DONE	INITIAL	DONE	FOLLOW-UP	DONE
Injection of sodium lactate solution into the subsurface at a specified number of groundwater injection wells (biostimulation to degrade chlorinated ethenes) and monitoring of the biostimulation process	• Verify that the ROICC has been notified. • Review Sections 6.1 and 6.1.2 of the RD/WP, vendor SOW for supplying biostimulation materials, and subcontractor submittals for biostimulation materials. • Review Sampling and Analysis Plan (Appendix A in the RD/WP). • Review AHA(s) for this activity.		• Verify that materials and equipment meet the requirements of Sections 6.1 and 6.1.2 of the RD/WP, vendor SOW, and match subcontractor submittals. • Check that preparation of the sodium lactate solution and injection of sodium lactate into the subsurface is being performed per Section 6.1.2 of the RD/WP. • Check that monitoring of the biostimulation process (sampling, data analysis, and decision-making for optimization of biostimulation process) is being performed in accordance with the Sampling and Analysis Plan (Appendix A in the RD/WP) and Section 6.1.2 of the RD/WP. • Check for compliance with the SHSP and with task AHA(s).		• Verify that work has been performed in compliance with the Sampling and Analysis Plan (Appendix A in the RD/WP) and the RD/WP.	

TABLE B.2-2

DEFINABLE FEATURES OF WORK

ACTIVITY	PREPARATORY	DONE	INITIAL	DONE	FOLLOW-UP	DONE
Introducing non-indigenous microorganisms to the groundwater (bioaugmentation to complete the dechlorination process) and monitoring of the bioaugmentation process	• Verify that the ROICC has been notified. • Review Section 6.2 of the RD/WP, vendor SOW for supplying bioaugmentation materials, and subcontractor submittals for bioaugmentation materials. • Review Sampling and Analysis Plan (Appendix A in the RD/WP). • Review AHA(s) for this activity.		• Verify that materials and equipment meet the requirements of Section 6.2 of the RD/WP, vendor SOW, and match subcontractor submittals. • Check that introduction of non-indigenous microorganisms to the groundwater is being performed per Section 6.2 of the RD/WP. • Check that monitoring of the bioaugmentation process (sampling, data analysis and decision making for optimization of bioaugmentation process) is being performed in accordance with the Sampling and Analysis Plan (Appendix A in the RD/WP) and Section 6.2 of the RD/WP. • Check for compliance with the SHSP and with task AHA(s).		• Verify that work has been performed in compliance with the Sampling and Analysis Plan (Appendix A in the RD/WP) and the RD/WP.	
Long-term groundwater monitoring	• Verify that the ROICC has been notified for each groundwater monitoring event. • Review the Sampling and Analysis Plan (Appendix A in the RD/WP) and Section 6.6 of the RD/WP. • Review AHA(s) for this activity.		• Check that each groundwater monitoring event is being performed in accordance with the Sampling and Analysis Plan (Appendix A in the RD/WP) and Section 6.6 of the RD/WP. • Check for compliance with the SHSP and with task AHA(s).		• Verify that work has been performed in compliance with the Sampling and Analysis Plan (Appendix A in the RD/WP) and the RD/WP.	
Health and safety monitoring (soil vapor monitoring and indoor air monitoring)	• Verify that the ROICC has been notified. • Review the SHSP and Sections 6.5.1 and 6.5.2 of the RD/WP. • Review AHA(s) for this activity.		• Check that health and safety monitoring is being performed in accordance with the SHSP and Section 6.5 of the RD/WP. • Check for compliance with task AHA(s).		• Verify that work has been performed in compliance with the SHSP and the RD/WP.	

TABLE B.2-2

DEFINABLE FEATURES OF WORK

ACTIVITY	PREPARATORY	DONE	INITIAL	DONE	FOLLOW-UP	DONE
Transportation and disposal of waste	• Verify that the ROICC has been notified. • Review applicable sections of the RD/WP and appendices. • Verify that waste sample results are received and reviewed. • Verify that transport personnel are qualified and know the procedure. • Verify that transport forms are completed and reviewed by the Regulatory Compliance Officer. • Verify that the TSDF is TtFW-approved. • Verify that the TtFW-approved TSDF is prepared to receive the material. • Review AHA(s) for this activity.		• Verify that proper profile and manifests are generated and signed. • Verify that correct waste is being loaded. • Verify that loaded trucks are being weighed with a portable truck scale. • Verify that trucks are using approved route. • Verify that the material is being transported to the TtFW-approved TSDF. • Check for compliance with the SHSP and with task AHA(s). • Check that work is being performed in accordance with the Waste Management Plan (Section 7.0 of the RD/WP).		• Verify that the original copies of the manifest are being provided to the transporter. • Verify that copies of the manifest are being provided to the NAVWPNSTA IR Program Coordinator. • Verify receipt and proper disposal at correct location. • File completed transport records.	
Demobilization of equipment, facilities, and materials	• Verify that the ROICC has been notified. • Review demobilization procedure. • Verify that final completion inspection has been completed and all action items have been completed. • Review AHA(s) for this activity.		• Inspect and document decontamination of equipment and verify that proper procedure is being used. • Check that work is being performed in accordance with the Waste Management Plan (Section 7.0 of the RD/WP). • Check for compliance with the SHSP and with task AHA(s).		• Verify that all equipment has been decontaminated. • Verify that all equipment, facilities, and materials have been demobilized. • Submit original field documentation to the ROICC for archive.	

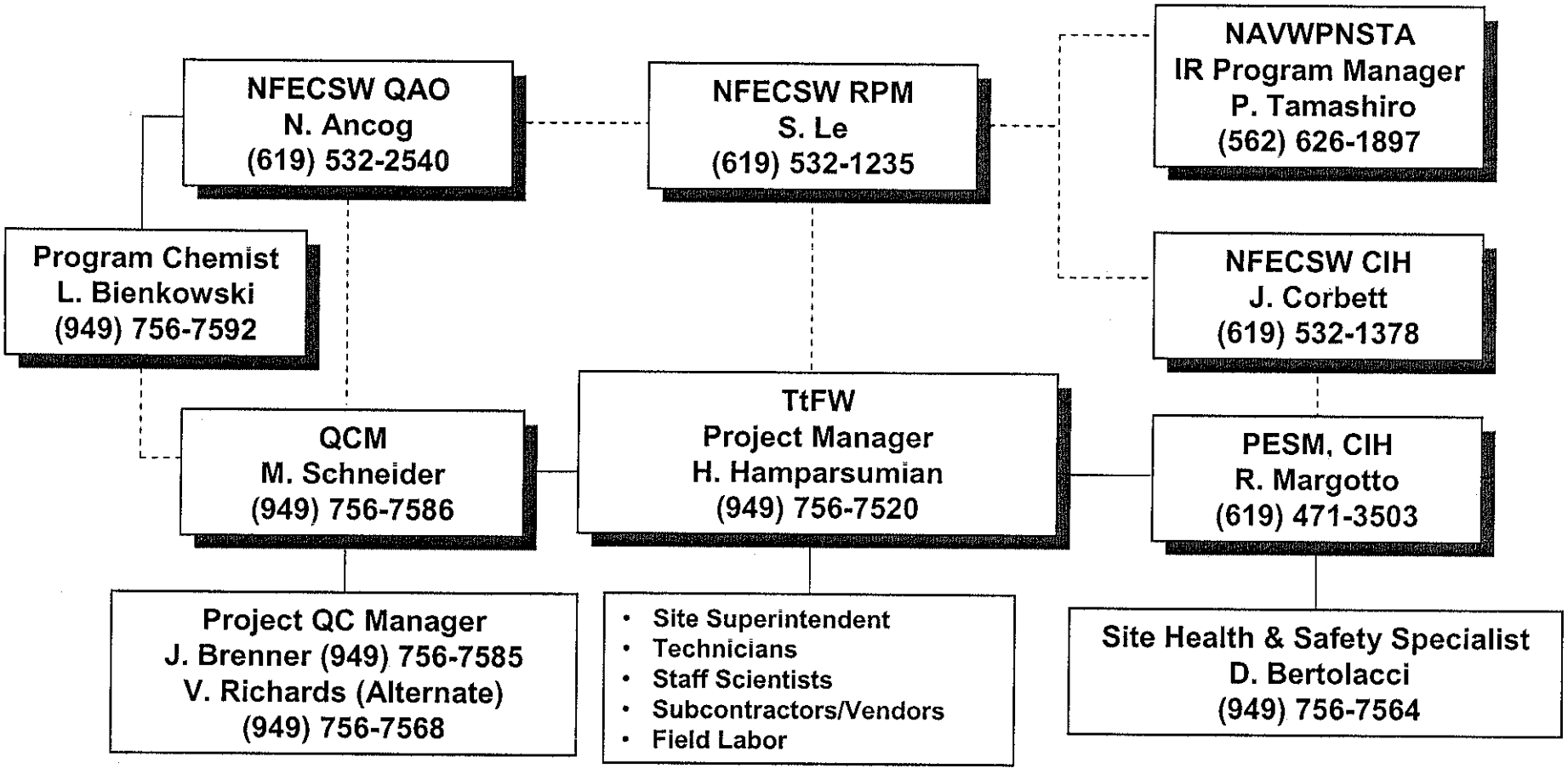
Notes:

AHA – Activity Hazard Analysis
IR – Installation Restoration
NAVWPNSTA – Naval Weapons Station
NFECSW – Southwest Division, Naval Facilities Engineering Command
QA – Quality Assurance
RD/WP – Remedial Design/Work Plan
ROICC – Resident Officer in Charge of Construction
SHSP – Site-Specific Health and Safety Plan
SOW – Scope of Work
TtFW – Tetra Tech FW, Inc.
TSDF – treatment, storage, and disposal facility

FIGURES

Figure B.2-1

Project Organization Chart



Legend

- - - - - = In regular contact and coordination

_____ = Directly reports to above

ATTACHMENT 1

RESUME

EXPERIENCE SUMMARY

Mr. Brenner is a Geologist with a strong background in chemistry and geochemistry. He has over 7 years experience in managing large tasks associated with large-scale remedial investigations and remedial systems operations. His management responsibilities have included budget preparation and tracking, procurement of equipment and subcontractors, scheduling, and communications with client. Direction of all field activities including oversight of geologists, engineers, and subcontractors.

Technical responsibilities have included the preparation of written interpretations and analyses of lithologic, geochemical, and hydrologic data in the form of formal report deliverables. Preparing work plans, SOWs, technical memos, SOPs, and sampling plans. Preparation of written responses to regulatory agency comments on all technical deliverables. Also provide technical assistance for preparation of engineering design specifications. He has supervised and participated in numerous critical well drilling and installation projects involving a wide variety of innovative drilling techniques and well completions.

EDUCATION

MS, Geological Sciences, California State University, 1996
BS, Geological Sciences, Michigan State University, 1988

REGISTRATIONS/CERTIFICATIONS

Registered Geologists, CA, Number 7134, Earned 12/15/00, Expires 1/31/05

TRAINING

Project Management Training (PM 300), 2003
Project Management Training (PM 200), 1999
Project Management Training (PM 100), 1997
DNV Loss Control Management, 1999
GIS/Geostatistics Course, DON, Naval School, Civil Engineering Corps Officers (CECOS), 2000
(ESS) 40-hour Health & Safety Officer Course, 1997
40-hour OSHA 29 CFR 1910.120(e) HAZWOPER Training, 1996
8-hour OSHA 29 CFR 1910.120(e) HAZWOPER Refresher Training, 1997, 1998, 1999, 2000, 2001, 2002, 2003
Waste Management Employee Training 40 CFR 265.16, 1996, 1998, 1999, 2000, 2001, 2002, 2003
DOT/HM-126F Hazmat Training, 1996, 1997
Environmental Site Assessment Training, 1997
American Red Cross Standard First Aid, 1998, 2002 (valid through 1/2004)
American Red Cross Adult CPR, 2000

CORPORATION PROJECT EXPERIENCE

Project Manager, 01/03-Present
Navy Southwest Division - Marine Corps Logistics Base Barstow, Barstow, California
Currently serving as Project Manager for large-scale mutli-year monitoring project for three wastewater treatment plants at the MCLB Barstow. Responsibilities include all management aspects related to the execution of the monitoring and reporting program, including consistent interaction with multiple clients/stakeholders.

Assistant Project Manager/Task Manager, 01/00-Present
Navy Southwest Division - Marine Corps Logistics Base Barstow, Barstow, California
Currently serve as assistant project manager for all subsurface activities and investigations for a large, ongoing remediation project covering two geographically-separate base facilities under the SWDIV RAC Contract. Responsibilities include planning, implementing, and documenting all subsurface activities.

Prepare written interpretations and analyses of lithologic, hydrologic, and geochemical data in the form of formal report deliverables. Responsible for all aspects of long-term quarterly groundwater monitoring program that includes a network of over 150 monitoring wells and a large groundwater extraction/treatment system. Provide technical assistance in preparation of work plans, sampling plans, and engineering design specifications.

Task Manager/Field Lead, 01/99-01/00
Responsible for all aspects of quarterly groundwater monitoring program. Also responsible for planning and execution of several drilling programs to install a variety of different monitoring well types involving numerous drilling techniques. Directed all field activities during several drilling programs, including oversight of geologists, engineers, and drilling subcontractors for a multiple-crew, multiple-rig operation.

Project Geologist, 10/99 - Present
Navy Southwest Division - Seal Beach Naval Weapons Station, Seal Beach, CA
Installed multiple groundwater wells and soil borings as part of Baseline Survey of former leaking UST site. Conducted initial groundwater sampling of groundwater wells. Prepared substantial portions of Work Plan and Baseline Survey Results Report associated with installation, development, and sampling of wells and soil borings. Performed 3 formal presentations regarding the Baseline Survey work plan, results, and proposed work at 3 different Residential Advisory Board (RAB) meetings over the course of project. Provide ongoing technical advice and assistance to project manager.

Project Geologist, 10/00 – 1/2002
ICI-Americas, Former ARBCO Site, Van Nuys, CA
Provided technical input and assistance for design, procurement, and construction of several deep, multiple-completion monitoring wells drilled /installed at an angle to reach underneath crowded industrial property. The angled wells provided a technically sophisticated and economically feasible solution to several problems that could not be addressed by conventional means. Supervised all drilling/installation efforts using sonic drillng technique.

Installed and sampled multiple deep confirmation soil borings as part of site closure efforts at a former manufacturing facility. Utilized limited access drilling equipment to install boring inside former production facility. Sampling included use of EnCore® samplers for volatile organic compounds.

Field Lead/Client Liaison, 06/00-07/00
California-Nevada Developments, LLC - ASCON Site, Huntington Beach, CA
Performed radiological field screening at high-profile disposal site for oil and gas production wastes. Frequently engaged in direct communication with client regarding technical, regulatory, and other project-related issues.

Task Manager, 12/98-07/99
NASA-Jet Propulsion Laboratory (JPL), Pasadena, CA
For the Long-Term Groundwater Monitoring program as part of the Comprehensive Environmental Response, Cleanup Liability Act (CERCLA) Remedial Investigation at JPL. Primarily responsible for the successful planning and execution of the $1 million dollar per year long-term quarterly groundwater monitoring program. Management responsibilities included budget preparation and tracking, procurement of equipment and subcontractors, scheduling, and communication with client. Technical responsibilities included performing and supervising field operations, training and oversight of field personnel, and preparation of technical reports and correspondences.

Task Manager, 12/98-07/99
Project Geologist, 08/96-12/98
Conducted quarterly groundwater sampling and monthly water-level measurements for long-term monitoring program. Presence of 13 deep, multi-port GW wells required the use of specialized sampling equipment manufactured by Westbay®, Inc. Installed several deep, multi-screened groundwater wells completed with Westbay® multi-port sampling system. Installed multiple deep multi-depth soil-vapor monitoring probes. Drilling experiences included deep drilling using reverse-circulation mud-rotary and rotary-sonic techniques.

Project Manager/Geologist, 01/97-07/00
Teledyne Cast Parts, Pomona, CA
For Semi-Annual Groundwater Monitoring Program at an existing casting facility. Responsible for all aspects of planning and execution of semi-annual groundwater program. Specific responsibilities included preparing and tracking of budget, procurement of all necessary equipment and subcontractors/vendors, performing sampling all activities, supervising subcontractors, management of generated wastes, and preparation of formal reports for submittal. Additional functions included frequent interaction with client and regulatory agencies regarding project-related issues.

Project Manager/Geologist, 02/97-05/98
H. Kramer and Co., El Segundo, CA
For post-closure Groundwater Monitoring program at a high-profile, former industrial site. Responsible for all aspects of planning and execution of semi-annual groundwater program. Specific responsibilities included preparing and tracking of budget, procurement of all necessary equipment and subcontractors/vendors, performing sampling activities, management of generated wastes, and preparation of formal reports for submittal. Additional functions included frequent interaction with client and regulatory agencies regarding project-related issues. Data interpretation involved statistical analysis of groundwater results to monitor effectiveness of remediation effort.

Project Geologist, 01/97-09/97
Teledyne Battery Products, Redlands, CA
Performed semi-annual groundwater sampling using micro-purge and conventional techniques as part of RCRA Facility Investigation. Prepared Groundwater RCRA Facility Investigation (RFI) Report at project completion.

PREVIOUS EXPERIENCE

Research Assistant
California State University, Long Beach, Dept. of Geological Sciences
Investigated relationship between the organic geochemistry and lithology of source rocks in Miocene Monterey Formation. Research focused on the correlation of several specific biological marker compounds to specific lithologic compositions.

Investigated effects of microbial degradation of a large crude oil spill in the shore zone of Huntington Beach, California, February 1990. Conducted a nine-month study concerning the rates and efficacy of biodegradation by a natural microbial population on a large crude oil spill in the shore zone of Huntington Beach, California.

Teaching Associate/Lab Instructor
California State University, Long Beach, Dept. of Geological Sciences
Performed all functions necessary to successfully teach a variety of laboratory and lecture courses in Geology. Courses taught included physical geology, field geology, historical geology lab, and igneous/metamorphic petrology lab. Also served as teaching/field assistant for CSULB summer field

geology camp in southern Utah, providing instruction/supervision to senior-level students learning advanced field and mapping techniques.

PUBLICATIONS & PRESENTATIONS

Brenner, J. P., 1994, Lithologic variation of the rare biomarker 28,30-bisnorhopane within the Miocene Monterey Formation in the Texaco Anita-14 Well, Santa Barbara County, California: AAPG Bulletin, Abstracts from Pacific Section Meeting, April 27-29, 1994, v. 78, p. 658.

Francis, R. D., Javanafar, A., and Brenner, J. P., 1993, Rapid disappearance of oil from a moderate-sized spill: cleanup effort coupled with natural degradation processes: Marine Technology Society Bulletin, v. 26, no. 3, p. 26-33.

Brenner, J. P., 1991, Compositional and ecological effects of the oil residues on shore from the Southern California Oil Spill, February 7, 1990. Proceedings of the VIII International Symposium of Marine Biology, June 1990, p. 138-144.

Francis, R. D., Brenner, J. P., and Chan, K. W., 1991, Short term degradation of crude oil in the shore zone, Huntington Beach, California Oil Spill, February 7, 1990. Proceedings of the Marine Technology Society Meeting, Washington D.C., 1990, p. 442-447.

PROFESSIONAL ACCOMPLISHMENTS

Letter of Appreciation/Recognition for Technical Presentation, Department of the Navy, Southwest Division, Naval Facilities Engineering Command, January, 2000.

Departmental Honor Award, Department of Geological Sciences, California State University, Long Beach, June 1994.

DISCIPLINE CODES

Chemical Experts: 136, N
Geologists: 011, Y
Hydrologists: 012, N
Specification Writers: 021, N

SKILL SET

CHEMICAL SCIENCES
Field Sampling and Analysis Plan
Gas Chromatography
Gas Chromatography / Mass Spectrometry
Groundwater / Surface Water Sampling
Inorganics
Ion Current Plasma
Organics
Remedial Investigation
Remedial Investigation / Feasibility Study
Scanning Electron Microscopy
Volatile Headspace Analysis
Wet Chemistry
X-Ray Diffraction
X-Ray Flourescence

GEOSCIENCE
Borings and Wells - Monitoring Well Installation
Borings and Wells Recovery
Well / Production Well Installation
Borings and Wells - Soil Classification / Logging
Geochemistry - Organic
Geochemistry - Water Quality
Geophysics - Borehole
Geophysics - Nuetron / Gamma
Geophysics - Resistivity
Hydrogeology - Groundwater Hydraulics
Hydrogeology - Water Quality
Hydrogeology - Water Supply
Sampling - Groundwater
Sampling - Soil
Sampling - Sediment
Sampling Water Level Measurements

TECHNICAL EXPERTISE

Subsurface Investigations
Groundwater Geochemistry
Sedimentology
Organic/Petroleum Geochemistry

LANGUAGE SKILLS

English Knowledge Level: Primary
Spanish Knowledge Level: Secondary: Familiar

PROFESSIONAL REFERENCES

Mark Cutler, R.G.
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Santa Ana, CA 92705
(949) 756-7526

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(949) 756-7500

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Mark Losi, Ph.D.
Senior Scientist
1940 E. Deere St., Suite 200
Santa Ana, CA 92705
(949) 756-7516

RELATED COMPANY INFORMATION

Office Location: Santa Ana
Hire Date: 8/5/96
Years with Other Firms: 8
Years with Current Firm: 8
Supervisor: Mark A. Cutler, Supervising Geoscientist
Phone: (949) 756-7585
Fax: (949) 756-7560
E-mail Address: jbrenner@ttfwi.com
Resume Last Revised: 1/6/2004

EXPERIENCE SUMMARY

Mr. Richards is a Certified Engineering Geologist registered in the State of California with over 20 years of experience in the geotechnical field. During the past 16 years, his work has been focused on the environmental and solid waste management fields. His duties have included managing remediation projects and specific tasks associated with landfill construction jobs, as well as conducting various geotechnical and groundwater environmental studies for both private and government agencies. Mr. Richards has participated in numerous drilling projects involving a variety of equipment and has experience with many water and soil sampling techniques. Mr. Richards field experience with large type construction projects has enabled him to perform or monitor quality control task associated with a wide variety of activities on these sites and has completed Army Corp of Engineers training. He has been responsible for preparing remedial investigation reports, remedial action and closure plans, detailed work plans, health and safety reports, permitting documents, and final reports for hazardous and non-hazardous waste facilities.

Currently, Mr. Richards serves as a Geologist on various open delivery orders for the Southwest Division Remedial Action Contract (SWDIVRAC). He is responsible for supervising drilling and excavation projects, conducting quality control and site health and safety duties, and performing other tasks associated with remediation contracts.

EDUCATION

BS, Geology, California State University, 1979

REGISTRATIONS/CERTIFICATIONS

Certified Engineering Geologist, CA, Number 1483, Earned 1/1/90, Expires 7/23/07
Registered Engineering Geologist, CA, Number 4627, Earned 1/1/89, Expires 7/23/07

TRAINING

OSHA Hazardous Waste 8-hour Refresher Training, 2003
DOT/HM-126F Hazardous Material Training, 2002
Environmental and Safety Supervisor Course, 2000
Project Management Training (PM-200), 2000
Waste Management Training, 2002
Loss Control Management Training, 1998
Project Management Training (PM-100), 1998
OSHA Hazardous Waste 40-hour Training, 1988
Project Management Training (PM-300), 2002
U.S.A.C.E. Construction Quality Management for Contractors, 2002

CORPORATION PROJECT EXPERIENCE

Senior Project Geologist
U.S. Navy, Southwest Remedial Action Contract (SWDIVRAC), Various U.S. Navy Facilities, CA
Responsible for various open delivery orders including supervising drilling and excavation projects, soil and groundwater sampling, conducting quality control and site health and safety duties, and performing other various task associated with remediation contracts. Sites include: Alameda Point, Moffett Field, Barstow MCLB, Yermo MCLB, Long Beach and Seal Beach California. Drilling experience include sonic, air-rotary, hollow-stem auger and direct-push technologies.

Senior Geologist
EPA Superfund Site, Operating Industries Inc. (OII) Landfill, CA
Primarily responsible for supervising and performing work activities associated with the installation of final landfill gas (LFG) collection system. Tasks included performing well and probe drilling and abandonment, installing gas headers and gas controls systems. These duties required constant quality control checks to assure that the proper materials were delivered and used in the system in addition to the proper operation of the system. System included 350 gas/leachate wells, 10 miles of gas headers, air blowers and landfill gas flaring equipment. Responsible for identifying, approving and coordinating the import of one million cubic yards of offsite soil used during capping activities at the site area. These duties required the supervision of the quality control activities that included geotechnical and chemical testing of the soil and placement. Provided additional quality control assistance with the installation of concrete drainage swales, road crossings for underground headers, above layout of gas header system and as-built survey work. Provided geologic logging and design support groundwater and leachate control during early work activities associated with the Final Remedy.

Site Engineer
City of Los Angeles, Lopez Canyon Landfill, Los Angeles, CA
Supervised construction of a low-permeability clay and synthetic liner for a 10-acre expansion at an existing landfill. Performed quality control activities associated with the benificiation of onsite soils with bentonite products to meet permeability requirements, and reviewing test data on quality control test for a synthetic liner

Site Geologist
Los Angeles County Sanitation District, Puente Hills Landfill, Whittier, CA
Performed oversight activities associated with the construction of a 1000-foot long, 100-foot deep bentonite slurry trench with a clamshell bucket and 50-foot mast crane. Responsibilities included observation of the excavation, verifying bedrock contacts and reviewing quality control test on the slurry mixture.

Project Manager
Operable Unit No. 3, Jet Propulsion Laboratory, Pasadena, CA
Supervised the drilling, construction and sampling of five, 1000-feet deep, groundwater monitoring wells in a residential area. Responsible for the scheduling, coordination of drill and geology crews, quality control for well drilling and site control issues to assure safety of the residents. Supervised the installation of the WestBay sampling system in each well and assure proper operation.

Site Geologist
U.S. Air Force Air Combat Command, Kelly Air Force Base, San Antonio, TX
Supervised the installation of a groundwater monitoring and recovery well system.

Site Assessment Manager
Army Corps of Engineers, Davis-Monthan AFB, Tucson, AZ
Technical engineering lead for the construction of a 25-gpm activated carbon groundwater treatment plant. Facilitated the design of a mobile treatment system constructed on east coast and transported to site. Supervised construction and testing of a reinforced, bermed, concrete pad for the treatment module. Oversight responsibilities for the start-up of the system that included electrical testing, program logic and leak testing of the liquid piping and treatment vessels.

Assessment Manager
Department of the Navy, Concord Naval Weapons Station, Concord, CA
Supervised the stabilization and removal of approximately 1000 cy of heavy metal contaminated soils on base property.

Technical Engineer Lead, 1995 - 1997
Remediation Corporation, Southwest Division Remedial Action Contract (SWDIVRAC) OHM, El Toro Marine Corps. Base, Irvine, CA
Participated in completing open delivery orders in excess of 30 million dollars. Responsible for supervising a variety of remediation projects at the site including free-product recovery, UST removals, in situ remediation, groundwater treatment, groundwater monitoring and soil vapor recovery.

PREVIOUS EXPERIENCE

1991 - 1992
City of Los Angeles, Lopez Canyon Landfill, Los Angeles, CA
Supervised field studies and the regulatory agencies approval process associated with expanding the Lopez Canyon Landfill. Responsible for selecting a low-permeability soil liner and a state-of-the-art sidewall liner system.

1991 - 1992
Bryan A. Stirrat & Associates, Colton Landfill, San Bernardino County, California
Supervised construction of interim drainage facilities for stormwater discharge at the site. Quality control responsibilities included verification of survey control, and installation of designed construction materials including CMP and geosynthetic slope stability materials.

1991 - 1992
Orange County Steel Salvage Company, Anaheim, CA
Prepared the Treatability Study and Remedial Action Plan for chemical fixation of PCB-contaminated auto-shredder fluff.

1991 - 1992
Elixer Industries, Gardena, CA
Conducted a groundwater investigation on a shallow aquifer contaminated with paint manufacturing by-products and enhanced the existing free-product removal system.

Construction Manager, 1987 - 1991
Law Environmental, Azusa Land Reclamation Class III Landfill, Azusa, CA
The site activities involved a 17-acre expansion of an existing landfill. Expansion site required the excavation of approximately 100,000 cubic yards of construction debris, installation of a soil and geosynthetic liner and soil buffer layer. Responsibilities included review of all quality control documents regarding verification of bedrock, soil types, liner thickness, material testing of geosynthetic liner and liner repairs. Acted as direct liaison between the client and regulatory agencies for implementing all regulatory-approved specifications during the construction and coordinating field changes as required.

1987 - 1991
Law Environmental, Regional Water Quality Control Board, Southern California
Participated in investigations required by RWQCB permit conditions for numerous landfill operators at a wide variety of landfill sites. Tasks involved performing Solid Waste Assessment Test (SWAT) projects and preparing a variety of permit applications. Maintained constant interaction with regulatory personnel. Activities included field investigations, water and gas well drilling, soil and water sampling, vadose zone monitoring, and report preparation.

Site Geologist, 1984 - 1987
BKK Landfill Corporation, BKK Class I Landfill, West Covina, CA
Responsible for supervising groundwater and gas well drilling operations, providing survey control, and quality control duties related to documenting field activities. Prepared geotechnical information for preparation and implementation of the first approved Final Closure and Post-Closure Plans for a Class I Landfill in California. As a member of the site engineering team, negotiated on a regular basis with federal and state government regulators to implement state-of-the-art closure design.

Senior Environmental Specialist, 1991 - 1992
Participated in studies and the agency approval process associated with selecting and using low-permeability soil liners for the expansion area of the City of Los Angeles, Lopez Canyon Landfill. Supervised test pad construction and field-testing, utilized heavy earth-moving equipment and a large field permeability test apparatus called a Sealed Double-Ring Infiltrometer. Supervised the testing and agency approval process for an alternative side slope protection system for the liner installation, which involved the air application of a sand and cement mixture on 1:1 cut slopes in the proposed expansion area. Responsibilities also included preparing specifications and QA/QC procedures for the installation of soil, gunite and geosynthetic materials used in the composite liner system.
Supervised the construction of interim drainage facilities at the Colton Landfill, San Bernardino County, California. Responsible for the quality control of construction activities to ensure design specifications. Duties included directing survey work and coordinating engineers with the necessary design changes due to field conditions. Assisted in preparing the Treatability Study for the chemical fixation of PCB-contaminated auto-shredder fluff at the Orange County Steel Salvage Company in Anaheim, California. Also assisted in the Remedial Action Plan (RAP) for projects including the Gardena Valley Landfills 1 and 2 in Gardena, California, and the Orange County Steel Salvage in Orange, California. Conducted groundwater investigations, collected water and product level information, and formulated water contour and contamination plume maps at Elixer Industries in Gardena, California.

Senior Geologist, 1987 - 1991
Conducted SWAT studies including field investigations, water and gas well drilling, soil and water sampling, vadose zone monitoring, and preparation of a Final SWAT Report. Performed studies to identify any environmental hazards created from processes associated with the decomposition of refuse (creation of leachate and gas) for existing, closed, or abandoned solid waste sites. SWAT studies included Cal Mat's Inert Waste Facility in Sun Valley, California; Hewitt Sanitary Landfill (closed site) in North Hollywood, California; Penrose Sanitary Landfill (closed site) in Sun Valley, California; Tuxford Sanitary Landfill (closed site) in Sun Valley, California; Newberry Inert Landfill (closed site) in Sun Valley, California; Nu-Way Inert Landfill in Irwindale, California; Lopez Canyon Sanitary Landfill in Los Angeles, California; and Chandlers Palos Verdes Inert Landfill in Palos Verdes, California.

Participated in preparing a variety of permit applications including Revised Waste Discharge Reports, Solid Waste Facility Permits, and Report of Disposal and Site Information documents for projects including Azusa Land Reclamation Class II Landfill in Azusa, California; Nu-Way Industries in Owl Rock Inert Landfill in Irwindale, California; and Cal Mat's Irwindale Inert Landfill in Irwindale, California.

Conducted Title 23, Chapter 15 groundwater monitoring and prepared quarterly and annual reports for sites including Azusa Land Reclamation Class III Landfill in Azusa, California; Nu-Way Industries Inert Landfill in Irwindale, California; Chandler Inert Landfill in Palos Verdes, California; and Orange County Steel Salvage.

Served as the former on-site manager for a 30-acre expansion of the Azusa Land Reclamation Class III Landfill in Azusa, California. Responsible for implementing all regulatory-approved specifications during the construction of a HDPE and clay liner and sidewall protection system. Prepared technical specifications on the liner system for regulatory agency approval and managed bid documents for construction work. Also conducted groundwater investigations for organic contamination. Duties included well installation, soil and water sampling, groundwater contouring and defining contamination plumes at several California locations.

Site Geologist, 1984 - 1987
BKK Class I Landfill, West Covina, California
Assisted engineers in developing a water and gas well monitoring system for the site. Supervised drilling operations, survey control, and activity documentation. Prepared geotechnical information for preparation and implementation of the Final Closure and Post-Closure Plans for the BKK Class I Landfill. Managed necessary geotechnical information required for permitting of the BKK Class III Landfill and prepared QA/QC procedures for the installation of low-permeability cover and liner systems that included in situ and test-pad permeability testing.

Geophysical Geologist, 1981 - 1984
Served as a Geologist for offshore investigations at platform and pipeline sites. Prepared detailed geologic hazard maps from seismic interpretation for the Exxon offshore facilities in Santa Barbara Channel and Shell Oil in the San Pedro Basin. Participated as a member of research crews in the Santa Barbara Channel collecting shallow seismic data information on geologic features of the ocean bottom.

Geologist, 1980 - 1981
MX Missile-Siting Project, Nevada and Utah
Conducted geologic field studies in the Nevada and Utah deserts to assist engineers in siting missile facilities. Interpreted aerial photographs, prepared surface soil maps, identified geologic hazards, and presented information in site-specific reports.

Student Engineer, 1978 - 1980
Edison, San Onofre Nuclear Generating Station, Units 2 and 3 (SONGS), Southern California
Staff member of a field geology group remediating soil stabilization problems. Supervised drilling crews, prepared geologic logs and supervised pressure grouting for soil stabilization.

DISCIPLINE CODES

Geologists: 011, Y

SKILL SET

GEOSCIENCES
Borings and Wells - Geotechnical Borings
Borings and Wells - Monitoring Well Installation
Borings and Wells - Recovery Well / Production Well Installation
Borings and Wells - Soil Classification / Logging
Geophysics – Borehole
Geophysics - Other
Hydraulics / Design - Extraction Well Design
Hydraulics / Design - Injection Well Design
Hydraulics / Design - Interceptor Trenches / French Drains
Hydraulics / Design - Slurry Walls / Cut Off Trenches
Hydrogeology - Pump Test
Hydrogeology - Slug Test
Hydrogeology - Wellhead Protection
Manufacturing Facilities / Property Transfer
Marine Geology - Oceanography
Sampling - Groundwater
Sampling - Sediment
Sampling - Soil
Sampling - Water Level Measurements
Underground Storage Tanks / Refineries
CHEMICAL SCIENCES
Air Sampling and Analysis

Analytical Method Development
Chemical Warfare Agents
Enzyme Linked Immunoassay
Fate and Transport Analysis/Modeling
Feasibility Study
Field/Mobile Laboratory Oversight
Field QA Audits
Field Sampling and Analysis Plan
Field Screening
Gas Chromatography
Gas Chromatography/Mass Spectrometry
Geotechnical Sampling
Groundwater/Surface Water Sampling
Immunoassay
Inorganics
Laboratory QA Audits
Metals
Mixed Waste
Mobile Laboratories
Monitoring Programs (air,biota,soil,water)
National Pollution Discharge Elimination System
Nerve Agents
NORM Waste
Organics
PCBs
Pesticides
Process Monitoring
Proposal Lead
Project Manager
Quality Assurance
Quality Assurance Manager
Quality Assurance Officer
Quality Assurance Plan
Quality Control
Risk Assessment
Radionuclides
Remedial Action
Remedial Investigation/Feasibility Study
Scanning Electron Microscopy
Semivolatiles
Site Characterization
Soil Gas Analysis
Soil/Sediment Sampling
Task Leader
Transmission Electron Microscopy
Treatability Studies
Volatiles
Volatile Headspace Analysis
Waste Characterization
Wet Chemistry
Work Plan
X-Ray Fluorescence

TECHNICAL EXPERTISE

Mr. Richards has extensive experience performing remediation investigations, implementing remediation systems, and managing landfills including providing gas field services, construction support, and closure permitting.

PROFESSIONAL REFERENCES

Dr. Les LaFountain, New Cure Incorporated, 323-727-5576

RELATED COMPANY INFORMATION

Office Location: Santa Ana
Hire Date: 11/12/97
Years with Other Firms: 13
Years with Current Firm: 7
Supervisor:
Phone: (949) 756-7568
Fax: (949) 756-7560
E-mail Address: vrichards@ttfwi.com
Other E-mail Address (if any):
Resume Last Revised: 1/6/2004

ATTACHMENT 2

DELEGATION OF AUTHORITY LETTER

TETRA TECH FW, INC.

February 18, 2005

Mr. Jeffery Brenner
Tetra Tech FW
1940 E. Deere Ave., Suite 200
Santa Ana, CA 92705

Subject: **Project Quality Control Manager**

Reference: Contract No. N68711-98-D-5713,
Southwest Division Naval Facilities Engineering Command (SWDIV)
Environmental Remediation Contract, Contract Task Order (CTO) No. 0090,
Naval Weapon Station Seal Beach, Seal Beach, California

Dear Mr. Brenner,

In accordance with the terms of Tetra Tech FW (TtFW) Contract No. N68711-98-D-5713, this letter notifies you of your appointment as the Project Quality Control Manager for CTO No. 0090 at the Naval Weapon Station Seal Beach, Seal Beach, California.

As the designated Project Quality Control Manager, you will be responsible for managing the site-specific quality control requirements in accordance with the Project Contractor Quality Control Plan. You will be responsible for conducting quality control meetings, perform the three phases of control, and perform submittal review. You will be required to be present during all quality control testing to verify that testing is conducted in accordance with required specification. In addition, you will be required to prepare the necessary quality control certification and documentation.

You have the authority and responsibility for suspending work when conditions adverse to quality are identified and for directing the correction of all nonconforming work.

This letter is effective immediately until modified by the Quality Control Program Manager with concurrence of the TtFW CTO Project Manager, the SWDIV Remedial Project Manager, and the Resident Officer in Charge of Construction.

Sincerely,

Tetra Tech FW

Mary Schneider
Quality Control Program Manager

cc: H. Hampursumian, Project Manager

1940 E Deere Avenue Suite 200 Santa Ana CA 92705
Tel 949 756 7500 Fax 949 756 7560

TETRA TECH FW, INC.

February 18, 2005

Mr. Vince Richards
Tetra Tech FW
1940 E. Deere Ave., Suite 200
Santa Ana, CA 92705

Subject: **Alternate Project Quality Control Manager**

Reference: Contract No. N68711-98-D-5713,
Southwest Division Naval Facilities Engineering Command (SWDIV)
Environmental Remediation Contract, Contract Task Order (CTO) No. 0090,
Naval Weapon Station Seal Beach, Seal Beach, California

Dear Mr. Richards,

In accordance with the terms of Tetra Tech FW (TtFW) Contract No. N68711-98-D-5713, this letter notifies you of your appointment as the Alternate Project Quality Control Manager for CTO No. 0090 at the Naval Weapon Station Seal Beach, Seal Beach, California.

As the designated Alternate Project Quality Control Manager, you will be responsible for managing the site-specific quality control requirements in accordance with the Project Contractor Quality Control Plan. You will be responsible for conducting quality control meetings, perform the three phases of control, and perform submittal review. You will be required to be present during all quality control testing to verify that testing is conducted in accordance with required specification. In addition, you will be required to prepare the necessary quality control certification and documentation.

You have the authority and responsibility for suspending work when conditions adverse to quality are identified and for directing the correction of all nonconforming work.

This letter is effective immediately until modified by the Quality Control Program Manager with concurrence of the TtFW CTO Project Manager, the SWDIV Remedial Project Manager, and the Resident Officer in Charge of Construction.

Sincerely,

Tetra Tech FW

Mary Schneider
Quality Control Program Manager

cc: H. Hampursumian, Project Manager

1940 E. Deere Avenue, Suite 200, Santa Ana, CA 92705
Tel 949.756.7500 Fax 949.756.7560

ATTACHMENT 3

QUALITY CONTROL FORMS

PREPARATORY PHASE CHECKLIST

(CONTINUED ON SECOND PAGE)

CONTRACT NO	DEFINABLE FEATURE OF WORK	SPEC SECTION	DATE
N68711-98-D-5713 CTO No. 0090		SCHEDULE ACT NO	INDEX #

PERSONNEL PRESENT

GOVERNMENT REP NOTIFIED _____ HOURS IN ADVANCE: YES ☐ NO ☐

NAME	POSITION	COMPANY/GOVERNMENT

SUBMITTALS

REVIEW SUBMITTALS AND/OR SUBMITTAL REGISTER. HAVE ALL SUBMITTALS BEEN APPROVED? YES ☐ NO ☐

IF NO WHAT ITEMS HAVE NOT BEEN SUBMITTED? _____

ARE ALL MATERIALS ON HAND? YES ☐ NO ☐

IF NO, WHAT ITEMS ARE MISSING? _____

CHECK APPROVED SUBMITTALS AGAINST DELIVERED MATERIAL (THIS SHOULD BE DONE AS MATERIAL ARRIVES)

COMMENTS: _____

MATERIAL STORAGE

ARE MATERIALS STORED PROPERLY? YES ☐ NO ☐

IF NO WHAT ACTION IS TAKEN? _____

SPECIFICATIONS

REVIEW EACH PARAGRAPH OF SPECIFICATIONS _____

DISCUSS PROCEDURE FOR ACCOMPLISHING THE WORK _____

CLARIFY ANY DIFFERENCES _____

PRELIMINARY WORK & PERMITS

ENSURE PRELIMINARY WORK IS CORRECT AND PERMITS ARE ON FILE

IF NOT WHAT ACTION IS TAKEN? _____

PREPARATORY PHASE CHECKLIST

(CONTINUED ON SECOND PAGE)

		SPEC SECTION	DATE
CONTRACT NO N68711-98-D-5713 CTO No. 0090	DEFINABLE FEATURE OF WORK	SCHEDULE ACT NO	INDEX #

TESTING

IDENTIFY TEST TO BE PERFORMED FREQUENCY AND BY WHOM

WHEN REQUIRED?

WHERE REQUIRED?

REVIEW TESTING PLAN

HAS TEST FACILITIES BEEN APPROVED?

SAFETY

ACTIVITY HAZARD ANALYSIS APPROVED? YES ☐ NO ☐

REVIEW APPLICABLE PORTION OF EM 385-1-1

MEETING COMMENTS

NAVY/ROICC COMMENTS DURING MEETING.

OTHER ITEMS OR REMARKS

OTHER ITEMS OR REMARKS:

PQCM DATE

INITIAL PHASE CHECKLIST

		SPEC SECTION	DATE
CONTRACT NO N68711-98-D-5713 CTO No. 0090	DEFINABLE FEATURE OF WORK	SCHEDULE ACT NO	INDEX #

PERSONNEL PRESENT

GOVERNMENT REP NOTIFIED _____ HOURS IN ADVANCE: YES ☐ NO ☐

NAME	POSITION	COMPANY/GOVERNMENT

PROCEDURE COMPLIANCE

IDENTIFIY FULL COMPLIANCE WITH PROCEDURES IDENTIFIED AT PREPARATORY COORDINATE PLANS SPECIFICATIONS AND SUBMITTALS

COMMENTS: _____

PRELIMINARY WORK

ENSURE PRELIMINARY WORK IS COMPLETE AND CORRECT IF NOT WHAT ACTION IS TAKEN?

WORKMANSHIP

ESTABLISH LEVEL OF WORKMANSHIP
WHERE IS WORK
LOCATED? _____

IS SAMPLE PANEL REQUIRED? YES ☐ NO ☐

WILL THE INIITAL WORK BE CONSIDERED AS A SAMPLE? YES ☐ NO ☐
(IF YES, MAINTAIN IN PRESENT CONDITION AS LONG AS POSSIBLE AND DESCRIBE LOCATION OF SAMPLE) _____

RESOLUTION

RESOLVE ANY DIFFERENCES

COMMENTS: _____

CHECK SAFETY

REVIEW JOB CONDITIONS USING EM 385-1-1 AND JOB HAZARD ANALYSIS

COMMENTS: _____

OTHER

OTHER ITEMS OR REMARKS

_____
PQCM DATE

CONTRACTOR QUALITY CONTROL REPORT

(ATTACH ADDITIONAL SHEETS IF NECESSARY)

DATE

REPORT NO

PHASE | CONTRACT NO N68711-98-D-5713, CTO No. 0011 | CONTRACT TITLE

PREPARATORY

WAS PREPARATORY PHASE WORK PREFORMED TODAY? YES ☐ NO ☐

IF YES, FILL OUT AND ATTACH SUPPLEMENTAL PREPARATORY PHASE CHECKLIST.

Schedule Activity No.	Definable Feature of Work	Index #

INITIAL

WAS INITIAL PHASE WORK PREFORMED TODAY? YES ☐ NO ☐

IF YES, FILL OUT AND ATTACH SUPPLEMENTAL INITIAL PHASE CHECKLIST.

Schedule Activity No.	Definable Feature of Work	Index #

FOLLOW-UP

WORK COMPLIES WITH CONTRACT AS APPROVED DURING INITIAL PHASE? YES ☐ NO ☐

WORK COMPLIES WITH SAFETY REQUIREMENTS? YES ☐ NO ☐

Schedule Activity No.	Description of Work, Testing Performed & By Whom Definable Feature of Work Specification Section, Location and List of Personnel Present

REWORK ITEMS IDENTIFIED TODAY (NOT CORRECTED BY CLOSE OF BUSINESS)

Schedule Activity No.	Description

REWORK ITEMS CORRECTED TODAY (FROM REWORK ITEMS LIST)

Schedule Activity No.	Description

REMARKS (Also Explain Any Follow-Up Phase Checklist Item From Above That Was Answered "NO"), Manuf. Rep On-Site, etc.

Schedule Activity No.	Description

AUTHORIZED QC MANAGER AT SITE DATE

GOVERNMENT QUALITY ASSURANCE REPORT

DATE

QUALITY ASSURANCE REPRESENTATIVE'S REMARKS AND/OR EXCEPTIONS TO THE REPORT

Schedule Activity No.	Description

GOVERNMENT QUALITY ASSURANCE MANAGER DATE

CONTRACTOR PRODUCTION REPORT

(ATTACH ADDITIONAL SHEETS IF NECESSARY)

CONTRACT NO N68711-98-D-5713 CTO 0090	TITLE AND LOCATION	DATE REPORT NO
CONTRACTOR TETRA TECH FW, INC.	SUPERINTENDENT	
AM WEATHER	PM WEATHER	MAX TEMP (F) / MIN TEMP (F)

WORK PERFORMED TODAY

WORK LOCATION AND DESCRIPTION	EMPLOYER	NUMBER	TRADE	HRS

JOB SAFETY

WAS A JOB SAFETY MEETING HELD THIS DATE? (If YES attach copy of the meeting minutes)	☐ YES	☐ NO
WERE THERE ANY LOST TIME ACCIDENTS THIS DATE? (If YES attach copy of completed OSHA report)	☐ YES	☐ NO
WAS CRANE/MANLIFT/TRENCHING/SCAFFOLD/HV ELEC/HIGH WORK/ HAZMAT WORK DONE? (If YES attach statement or checklist showing inspection performed)	☐ YES	☐ NO
WAS HAZARDOUS MATERIAL/WASTE RELEASED INTO THE ENVIRONMENT? (If YES attach description of incident and proposed action.)	☐ YES	☐ NO

TOTAL WORK HOURS ON JOB SITE THIS DATE, INCL CON'T SHEETS	
CUMULATIVE TOTAL OF WORK HOURS FROM PREVIOUS REPORT	
TOTAL WORK HOURS FROM START OF CONSTRUCTION	

LIST SAFETY ACTIONS TAKEN TODAY/SAFETY INSPECTIONS CONDUCTED ☐ SAFETY REQUIREMENTS HAVE BEEN MET

EQUIPMENT/MATERIAL RECEIVED TODAY TO BE INCORPORATED IN JOB (INDICATE SCHEDULE ACTIVITY NUMBER)

Submittal #	Description of Equipment/Material Received

CONSTRUCTION AND PLANT EQUIPMENT ON JOB SITE TODAY. INDICATE HOURS USED AND SCHEDULE ACTIVITY NUMBER.

Owner	Description of Construction Equipment Used Today (incl Make and Model)	Arrival	Off Rent Date	Actual Demob Date	Hours Idle	Hours Used	Reason for Idle

REMARKS

CONTRACTOR/SUPERINTENDENT

DATE

MONTHLY REWORK ITEMS LIST

Contract No. **N68711-98-D-5713** CTO No. **0090** Project :

Contractor: Tetra Tech FW, Inc. Date:

NUMBER	DATE IDENTIFIED	DESCRIPTION	CONTRACT REQUIREMENT (Spec. Section and Par. No., Drawing No. and Detail No., etc.)	ACTION TAKEN BY QC MANAGER	RESOLUTION	DATE COMPLETED

TETRA TECH FW, INC

FIELD CHANGE REQUEST FORM

Contract No.	CTO No.	Field Change Request Form No.
N68711-98-D-5713	0090	FCRF-
Location		Date

RE: Drawing No. _____ Title _____

Specification Section _____ Title _____

Other _____

Description (items involved, submit sketch, if applicable)

Reason for Change

Recommended Disposition (submit sketch, if applicable)

TETRA TECH FW, INC

FIELD CHANGE REQUEST FORM

Contract No.	CTO No.	Field Change Request Form No.
N68711-98-D-5713	0090	FCRF-

Additional Details

Will this change result in a contract cost or time change? ☐ Yes ☐ No

Estimate of contract cost or time charge (if any) _____

Preparer (signature)	Date	Preparer's Title	Site Superintendent (Signature)	Date

Disposition

☐ Approved.

☐ Not approved (give reason). _____

TtFW Engineer (signature) (if engineering related)	Date	TtFW Project Manager (signature)	Date
☐ Comments (attached) ☐ No Comments		☐ Comments (attached) ☐ No Comments	
TtFW PESM (signature)	Date	TtFW Scientist (signature) (if science related)	Date
☐ Comments (attached) ☐ No Comments		☐ Comments (attached) ☐ No Comments	
TtFW QC Program Manager (signature)	Date		
☐ Comments (attached) ☐ No Comments			

Distribution: Original to Project File, Copy to Site File,
Project Manager, DON RPM, DON ROICC PQCM, QCM, Site Superintendent

NONCONFORMANCE REPORT

	Report No.
Client or Project:	Drawing No /Spec. No.
Supplier, Construction QC or Contractor	P.O. No.
Description of Component, Part or System	

I. Description of Nonconformance *(Items involved, specification, code or standard to which items do not comply, submit sketch if applicable)*

Name and Signature of Person Reporting Nonconformance	Title/Company	Date

II. Recommended Disposition *(Submit sketch, if applicable)*

Name and Signature of Person Recommending Disposition	Title/Company	Date

III. Evaluation of Disposition by Tetra Tech FW, Inc., Reason for Disposition

IV. Corrective Action ☐ Required ☐ Not Required

V. ☐ Engineering	☐ QA/QC	☐ Construction	☐ Other
Name *(Signature)*	Name *(Signature)*	Name *(Signature)*	Name *(Signature)*
Date	Date	Date	Date
☐ Accepted ☐ Rejected ☐ Accepted with Comments	☐ Accepted ☐ Rejected ☐ Accepted with Comments	☐ Accepted ☐ Rejected ☐ Accepted with Comments	☐ Accepted ☐ Rejected ☐ Accepted with Comments

VI. Verification of Disposition ☐ Required ☐ Not Required

By	Signature	Title	Date

NONCONFORMANCE REPORT LOG

PROJECT TITLE: Enhanced In Situ Bioremediation IRP Site 40 (Concrete Pit/Gravel Area)

PROJECT LOCATION: Naval Weapons Station Seal Beach Seal Beach, California

CONTRACTOR:

NCR NO.	HOLD TAG NO.	DESCRITION OF CONDITIONS/ ITEM AFFECTED	LOCATION	DATE					REMARKS
				VALIDATION	DISPOSITION/ APPROVAL	RE-INSPECTION	CLOSURE	HOLD TAG REMOVAL	

Rev. February 2005

CATALOG CUT/SHOP DRAWING TRANSMITTAL AND APPROVAL
SOUTHWESTNAVFACENGCOM 4355 / 2 (10-89)

See instructions on reverse
No carbon paper is required to complete this form
No transmittal letter required

SUBMITTAL NO.

CQC CLAUSE ☐ IS APPLICABLE ☐ IS NOT APPLICABLE

REFERENCES TO USE WHEN CQC CLAUSE IS APPLICABLE	PART I – FOR CONTRACTOR USE	REFERENCES TO USE WHEN CQC CLAUSE IS NOT APPLICABLE
(A) ROICC/REICC	FROM (Contractor): Tetra Tech FW, Inc. 1230 Columbia Street, Suite 500 San Diego, CA 92101 — TO (A):	(A) DESIGNER
	CONTRACT NO — CONTRACT TITLE	
(B) *(Check one)* ☐ RECORD ☐ APPROVAL	THE FOLLOWING ITEM IS SUBMITTED FOR (B) PER SPECIFICATION SECTION NUMBER	(B) APPROVAL
	CERTIFICATION (This form shall not be used to forward proposed substitutions): IT IS HEREBY CERTIFIED THAT THE ☐ EQUIPMENT ☐ MATERIAL SHOWN AND MARKED IN THIS SUBMITTAL IS THAT PROPOSED TO BE INCORPORATED INTO CONTRACT N68711–98–D–5713, CTO 00XX IS IN COMPLIANCE WITH THE CONTRACT DRAWINGS AND SPECIFICATIONS AND CAN BE INSTALLED IN THE ALLOCATED SPACES.	
(C) AUTHORIZED CONTRACTOR QUALITY CONTROL REPRESENTATIVE	CERTIFIED BY (C) — DATE	(C) PERSON DESIGNATED BY CONTRACTOR AS HAVING AUTHORITY TO SIGN CERTIFICATION
	PART II – FOR DESIGNER USE	
	FROM (Designer) — TO (ROICC/REICC)	
(D) CURSORY REVIEW REQUIRED ON RECORD COMES – REPLY TO ROICC ONLY IF APPROPRIATE. DETAILED REVIEW REQUIRED ON SUBMITTALS FOR GOVERNMENT APPROVAL. STAMP AND MARK EACH COPY AS APPROPRIATE	THIS SUBMITTAL HAS BEEN REVIEWED (D). THE FOLLOWING RECOMMENDATION IS MADE:	(D) DETAILED REVIEW REQUIRED. STAMP AND MARK EACH COPY AS APPROPRIATE
	SIGNATURE — DATE	
	PART III – FOR ROICC/REICC USE	
(E) DESIGNER *(Copy to ROICC)*	FROM (ROICC/REICC) — TO (E)	(E) CONTRACTOR *(Copy to ROICC)*
	ENCLOSURES ARE RETURNED WITH THE FOLLOWING COMMENTS:	
	SIGNATURE — DATE	

INSTRUCTIONS

Enter submittal number
Check applicable CQC clause

CONSTRUCTION CONTRACTOR – PART I

From: *Construction contractor's name and address.*
To: *Designer's name and address or ROICC/REICC as applicable.*

Enter contract number.

Enter title of contract and location.

Describe item being transmitted. A separate form must be used for each set of catalog cuts or shop drawings. Include name of manufacturer, catalog sheets, drawing no., name of item, and number of copies forwarded.

Check submittal for record or approval purposes.

Type date and name.

Sign original and one.

Distribution (as applicable to CQC clause):

Send to designer: *original and four transmittal forms with the seven copies of catalog cuts or shop drawings. When factory inspection is required, send eight copies.*

Send to ROICC/REICC. *one carbon copy of form.*

Send to ROICC/REICC (CQC): *Original and three copies of catalog cuts or shop design.*

Retain one copy for your files.

DESIGNER (A&E CONTRACTOR, SOUTHWESTNAVFACENGCOM) OR OICC RESPONSIBLE FOR DESIGN – PART II

From: *Designer's name and address.*
To: *ROICC/REICC and address.*

Enter recommended action (i.e., approval recommended or disapproved, with appropriate comments).

Type date and name.

Sign original and one.

Distribution:

Send to ROICC/REICC: *original and three copies with six (or seven when factor inspection is required) copies of catalog cuts or shop drawings.*

Retain one copy of form and one copy of cuts or drawings for your files.

ROICC OR REICC – PART III

From: *ROICC or REICC and address.*
To: *Construction contractor's name and address.*

Enter action taken (i.e., approved subject to, etc.).

Type date and name.

Sign original and one.

Distribution:

Send to construction contractor: *original with three copies of cuts or drawings.*

Send to ROICC one carbon copy of form with one copy of cut or drawings.

Retain two copies of form and two copies of cuts or drawings: *one for field use and one for ROICC/REICC file.*

NOTE: When factory inspection is required, forward one approved copy of cuts or drawings to the OICC, Construction Division. Cover transmittal should state the information is forwarded for factory inspection.

DEFICIENCY NOTICE

TETRA TECH FW, INC. CONTRACT NO. N68711-98-D-5713	DEFICIENCY NOTICE NO.: _____ TASK ORDER: ~~CTO 0090~~ DATE: _____ LOCATION: _____

DESCRIPTION OF DEFICIENT ITEM OR SPEC/DRAWING/PLAN OR PROCEDURE _____

I DESCRIPTION OF DEFICIENCY

QC Notification required prior to initiating Corrective Action: Yes _____ No _____

Deficiency Notice prepared by: _____ Approved by: _____

II Corrective Action

_____ Organization

_____ Signature

_____ Date

III Re-inspection Results

_____ Accepted

_____ Rejected

- Reissue Under: D.N. No. _____ NCR No. _____

_____ PQCM

_____ Date

IV Distribution

Responsible Organization _____

Site Superintendent _____

IR Program Coordinator _____

QC Program Manager _____

PjM _____

MATERIALS INSPECTION CHECKLIST

Date

Report No.

Contract No.: N68711-98D-5713, CTO No. 0090

Contract Title:

Contract Specifications:

Material	Qty	Condition	Testing	Comments

Storage Conditions:

Submittals:

MATERIALS INSPECTION CHECKLIST

Date	
Report No.	

Contract No.: N68711-98D-5713, CTO No. 0090	Contract Title:

Contract Specifications:

Material/Equipment Certifications:

Preparatory Site Conditions:

Contract Variance:

Comments:

Attendees:		
	QC Representative	Date
	QCM	Date

PHOTOGRAPH LOG SHEET

Date Submitted

Roll No

Contract No.: N68711-98D-5713, CTO No. 0090

Contract Title:

Photographer:

Frame	Date	Time	Location/Grid No.	Description/Work No.	Notes
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REQUEST FOR INFORMATION (RFI)

Contract No.	CTO No.	RFI No.
N68711-98-D-5713	0090	
Project Title and Location Enhanced In Situ Bioremediation IRP Site 40 (Concrete Pit/Gravel Area) Naval Weapons Station Seal Beach, Seal Beach, California	Issue Date	Closure Date

Work Area _____

Subcontractor _____

Applicable Plans, Drawings, Specifications _____

Information Requested _____

Project Quality Control Manager Signature _____ Date _____

ROICC Requested _____

ROICC Signature _____ Date _____

Distribution:

		Date
PJM:	Hamlet Hamparsumian	
PQCM:	Jeff Brenner	
QCM:	Mary Schneider	
Site Superintendent:	Glenn Nardin	
Navy RPM:	Si Le	
ROICC:	David Crawley	
Subcontractor:		

DESIGN CHANGE NOTICE

CTO # 0090 _____ DCN # _____ DATE_____

LOCATION _____ NTR / RPM _____

Re: _____ Drawing No. _____ Title _____

_____ Spec. Section _____ Title _____

_____ Other _____ Title _____

1. Description of Change (Items involved, submit sketch, if applicable): **(Use continuation sheet if necessary)**

Engineering "HOLD" placed on all activities in area defined herein pending receipt of formally revised document(s) and / or Released for construction basis of modifications prescribed by this

2. Reason for Change **(Use Continuation Sheet if**

___ Field Change Request (FCR _____)

___ Required Modifications to Drawings or

___ Other _____

Exhibits Attached

_____ Copies of marked-up area of

_____ Field Change Request (FCR ____)

_____ Other (Describe)

3. COMMENTS

Originator _____ Date____

1) QC Program Manager	Date	2) Project Manager (Signature)	Date

Distribution:

Original to CTO File. Copy to Site

Signatories from above Site Superintendent PQCM SHSS

REQUEST FOR ENGINEERING INFORMATION (REI)

Contract No.	CTO No.	REI No.
N68711-98-D-5713	0090	
Project Title and Location Enhanced In Situ Bioremediation IRP Site 40 (Concrete Pit/Gravel Area) Naval Weapons Station Seal Beach, Seal Beach, California	Issue Date	Closure Date

Work Area _____

Subcontractor _____

Applicable Plans, Drawings, Specifications _____

Information Requested _____

Subcontractor Signature _____ Date _____

TtFW Requested _____

Project Engineer Signature _____ Date _____

Project Manager Signature _____ Date _____

Distribution:

		Date
PJM:	Hamlet Hamparsumian	
PQCM:	Jeff Brenner/Vince Richards	
QCM:	Mary Schneider	
Site Superintendent:	Glenn Nardin	
Navy RPM:	Si Le	
ROICC:	David Crawley	
Subcontractor:		

PRE-FINAL COMPLETION INSPECTION CHECKLIST

CONTRACT NO.: N68711-98-D-5713 DATE:_____

TITLE: Enhanced In Situ Bioremediation IRP Site 40 (Concrete Pit/Gravel Area)

MAJOR DEFINABLE FEATURE OF WORK:_____

LOCATION: Naval Weapons Station Seal Beach, Seal Beach, California
(Refer to Final Follow-Up Inspection Checklist)

A. OPEN PUNCHLIST ITEMS FROM FOLLOW-UP INSPECTION CHECKLIST:

	ITEM	DATE OF COMPLETION
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		

B. NEW PUNCHLIST ITEMS NOTED:

	ITEM	DATE OF COMPLETION
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

C. ROICC NOTIFIED? Yes ____ No _____

On behalf of Tetra Tech FW, Inc., I certify this activity is completely in accordance with the Contract Documents, based upon the information available to me.

_____
Project Quality Control Manager

FINAL COMPLETION INSPECTION CHECKLIST

CONTRACT NO.: N68711-98-D-5713 DATE:_____

TITLE: Enhanced In Situ Bioremediation IRP Site 40 (Concrete Pit/Gravel Area)

MAJOR DEFINABLE FEATURE OF WORK:_____

LOCATION: Naval Weapons Station Seal Beach, Seal Beach, California
(Refer to Final Follow-Up Inspection Checklist)

SPEC SECTION: _____

A. OPEN PUNCHLIST ITEMS FROM PRE-FINAL COMPLETION INSPECTION CHECKLIST:

ITEM	DATE OF COMPLETION
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	

B. NEW PUNCHLIST ITEMS NOTED:

ITEM	DATE OF COMPLETION
1.	
2.	
3.	

C. ROICC NOTIFIED? Yes ____ No _____

On behalf of Tetra Tech FW, Inc., I certify this activity is completely in accordance with the Contract Documents, based upon the information available to me.

_____
Project Quality Control Manager

ATTACHMENT 4

SUBMITTAL REGISTER

SUBMITTAL REGISTER

TITLE AND LOCATION	CONTRACTOR	CONTRACT NO.
Enhanced In Situ Bioremediation, IRP Site 40, NAVWPNSTA Seal Beach, Seal Beach, CA	Tetra Tech FW, Inc.	N68711-98-D-5713, CTO No. 0090

TRANSMITTAL NO	SPECIFICATION NO	DESCRIPTION ITEM SUBMITTED	CONTRACTOR SCHEDULE DATES: CLASSIFICATION OR ACTIVITY	SUBMIT	APPROVED	MEETING DATE	CONTRACTOR ACTION: ACTION CODE	DATE OF ACTION	DATE PCD FORWARDED TO CEFW/DDOT	APPROVING AUTHORITY: DATE RECEIVED FROM CEFW/DDOT	DATE RETURNED TO CEFW/DDOT	ACTION CODE	DATE OF ACTION	CONTRACT/MAIL CODE	REMARKS
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)
		SD-01 Preconstruction Submittals:													
		Pre-Draft Remedial Design/Work Plan	G	9/23/2004											
		Final Remedial Design/Work Plan		2/22/2005											
		Kickoff Meeting Minutes		2/10/2005											
		SD-03 Product Data:													
		Backflow Preventer		1/17/2005	01/24/05										
		Sodium lactate delivery system components		upon receipt from vendor											
		Dedicated well pumps		upon receipt from vendor											
		SD-07 Certificates:													
		Backflow Tester Certification		1/24/05 Quarterly thereafter	01/31/05										
		Backflow Preventer		1/24/2005	01/31/05										
		SD-06 Test Reports:													
		Backflow Preventer Test		1/24/05 Quarterly thereafter	01/31/05										
		Other:													
		CQC Meeting Minutes		weekly											
		Monitoring and Remediation Status Report		bi-annually											
		Waste profiles / manifests		on-going											
		Pre-Final Completion Inspection Checklist		upon completion											
		Final Completion Inspection Checklist		upon completion											

Action Code: NR: Not Reviewed AN: Approved as Noted A: Approved RR: Disapproved; Revise and Resubmit

APPENDIX C

SITE-SPECIFIC HEALTH AND SAFETY PLAN

Southwest Division
Naval Facilities Engineering Command
Contracts Department
1220 Pacific Highway, Building 127, Room 112
San Diego, California 92132-5190

CONTRACT NO. N68711-98-D-5713
CTO NO. 0090

APPENDIX C

FINAL

SITE-SPECIFIC HEALTH AND SAFETY PLAN

Revision 0
February 24, 2005

ENHANCED IN SITU BIOREMEDIATION
INSTALLATION RESTORATION PROGRAM SITE 40
(CONCRETE PIT/GRAVEL AREA)
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

DCN: FWSD-RAC-05-0380

TETRA TECH FW, INC.
1230 Columbia Street, Suite 500
San Diego, CA 92101

Roger Margotto, CIH
Program Health and Safety Manager

Hamlet H. Hamparsumian
Project Manager

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ABBREVIATIONS AND ACRONYMS

AHA	Activity Hazard Analysis
CIH	Certified Industrial Hygienist
CNS	central nervous system
CO	carbon monoxide
CRZ	contamination reduction zone
CSP	Certified Safety Professional
DCE	dichloroethene
DON	Department of the Navy
DPM	Deputy Program Manager
DTSC	Department of Toxic Substances Control
EM	Engineer Manual
EMS	Emergency Medical Services
EZ	exclusion zone
FID	flame ionization detector
FWENC	Foster Wheeler Environmental Corporation
H_2S	hydrogen sulfide
HEPA	high-efficiency particulate air
IR	Installation Restoration
IRP	Installation Restoration Program
ISB	in situ bioremediation
LEL	lower explosive limit
mg/m^3	milligrams per cubic meter
MSDS	Material Safety Data Sheet
NAVWPNSTA	Naval Weapons Station
O_2	oxygen
PCE	tetrachloroethene
PEL	permissible exposure limit
PESM	Project Environmental Health Safety Manager
PID	photoionization detector
PPE	personal protective equipment
ppm	parts per million

ABBREVIATIONS AND ACRONYMS
(Continued)

QA	quality assurance
QC	quality control
RD/RA	remedial design/remedial action
ROICC	Resident Officer in Charge of Construction
RPM	Remedial Project Manager
RWQCB	Regional Water Quality Control Board
SCAQMD	South Coast Air Quality Management District
SHSP	Site-Specific Health and Safety Plan
SHSS	Site Health and Safety Specialist
Station-Wide Plan	Station-Wide Health and Safety Plan
SZ	support zone
TCE	trichloroethene
TLV	threshold limit value
TtFW	Tetra Tech FW, Inc.
USACE	United States Army Corps of Engineers
VOC	volatile organic compound

1.0 INTRODUCTION

This section describes the purpose and scope of the project, the application of this document and a summary of major risks, as well as defines the terminology used in this document.

1.1 PURPOSE AND SCOPE

This Site-Specific Health and Safety Plan (SHSP) applies to work to be performed under Remedial Action Contract N68711-98-D-5713 for Contract Task Order No. 0090, for in situ bioremediation (ISB) at Installation Restoration Program (IRP) Site 40 located at Naval Weapons Station (NAVWPNSTA) Seal Beach, in the City of Seal Beach, California (Figure C.1-1).

1.2 APPLICATION

This SHSP will be used in conjunction with the Station-Wide Health and Safety Plan (Station-Wide Plan) [Foster Wheeler Environmental Corporation (FWENC), 1999] for the work to be performed during the installation of wells, in situ injection and groundwater sampling at IRP Site 40. This SHSP applies to all work conducted by Tetra Tech FW, Inc. (TtFW) and its subcontractors for this project. Refer to the Station-Wide Plan for additional details common to all work performed at NAVWPNSTA Seal Beach. Subcontractors must have health and safety programs and plans that include, at a minimum, all the requirements of the TtFW health and safety program and plans.

1.3 SUMMARY OF MAJOR RISKS

The potential hazards associated with this project include those posed by drilling and installing wells, sampling groundwater, and injection of lactate. Specific physical hazards include, but are not limited to the potential for hazards associated with drilling and potential exposure to contaminants in groundwater. There is a possibility of increased levels of methane gas and hydrogen sulfide gas as the lactate solution reacts with the groundwater contaminants. There are no other anticipated chemical hazards associated with this site. Additional details with regards to potential site hazards are included in Section 4.0.

2.0 ORGANIZATION OF THE PROJECT

Table C.2-1 identifies the individuals from the Department of the Navy (DON), regulatory agencies, and TtFW who have responsibility for the oversight and/or implementation of this work. All employees and workers on this project are expected to maintain vigilance at all times to ensure that the work is conducted in a safe and efficient manner.

3.0 SITE HISTORY AND PROJECT DESCRIPTION

This section discusses the site history and provides a description of the project, which includes the project duration.

3.1 SITE HISTORY

IRP Site 40 (Figure C.3-1) includes a concrete pit located in the Locomotive Shop (Building 240) and a gravel area located north of and adjacent to the building. The concrete pit formerly provided a collection point for oil and solvents spilled during locomotive maintenance activities. Oil that collected in the pit discharged into the gravel area through a drainpipe until the pipe was plugged in 1978. Currently, the gravel area is paved north of Building 240 and is unpaved to the northwest. Four railroad spurs terminate in Building 240 and provide locomotive access to the repair shop. Additional tracks traverse the asphalt-paved area to the south.

3.2 PROJECT DESCRIPTION

Implementation of the full-scale enhanced ISB system will require the use of an assortment of mechanical and monitoring equipment. Fieldwork will consist of well installation, reagent injection, bioaugmentation, groundwater monitoring and sampling, soil gas monitoring and sampling, indoor air monitoring, and waste management. Each of these tasks will require specific equipment.

Well installation activities will require the use of a state-certified drilling contractor. The wells (17 injection wells, 8 groundwater monitoring wells, and 4 vadose zone vapor monitoring wells) will be installed using a hollow-stem auger drilling rig. A field geologist will oversee the drilling activities and document all field proceedings. Following well installation, the injection and groundwater monitoring wells will be developed in accordance with Regional Water Quality Control Board (RWQCB) guidelines.

Reagent injection will require the management and storage of delivered reagent. The remedial design/remedial action (RD/RA) contractor shall determine the most appropriate and cost-effective manner for delivery and on-site storage of the sodium lactate. During injection events, the reagent will be moved in containers to each individual injection well via a motorized fork lift. The reagent will be injected into each well via a portable injection system. The injector will be connected to the appropriate container and injection well via tubing, hose, and proper fittings.

3.3 PROJECT DURATION

The field activities for the project at IRP Site 40 are estimated to require approximately 2 months to complete, followed by monitoring activities for the next year.

4.0 POTENTIAL HAZARDS

The Station-Wide Plan (FWENC, 1999) identifies hazards that are common to all projects within NAVWPNSTA Seal Beach. Site-specific hazards associated with monitoring well installation and lactate injection at IRP Site 40 are summarized below.

4.1 CHEMICAL HAZARDS

Based on previous studies conducted at IRP Site 40, there are no significant chemicals of concern at this site. The chemical contaminants in groundwater, tetrachloroethene (PCE), trichloroethene (TCE) and 1,2-dichloroethene (DCE) are very low and do not present an occupational exposure risk to workers. Personal protective equipment (PPE) and dust control measures will minimize all exposures (Table C.4-1). It is expected that chemical hazards will be limited to chemicals such as fuel and the lactate solution and the methane and hydrogen sulfide gas generated by the treatment method. Attachment 1 has the Material Safety Data Sheets (MSDSs) for the contaminants, fuels, bentonite and lactate that will be at the site. The Site Health and Safety Specialist (SHSS) will acquire MSDSs for materials brought onto the site.

4.2 BIOLOGICAL HAZARDS

Biological hazards, as described in Section 4.0 of the Station-Wide Plan (FWENC, 1999), are the only anticipated hazards.

4.3 PHYSICAL HAZARDS

The Station-Wide Plan (FWENC, 1999) identifies typical physical hazards commonly associated with projects performed at NAVWPNSTA Seal Beach under this contract. This project involves the installation of groundwater monitoring and injection wells. The physical hazards include hazards primarily with work around heavy equipment and drilling rigs. Refer to Attachment 2, Activity Hazard Analyses (AHAs), for a description of the hazards associated with each task of the remediation activities, as well as the control measures used to mitigate risk to site personnel. All site personnel will be informed of these hazards and the means taken to control them prior to beginning work.

The SHSS will inspect the areas to ensure that there are no overhead power lines that will interfere with the planned operations. Underground Service Alert will be notified prior to any disturbance of soil in the area.

Additional discussion regarding the potential hazards posed to site personnel is discussed in the remainder of this section.

4.3.1 Heavy Equipment Operation

Heavy equipment shall be inspected by the operator before each work shift. Operators shall report any abnormalities, such as equipment failure, fluid discharges, and unusual odors, to their supervisor.

- Heavy equipment shall only be operated by qualified personnel.
- Hard hats, steel-toed boots, and safety glasses or goggles shall be worn at all times around heavy equipment in addition to any other PPE specified for a particular activity or the SHSS.
- Workers shall not assume that the equipment operator is aware of their exact location. Workers shall make eye contact with the equipment operator before approaching the area where the equipment is being operated. Workers shall never walk directly behind or to the side of heavy equipment without the operator's knowledge.
- When an operator must maneuver equipment in tight quarters, the presence of a second person (spotter) must be required to ensure adequate clearance. Hand signals shall be established. The operator and spotter shall maintain continual visual contact.
- Equipment must have an audible alarm that sounds when the equipment is moving in reverse. Seat belts must be present in all vehicles and used by all occupants.

4.3.2 Drilling and Groundwater Monitoring Well Installation

Any drilling will be performed in accordance with Engineer Manual (EM) 385-1-1, 16.M [United States Army Corps of Engineers (USACE), 2003]. A survey of the job site to identify overhead electrical hazards, potential ground hazards, and underground utilities must be performed before placement of the drilling equipment. MSDSs for drilling fluids and bentonite must be provided to the SHSS before the start of work. Supervisors will ensure that a call has been made to Underground Service Alert (Dig Alert) and that drawings and maps from public works are reviewed to verify that there are no underground utilities that will be disturbed by the drilling operation.

The drilling rig must have two means of emergency shut-off, usually one for the operator and one for the helper. A guard around the auger, a barricade around the perimeter of the auger, or an electronic brake activated by a presence-sensing device must be provided to guard against employee contact with the auger (EM 385-1-1, 16.M.10.l).

5.0 ACTIVITY HAZARD ANALYSES

The AHAs for this project are located in Attachment 2. The SHSS shall modify these AHAs as appropriate and when field conditions have changed, add new AHAs for any changes in tasks, and ensure that all employees who perform the tasks receive a briefing on the appropriate AHA. The SHSS shall forward any modified or new AHAs to the Project Environmental Safety Manager (PESM) for review. Any additional information on the AHAs related to any changes to the field construction activities will be provided to the Resident Officer in Charge of Construction (ROICC). In addition, an AHA will be generated for any new activity not covered in the original SHSP and will be provided to the ROICC.

6.0 PERSONAL PROTECTIVE EQUIPMENT

Level D protection will be the basic work uniform during site reconnaissance, mobilization, land surveys, clearing of vegetation, drilling, hand augering, well installation, installation of injection system, site restoration, and demobilization.

PPE for Level D includes:

- Boots, leather or rubber, with steel toe and shank
- Safety glasses or goggles
- Hard hat
- Work gloves (as required)
- Chemical-resistant gloves (nitrile) (as required)
- Hearing protection (as required)
- Cotton coveralls (as required)
- Long pants, shirt with shoulders covered

Note: If dust levels are not controlled (as measured during air monitoring) or if it is ascertained that there may be an exposure to volatile organic compounds (VOCs), the level of protection will be increased to Level C to include the use of respiratory protection. See discussion of Level C below.

Modified Level C Protection

This level of protection is required when handling groundwater or the lactate solution. The PPE for Modified Level C includes:

- Coveralls, chemical-resistant, disposable (Tyvek™)
- Gloves, chemical-resistant (nitrile)
- Chemical-resistant boots with steel toe and shank
- Hard hat
- Hearing protection (as required)
- Face shield and chemical-resistant disposable apron (where the possibility of liquid splash is present)
- Safety glasses or goggles

Level C Protection

This level is required if there is sustained visible dust or air monitoring shows levels of VOCs at 10 parts per million (ppm) or greater sustained for a period longer than 15 minutes. PPE for Level C includes:

- Full face-piece air purifying respirator with P100 cartridges [high-efficiency particulate air (HEPA) filter] for dust or VOC protection. A cartridge change should be scheduled once every 8 hours for VOCs of 10 ppm in the breathing zone. Workers shall discard the cartridges at the end of each workday. This cartridge change schedule assumes very low concentrations of VOCs in the groundwater and that none of the VOCs are benzene.
- Work uniform
- Coveralls (outer), chemical-resistant, disposable, Tyvek
- Gloves (outer), chemical-resistant (nitrile)
- Gloves (inner), cotton or nitrile
- Boots, leather, with steel toe and shank
- Hard hat
- Hearing protection (optional or as required)

7.0 AIR MONITORING

Fugitive dust emissions are expected from drilling activities. All activities must comply with the intent of the substantive portions of South Coast Air Quality Management District (SCAQMD) Rule 401 (b)(1)(A) pertaining to fugitive dust emissions. It is noted that no SCAQMD permit will be required because of the IRP status of the activities. Air monitoring for organic vapors will be performed during any activity involving groundwater and the opening of wells.

Upwind and downwind air monitoring for respirable dust shall be performed by the SHSS during removal activities. The results of air monitoring will be used to determine if additional measures are required to control adverse impacts from respirable dust. Dust shall be controlled during drilling operations using water application.

The prevailing wind direction is from the southwest. Occasionally, strong, dry winds from the northeast, known as a "Santa Ana" condition, occur in the fall, winter, and early spring. In the event of Santa Ana winds, the wind will likely be blowing to the southwest across the sites. As work progresses, the SHSS shall remain vigilant regarding changes in wind direction in order to monitor both upwind and downwind levels of respirable dust.

7.1 DIRECT READING INSTRUMENT

7.1.1 PDM-3 MINIRAM

Respirable dust shall be measured using a "PDM-3 miniram" dust meter or equivalent. Monitoring results are shown on the instrument display in units of milligrams per cubic meter (mg/m^3) of respirable dust. The following action levels will be used for dust monitoring during soil excavation and screening operations:

Action Level	Action
$< 1\ mg/m^3$	Level D
$> 1\ mg/m^3$	Level C (or implement dust suppressants to reduce dust concentration)
$> 3\ mg/m^3$	Stop work, notify PESM

7.1.2 Flame Ionization Detector or Photoionization Detector

A flame ionization detector (FID) or photoionization detector (PID) will be used to determine the presence and concentration of organic vapor. Contaminants such as the halogenated hydrocarbons and benzene are detectable with a FID or PID.

Instrument:	FID or PID
Action Level:	10 ppm in breathing zone
Action:	Level C respiratory protection. Notify PESM

7.1.3 Multisensor Gas Meter

A multisensor gas meter will be used to screen for the presence of flammable vapors, carbon monoxide (CO), hydrogen sulfide (H_2S), and oxygen (O_2)-deficient and O_2-enriched atmospheres. If flammable vapors are at 10 percent lower explosive limit (LEL) or greater, work will cease and the area will be ventilated. If O_2 levels below 20.8 percent or above 22 percent are encountered, personnel will leave the area and the area will be ventilated.

Instrument:	Multisensor Gas Meter
Action Level:	10 percent ≥ LEL, <20.8 percent O_2 or >22 percent O_2
Action:	Stop work, allow area to ventilate and notify PESM
Sensor:	H_2S
Action Level:	5 ppm; at no time can level exceed 20 ppm 1 ppm or detectable odor at perimeter
Action:	Stop work, ventilate, and notify PESM
Sensor:	CO
Action Level:	10 ppm
Action:	Stop work, ventilate, and notify PESM

7.2 PERSONAL AIR SAMPLING

If the Certified Industrial Hygienist (CIH) determines that proposed processing methods may introduce a potential for exposure to lead, the CIH will require that personal air samples are collected following National Institute for Occupational Safety and Health methods and analytical protocols. A laboratory accredited by the American Industrial Hygiene Association will conduct air sample analyses. During the sampling time and while awaiting results, workers would wear protection as specified by the CIH.

7.3 MONITORING STRATEGY

Background levels will be measured with the FID or PID before any work commences. The FID or PID will be used to measure perimeter levels of VOCs continuously whenever there are discernible odors and during well drilling and opening. The SHSS, in consultation with the PESM and with the ROICC, will determine if further actions and/or measurements are warranted to prevent or minimize exposure of personnel. The dust meter will be used during drilling activity. The multisensor gas meter will be used after lactate injection begins and wells are

opened for sampling to verify that there are no explosive vapors or hydrogen sulfide gas at the wellheads.

7.4 QUALITY ASSURANCE/QUALITY CONTROL

Adherence to a proper quality assurance/quality control (QA/QC) plan is essential for a meaningful air sampling effort. The major concerns of a QA/QC plan are calibration of equipment and document control.

7.4.1 Calibration and Maintenance Procedures

Prior to each work shift, the dust monitor "zero" value will be checked as described in the operator manual. If this value exceeds 3.5, the instrument will be zero calibrated. This is achieved by placing the instrument inside a clean calibration bag, sealing the bag, and introducing ambient air into the bag via a hand pump equipped with a dust filter. Calibration results will be documented in the logbook or on a calibration form. If the instrument zero still exceeds 3.5, the instrument must be cleaned and then zero calibrated. The FID will be calibrated daily or before each use. The date, time span, gas, or other standard, and the name of the person performing the calibration will be recorded in the logbook. The calibration gas for the FID is methane. The SHSS will ensure that the instrument is kept clean and will follow manufacturer's directions on calibration and maintenance. The SHSS will perform no other maintenance procedures unless approved by the PESM. When hydrogen gas is used to refill the tank in the instrument, assure that manufacturer's directions are followed and that refilling is performed outdoors (***Note:*** Hydrogen gas cylinders should never be stored indoors). The calibration gas for the PID is isobutylene and it will be calibrated each day of use. The date, time span, gas, or other standard, and the name of the person performing the calibration will be recorded in the logbook. The calibration gas for the LEL is usually a methane/air or a hexane/air mixture. O_2 is calibrated against normal air in a clean environment. A low-O_2 calibration gas can be used for calibrating the response of the O_2 sensor. Often, 100 percent nitrogen is used to "zero" the O_2 sensor. For the purposes of this plan, calibration of the combustible gas meter means a daily field check with known calibration gases. The reading on the instrument must be within three percent of the stated value of the gas. If it is not, then formal calibration of the instrument must follow manufacturers' calibration procedure. The calibration gas for H_2S is a gas mixture containing a known concentration of H_2S gas. The reading on the instrument must be within 5 percent of the stated gas value; otherwise, formal calibration of the instrument following the manufacturers' calibration procedure is required.

7.4.2 Documentation

Strict adherence to document and data control procedures is essential for good QA/QC. Data and calibration records must be accounted for and retrievable at all times. Types of documents that are essential include notes, logbooks, maps, data sheets, and reports. Copies of all field data reports and personal sampling records will be sent to the PESM for review.

8.0 SITE CONTROL

This section describes the site control, protection of personnel, and communications necessary to maintain a safe work site.

8.1 CONTROL ZONES

The following shall be used for guidance in designating control zones as the work progresses:

Support Zone (SZ) – The SZ is an uncontaminated area (trailers, offices, and so forth) that will be the field support area for operations. The SZ provides for field team communications and staging for emergency response. Appropriate sanitary facilities and safety equipment will be located in this zone. Potentially contaminated personnel/materials are not allowed in this zone. The only exception will be appropriately packaged/decontaminated and labeled samples.

The SZ will be arranged considering accessibility, utility availability, wind direction, and line-of-sight to work. Included in this area will be the administration area, vehicle parking, and a break/lunch area

Exclusion Zone (EZ) – Any area of the site that involves activities that may involve exposure to site contaminants, hazardous materials, and/or conditions should be considered an EZ. This zone will be clearly delineated by cones, tapes, or other means.

Contamination Reduction Zone (CRZ) – The CRZ is established between the EZ and the SZ. The CRZ contains the contamination reduction corridor and provides for an area for decontamination of personnel and portable hand-held equipment, tools, and heavy equipment. The CRZ will be used for EZ entry and egress.

8.1.1 Drilling and Well Installation

Control zones for the drilling and well installation will include an EZ and SZ. The EZ will be established around each well site and the site of the injection system to prevent unauthorized personnel from entering the work area.

8.2 COMMUNICATIONS

The following equipment and procedures will be used for communication at the site.

8.2.1 Mobile Telephone

A cellular telephone will be maintained in the office trailer located in the SZ and in the project's support vehicle(s) for routine and emergency communications. ***Note:*** NAVWPNSTA Seal Beach must authorize the phones and radios that are used.

8.2.2 Buddy System

The buddy system will be employed during on-site work activities.

8.2.3 Hand Signals

Field operations personnel shall employ hand signals in order to communicate emergency information and to assist in the operation of loud mechanized equipment. The hand signals will be taught to all field personnel prior to commencement of field operations and shall be reviewed during the daily on-site safety briefings.

These signals are very important when working with heavy equipment. Typical hand signals are the following:

Signal	Meaning
Hand gripping throat	Out of air, cannot breathe
Grip on a partner's wrist or placement of both hands around a partner's waist	Leave area immediately, no debate
Hands on top of head	Need assistance
Thumbs up	OK, I'm all right, I understand
Thumbs down	No, negative

8.2.4 Emergency Signals

In the event of a fire, explosion, or major emergency, a portable air horn will be used to signal the site workers and field crew of an emergency condition. One continuous, 15-second blast on the air horn will signal a site evacuation and subsequent assembly at the designated assembly area.

9.0 MEDICAL SURVEILLANCE

There are no additional medical surveillance procedures for this project at this time.

10.0 SAFETY CONSIDERATIONS

Safety is the primary concern during drilling and well installation. Personnel engaged in these efforts will adhere to the provisions of this SHSP.

For safety considerations, refer to the Station-Wide Plan (FWENC, 1999). In addition, these guidelines should be adhered to:

- Smoking will not be allowed at any time at any work site. Smoking is only allowed in designated areas at NAVWPNSTA Seal Beach and is not allowed inside vehicles.
- Ensure that cellular telephones and hand-held radios are in working order with adequately charged batteries. Ensure all phones and radios have been authorized for use by the NAVWPNSTA Seal Beach Explosive Safety Officer.
- Workers will work in sight of each other. If it is necessary for workers to work out of sight of each other, the buddy system will be used and each team will have a means of communicating (such as, cellular phone or hand-held radio) with personnel in the site office trailer.
- All workers must comply with the TtFW Project Rules Handbook, Volume I and Volume II.
- Workers will park only in designated areas and are reminded to follow posted speed limits while driving at NAVWPNSTA Seal Beach. In particular, workers are reminded to wear seat belts in all vehicles.
- Workers will wear reflective safety vests at all times when working at each site.
- Ensure that the drilling auger is barricaded or guarded as required by EM 385-1-1 (USACE, 2003). Ensure that employees are not wearing loose clothing, jewelry, or hair when working in the vicinity of the drilling rig. Adhere to the AHA for drilling and well installation.

11.0 HOLDING, STORAGE, AND DISPOSAL REQUIREMENTS

Refer to the Station-Wide Plan (FWENC, 1999) for general guidelines and Section 7.0 of the Remedial Design Work Plan for details on the types of waste streams to be generated and the appropriate methods for packaging and disposal.

12.0 EMERGENCY RESPONSE PLAN

Emergency response procedures and requirements for situations that are relevant to conditions at each site are presented in this section. Refer to the Station-Wide Plan (FWENC, 1999) for general emergency response actions. Figure C.12-1, Route to the Nearest Clinic, shows the route to the nearest clinic that participates in the company worker compensation program. Figure C.12-2, Route to Emergency Medical Facility, shows the route to the hospital. Table C.12-1, Emergency Response Information/Contacts, is the list of emergency contacts and telephone numbers. Figures C.12-1 and C.12-2 and Table C.12-1 must be placed on the dashboard of each vehicle and posted in the project site office trailer.

12.1 EMERGENCY SITE EVACUATION PROCEDURES

In the event of an emergency situation such as fire or explosion, the SHSS or a supervisor will activate an air horn for approximately 15 seconds indicating the initiation of evacuation procedures. All personnel in both the restricted and non-restricted areas will evacuate and proceed to the assembly area designated by the SHSS at the start of work each day. The location of the assembly area should be upwind of the site as determined by the current wind direction. If the wind direction changes as work progresses, the SHSS will notify personnel of the revised location of the evacuation assembly area. Emergency agency notification will commence as soon as the safety of all site personnel has been confirmed. The SHSS must ensure that access for emergency equipment is provided and that all equipment that may cause combustion has been shut down once the alarm has been sounded.

12.2 FIRE PREVENTION AND PROTECTION

At least one 20-pound dry chemical ABC fire extinguisher will be located at the project site that is readily available to personnel within the EZ. Employees will follow safe work practices to include proper storage of flammable and combustible liquids. "Hot work" permits will be obtained from the NAVWPNSTA Seal Beach Fire Department prior to conducting activities that have the potential to start a fire, including: use of open flames, welding, use of electric or gas-powered saws, and so forth. Personnel will follow hot work procedures to ensure that work is performed in a safe environment. Smoking is authorized only in specific designated areas as approved by the NAVWPNSTA Seal Beach Fire Department and is not allowed inside of vehicles. Smoking is absolutely not allowed in any area within NAVWPNSTA Seal Beach, east of Kitts Highway. In the event of a fire or explosion, summon the NAVWPNSTA Seal Beach Fire Department immediately, take a head count, and implement evacuation procedures.

13.0 TRAINING

There are no additional training requirements for this project. Refer to the Station-Wide Plan (FWENC, 1999) for training required for all project sites.

14.0 LOGS, INSPECTIONS, REPORTS, AND RECORDKEEPING

Refer to the Station-Wide Plan (FWENC, 1999) for requirements.

15.0 REFERENCES

Foster Wheeler Environmental Corporation (FWENC). 1999. *Final Station-Wide Health and Safety Plan - Naval Weapons Station Seal Beach, Seal Beach, California*.

United States Army Corps of Engineers (USACE). 2003. *Safety – Safety and Health Requirements*. EM 385-1-1. November 3.

TABLES

TABLE C.2-1

LIST OF POINTS OF CONTACT

Agency	Contact	Project Title
Southwest Division, Naval Facilities Engineering Command 1220 Pacific Highway San Diego, CA 92132-5190	Mr. Si Le (619) 532-1235	DON RPM
NAVWPNSTA Seal Beach 800 Seal Beach Boulevard Building 110 Seal Beach, CA 90740-5000	Ms. Pei-Fen Tamashiro (562) 626-7897	NAVWPNSTA IR Program Coordinator
ROICC Los Angeles NAVWPNSTA Seal Beach Building 230 Seal Beach, CA 90740-5000	Mr. David Crawley (562) 626-7964	ROICC
Southwest Division, Naval Facilities Engineering Command 1220 Pacific Highway San Diego, CA 92132-5190	Mr. Chris Leadon (619) 532-3878	Remedial Technical Manager
Southwest Division, Naval Facilities Engineering Command 1220 Pacific Highway San Diego, CA 92132-5190	Ms. Ann Garrett (619) 532-4261	Contracting Officer
California Environmental Protection Agency Department of Toxic Substances Control Office of Military Facilities 5796 Corporate Way Cypress, CA 90630	Ms. Katherine Leibel (714) 484-5446	DTSC-RPM
California Regional Water Quality Control Board, Santa Ana Region 3737 Main Street, Suite 500 Riverside, CA 92501-3348	Ms. Patricia Hannon (951) 782-4498	RWQCB-RPM
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Mr. Jamshid Sadeghipour (949) 756-7519	DPM
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Mr. Hamlet Hamparsumian (949) 756-7520	Project Manager
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Mr. Mark Losi (949) 756-7516	Project Scientist (Microbiologist)

TABLE C.2-1

LIST OF POINTS OF CONTACT

Agency	Contact	Project Title
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Ms. June Yi (949) 756-7559	Project Scientist/Engineer
TtFW 1940 East Deere Avenue, Suite 100 Santa Ana, CA 92705	Ms. Mary Schneider (949) 756-7586	QC Program Manager
TtFW 1230 Columbia St, Suite 500 San Diego, CA 92101	Mr. Roger Margotto, CIH, CSP (619) 471-3503 (714) 810-37432 (24hr pager)	PESM
TtFW 1940 East Deere Avenue, Suite 100 Santa Ana, CA 92705	Mr. Glenn Nardin (714) 822-4691	Superintendent and also will act as the alternate SHSS.
TtFW 1940 East Deere Avenue, Suite 200 Santa Ana, CA 92705	Mr. Jeffrey Brenner/Vince Richards (949) 756-7585	Project QC Manager/SHSS

Notes:

CIH – Certified Industrial Hygienist
CSP – Certified Safety Professional
DON – Department of Navy
DPM – Deputy Program Manager
DTSC – Department of Toxic Substances Control
IR – Installation Restoration
NAVWPNSTA – Naval Weapons Station
PESM – Project Environmental Safety Manager
QC – quality control
ROICC – Resident Officer in Charge of Construction
RPM – Remdeial Program Manager
RWQCB – Regional Water Quality Control Board
SHSS – Site Health and Safety Specialist
TtFW – Tetra Tech FW, Inc.

TABLE C.4-1

CHEMICAL HAZARDS ASSESSMENT

Chemical Name	PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
1,2-dichloroethene (DCE) all isomers	PEL – 200 ppm TLV – 200 ppm	Skin absorption, inhalation, ingestion	Acute: narcosis, respiratory tract irritation, nausea, vomiting, tremor, weakness, central nervous system depression, cramps, eye and skin irritation. Chronic: none reported	CNS, eyes, respiratory system
Tetrachloroethene (PCE)	PEL – 100 ppm TLV – 25 ppm	Skin absorption, inhalation, ingestion	Acute: Liver damage, Eye nose, throat irritation, skin drying. Chronic: Impaired memory, extremity weakness, peripheral neuropathies, muscle cramps, liver damage, kidney damage. CARCINOGEN	CNS, liver, kidney, skin disorders
Trichloroethene (TCE)	PEL – 100 ppm TLV – 50 ppm	Skin absorption, inhalation, ingestion	Acute: irritation of eyes and skin, headache, vertigo, visual disturbance, nausea, vomiting, tremor, cardiac arrhythmia Chronic: suspect liver and kidney cancers	CNS, respiratory system, heart, liver, kidneys, eyes, skin

Notes:

CNS – central nervous system
DCE – 1.2-dichloroethene
PCE – tetrachloroethene
PEL – permissible exposure limit
ppm – parts per million
TLV – threshold limit value
TCE – trichloroethene

TABLE C.12-1

EMERGENCY RESPONSE INFORMATION/CONTACTS

REPORT ALL FIRES, SERIOUS INJURY, OR UNCONTROLLED SPILLS IMMEDIATELY: 911

Clinic: (ACE/ESIS Provider)	Talbert Medical Group 2925 Palo Verde Avenue Long Beach, CA 90815 (562) 429-2473
Directions:	From site, take Kitts Highway north to the gate on Westminster Avenue. Make a left at the gate. At the next intersection, turn right onto Seal Beach Boulevard, continue north on Seal Beach Boulevard. Take the I-405 Freeway North toward Los Angeles. Exit at Exit 25, Palo Verde and bear right to Palo Verde Avenue North. Proceed north ¾ of a mile.
Hospital:	Los Alamitos Medical Center 3751 Katella Ave. Los Alamitos, CA 90720 (562) 598-1311
Directions:	From site, take Kitts Highway north to the gate on Westminster Avenue. Make a left at the gate. At the next intersection, turn right onto Seal Beach Boulevard. Continue north on Seal Beach Boulevard. (Upon entering Los Alamitos, Seal Beach Boulevard is now called Los Alamitos Boulevard.) After going over the 405 Freeway, the right hand lane will become a lane that requires a right turn at Katella Avenue. Turn right on Katella Avenue. The hospital is approximately two blocks east on the left side of the street.
Fire/Police/EMS:	911 or (562) 626-7333 [If phones are hard-wired in (i.e. not a cellular phone), the SHSS will verify whether a prefix is needed]

TABLE C.12-1

EMERGENCY RESPONSE INFORMATION/CONTACTS

	Contact/Phone Numbers
Base Security/Emergency Dispatch:	(562) 626-7229 or dial 9911
Base Emergency – Fire Department:	(562) 626-7333 or 626-7518
CHEMTREC (Chemical Spill Center):	(800) 424-9300
California Poison Control Center (Los Angeles):	(213) 664-2121
Poison Control Service, Regional University of California (UC) Medical Center:	(714) 634-5988
Remedial Project Manager (RPM):	Si Le (619) 532-1235
NAVWPNSTA Seal Beach IR Program Coordinator:	Pei-Fen Tamashiro (562) 626-7897
Resident Officer in Charge of Construction:	David Crawley (562) 626-7964
TtFW Project Manager:	Hamlet Hamparsumian (949) 756-7520
TtFW PESM:	Roger Margotto (619) 471-3503 pager: (714) 810-3742
TtFW SHSS:	Jeffrey Brenner (949) 756-7585

Notes:

EMS – Emergency Medical Services
IR – Installation Restoration
NAVWPNSTA – Naval Weapons Station
PESM – Project Environmental Safety Manager
SHSS – Site Health and Safety Specialist
TtFW – Tetra Tech FW, Inc.

FIGURES

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DATE: 02/11/05	REV: REVISION 0		CTO: #0090	050380C11.DWG

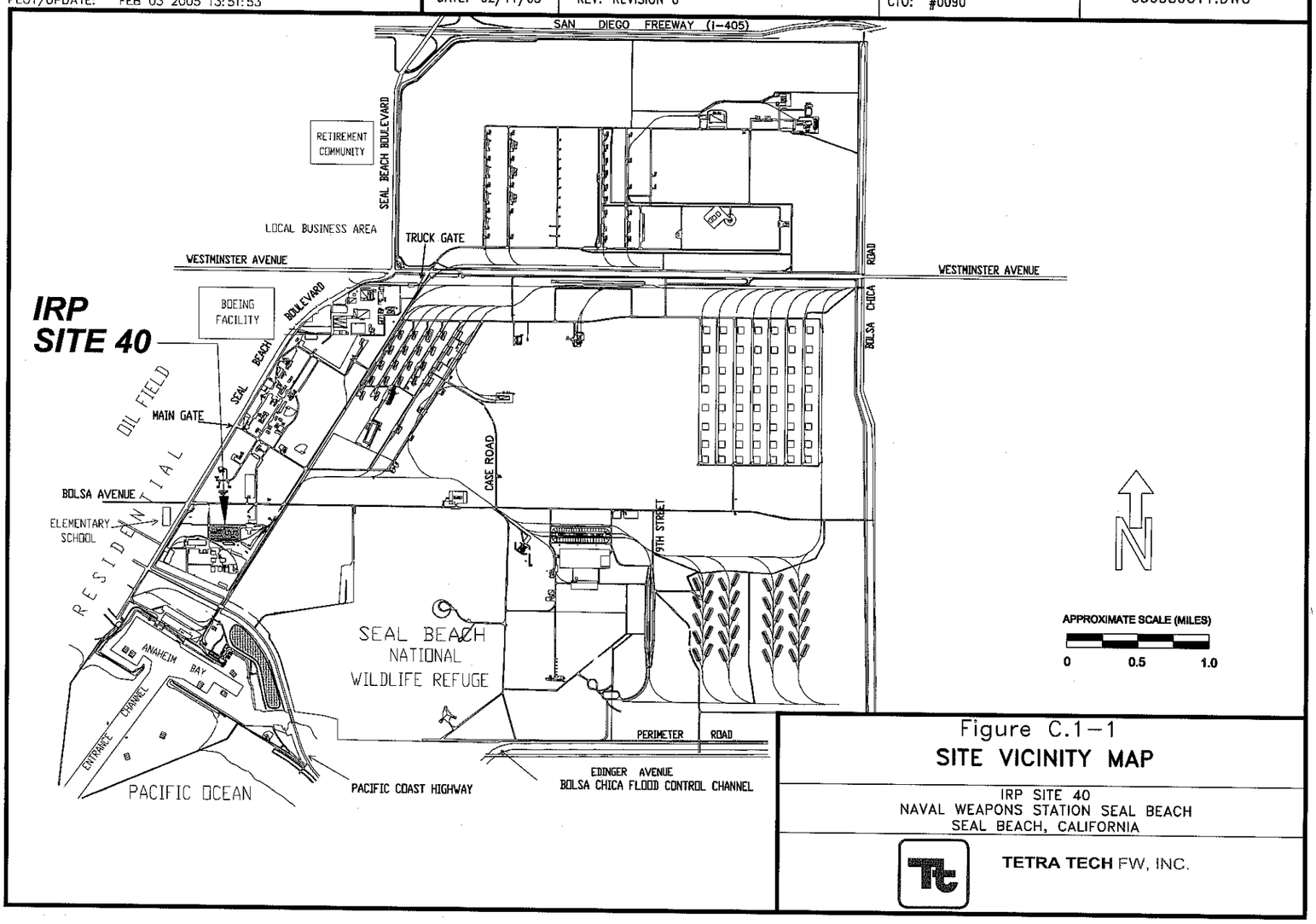

Figure C.1-1
SITE VICINITY MAP

IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC.

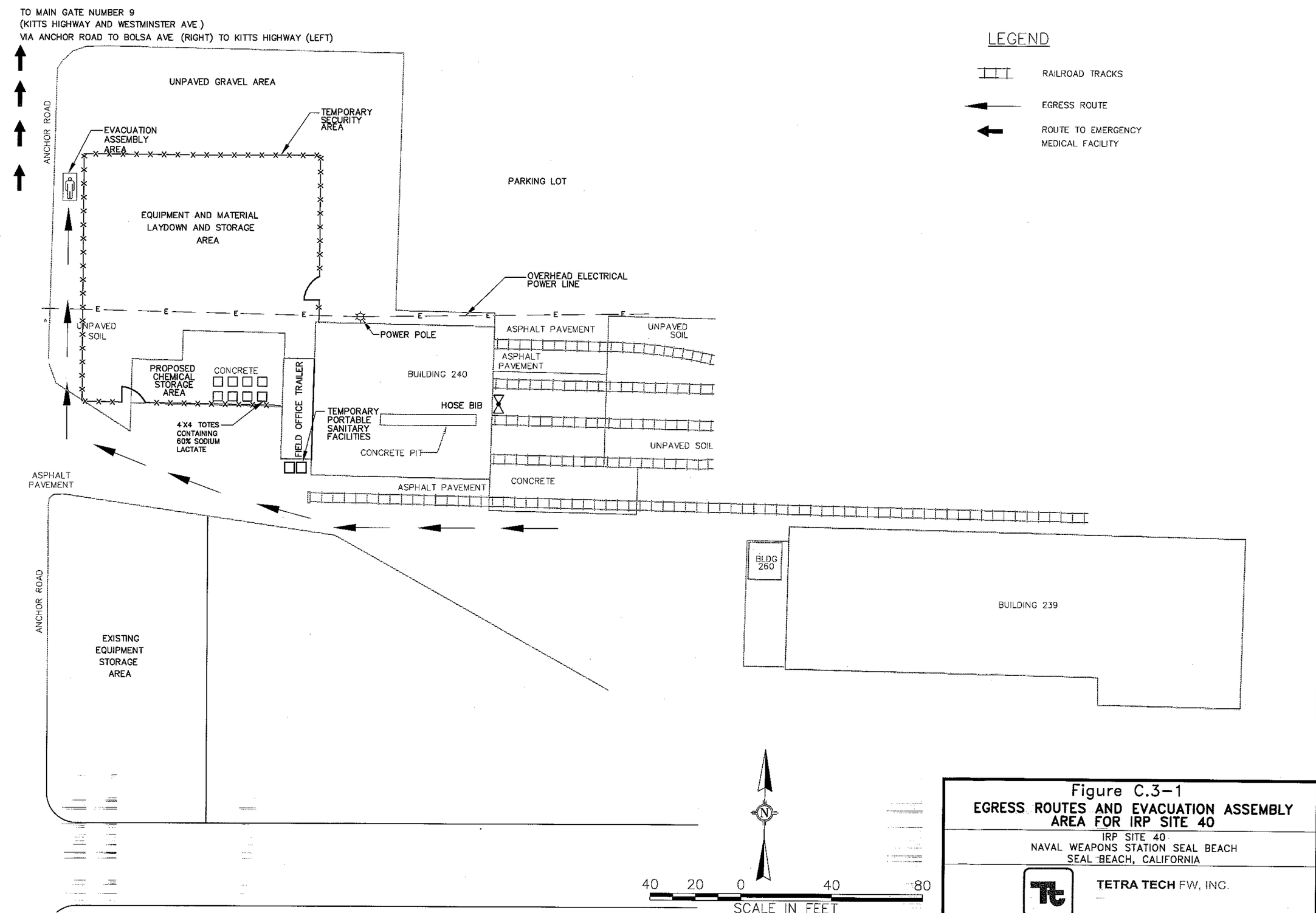

Figure C.3-1
EGRESS ROUTES AND EVACUATION ASSEMBLY AREA FOR IRP SITE 40

IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW, INC.

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DATE: 02/11/05	REV: REVISION 0		CTO: #0090	

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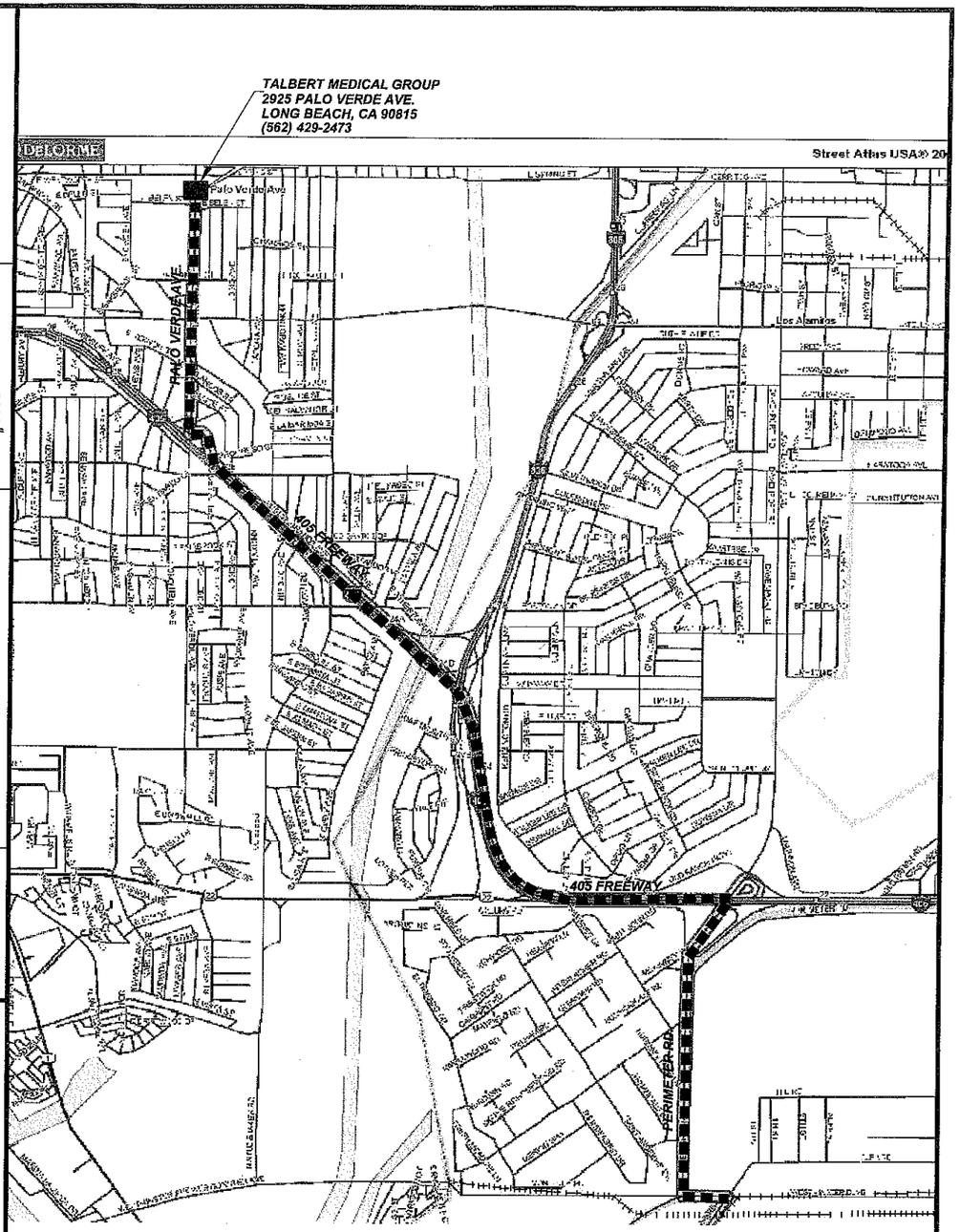

Figure C.12-1
ROUTE TO THE NEAREST CLINIC

IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW INC

DRAWN BY: MD	CHECKED BY: HH	APPROVED BY: HH	DCN: FWSO-RAC-05-0380	DRAWING NO: 050380C121.DWG
DATE: 02/11/05	REV: REVISION 0		CTO: #0090	

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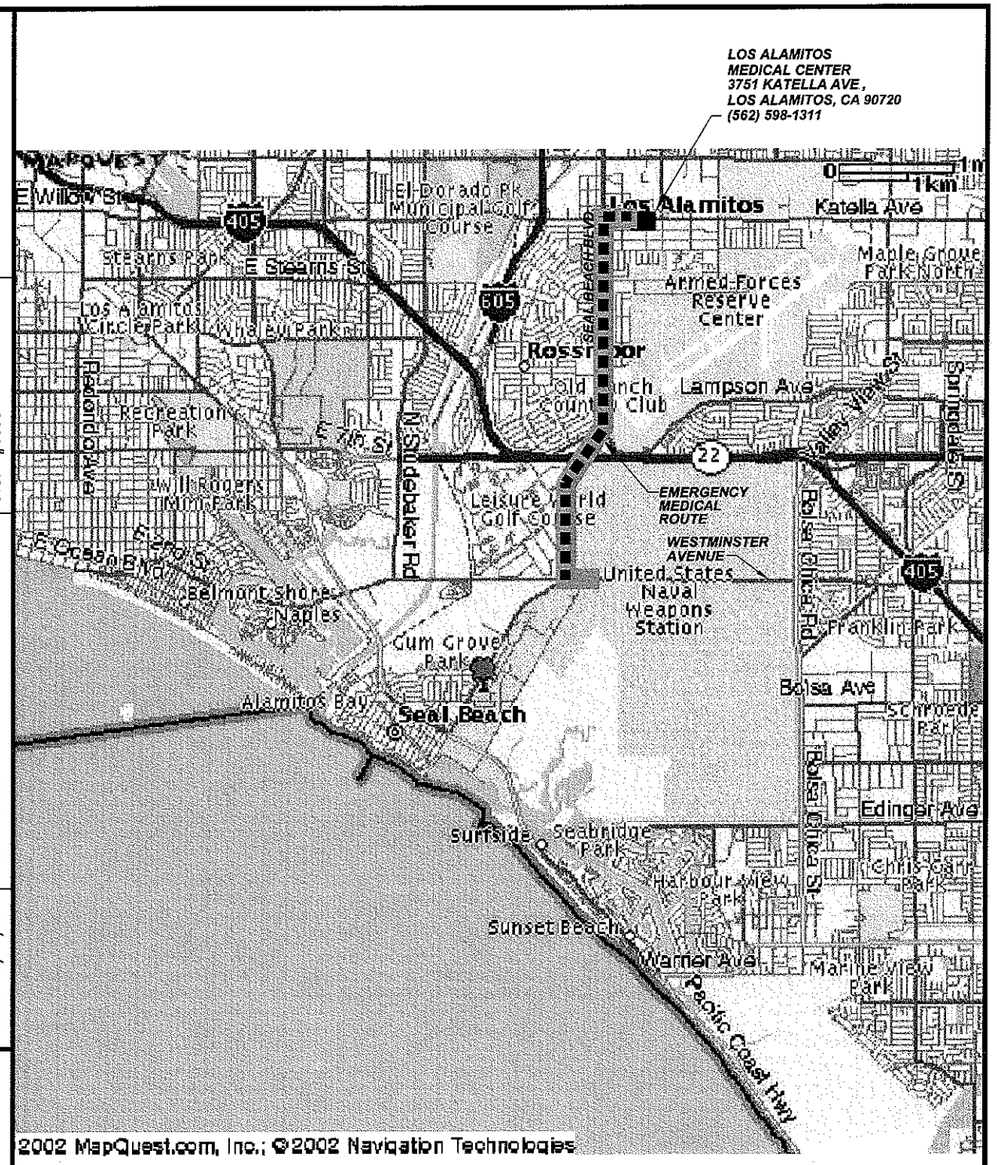

Figure C.12-2
ROUTE TO EMERGENCY MEDICAL FACILITY

IRP SITE 40
NAVAL WEAPONS STATION SEAL BEACH
SEAL BEACH, CALIFORNIA

TETRA TECH FW INC

DRAWN BY: MD	CHECKED BY: HH	APPROVED BY: HH	DCN: FWSD-RAC-05-0380	DRAWING NO: 050380C122.DWG
DATE: 02/11/05	REV: REVISION 0		CTO: #0090	

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ATTACHMENT 1

MATERIAL SAFETY DATA SHEETS

Genium Publishing Corporation
One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 312
Trichloroethylene

Issued: 7/79 Revision: F, 9/92

Section 1. Material Identification

Trichloroethylene (C_2HCl_3) Description: Derived by treating tetrachloroethane with lime or other alkali in the presence of water, or by thermal decomposition of tetrachloroethane followed by steam distillation Stabilizers such as epichlorohydrin, isobutanol, carbon tetrachloride, chloroform, benzene, or pentanol-2-triethanolamine are then added Used as a degreasing solvent in electronics and dry cleaning, a chemical intermediate, a refrigerant and heat-exchange liquid, and a diluent in paint and adhesives; in oil, fat, and wax extraction and in aerospace operations (flushing liquid oxygen) Formerly used as a fumigant (food) and anesthetic (replaced due to its hazardous decomposition in closed-circuit apparatus)

Other Designations: CAS No 79-01-6; acetylene trichloride; Algylen; Anamenth; Benzinol; Cecolene; Chlorylen; Dow-Tri; ethylene trichloride; Germalgene; Narcogen; Triasol; trichloroethene; TCE; 1,1,3-trichloroethylene

Manufacturer: Contact your supplier or distributor Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

R 1
I 2
S 2*
K 3
* Skin absorption

NFPA

HMIS
H 2†
F 2
R 0
PPE‡
† Chronic Effects
‡ Sec 8

Cautions: TCE is irritating and toxic to the central nervous system (CNS) Inhalation of high concentrations have lead to death due to ventricular fibrillation. Chronic exposure may lead to heart, liver, and kidney damage The liquid is absorbed through the skin Although it has a relatively low flash point, TCE burns with difficulty

Section 2. Ingredients and Occupational Exposure Limits

Trichloroethylene, < 100% [contains stabilizers (Sec. 1)].

1991 OSHA PELs
8-hr TWA: 50 ppm (270 mg/m^3)
15-min STEL: 200 ppm (1080 mg/m^3)

1990 IDLH Level
1000 ppm

1990 NIOSH REL
10-hr TWA: 25 ppm (~135 mg/m^3)

1992-93 ACGIH TLVs
TWA: 50 ppm (269 mg/m^3)
STEL: 200 ppm (1070 mg/m^3)

1990 DFG (Germany) MAK
Ceiling: 50 ppm (270 mg/m^3)
Category II: Substances with systemic effects
Half-life: 2 hr to shift length
Peak Exposure Limit: 250 ppm, 30 min average value; 2 peaks/shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 160 ppm/83 min caused hallucinations and distorted perceptions
Human, lymphocyte: 5 mL/L caused DNA inhibition
Rabbit, skin: 500 mg/24 hr caused severe irritation
Rabbit, eye: 20 mg/24 hr caused moderate irritation
Mouse, oral, TD_{Lo}: 455 mg/kg administered intermittently for 78 weeks produced liver tumors

* See NIOSH, *RTECS* (KX4550000), for additional irritation, mutation, reproductive, tumorigenic and toxicity data.

Section 3. Physical Data

Boiling Point: 189 °F (87 °C)
Freezing Point: -121 °F (-85 °C)
Viscosity: 0.0055 Poise at 77 °F (25 °C)
Molecular Weight: 131.38
Density: 1 4649 at 20/4 °C
Refraction Index: 1.477 at 68 °F (20 °C/D)
Odor Threshold: 82 to 108 ppm (*not an effective warning*)

Vapor Pressure: 58 mm Hg at 68 °F (20 °C); 100 mm Hg at 32 °F (0 °C)
Saturated Vapor Density (Air = 0.075 lbs/ft^3; 1.2 kg/m^3): 0.0956 lbs/ft^3; 1 53 kg/m^3
Water Solubility: Very slightly soluble; 0 1% at 77 °F (25 °C)
Other Solubilities: Highly soluble in organic solvents (alcohol, acetone, ether, carbon tetrachloride, & chloroform) and lipids
Surface Tension: 29 3 dyne/cm

Appearance and Odor: Clear, colorless (sometimes dyed blue), mobile liquid with a sweet chloroform odor

Section 4. Fire and Explosion Data

Flash Point: 90 °F (32 °C) CC | **Autoignition Temperature:** 788 °F (420 °C) | **LEL:** 8% (25 °C); 12.5% (100 °C) | **UEL:** 10% (25 °C); 90% (100 °C)

Extinguishing Media: A Class IC Flammable Liquid Although it has a flash point of 90 °F, TCE burns with difficulty. For small fires, use dry chemical, carbon dioxide, water spray, or regular foam For large fires, use water spray, fog, or regular foam. **Unusual Fire or Explosion Hazards:** Vapor/air mixtures may explode when ignited Container may explode in heat of fire. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode Structural firefighters' protective clothing provides only limited protection against TCE Apply cooling water to sides of container until well after fire is out Stay away from ends of tanks Do not release runoff from fire control methods to sewers or waterways

Section 5. Reactivity Data

Stability/Polymerization: TCE slowly decomposes in the presence of light and moisture to form corrosive hydrochloric acid Hazardous polymerization cannot occur **Chemical Incompatibilities:** Include alkalis (sodium hydroxide), chemically active metals (aluminum, beryllium, lithium, magnesium, sodium, potassium, and titanium), epoxides, and oxidants (nitrogen tetraoxide, perchloric acid) Contact with 1-chloro-2,3-epoxy propane or the mono and di 2,3-epoxypropyl ethers of 1,4-butanediol + 2,2-bis-4(2',3'-epoxypropoxy)-phenylpropane can, in the presence of catalytic quantities of halide ions, cause dehydrochlorination of TCE to explosive dichloroacetylene. **Conditions to Avoid:** Exposure to light, moisture, ignition sources, and incompatibles **Hazardous Products of Decomposition:** Thermal oxidative decomposition of TCE (above 300 °C) or exposure to ultraviolet light can produce carbon dioxide (CO_2) and toxic dichloro acetylene (explosive), chlorine, hydrogen chloride, and phosgene gas

Section 6. Health Hazard Data

Carcinogenicity: The following agencies have rated TCE's carcinogenicity: IARC (Class 3, limited animal evidence & insufficient human data), Germany MAK (Class B, justifiably suspected of having carcinogenic potential), & NIOSH (Class X, carcinogen defined with no further categorization). **Summary of Risks:** TCE vapor is irritating to the eyes, nose, and respiratory tract and inhalation of high concentrations can lead to severe CNS effects such as unconsciousness, ventricular arrythmias, and death due to cardiac arrest Mild liver dysfunction was also seen at levels high enough to produce CNS effects Contact with the liquid is irritating to the skin and can lead to dermatitis by defatting the skin Chronic toxicity is observed in the victims increasing intolerance to alcohol characterized by 'degreasers flush', a transient redness of the face, trunk, and arms The euphoric effect of TCE has led to craving, and habitual sniffing of its vapors

Continue on next page

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Section 6. Health Hazard Data, *Continued*

TCE crosses the placental barrier and thus exposes the fetus (any effects are yet unknown). There are increased reports of menstrual disorders in women workers and decreased libido in males at exposures high enough to cause CNS effects. TCE is eliminated unchanged in expired air and as metabolites (trichloroacetic acid & trichloroethanol) in blood and urine. **Medical Conditions Aggravated by Long-Term Exposure:** Disorders of the nervous system, skin, heart, liver, and kidney. **Target Organs:** Respiratory, central & peripheral nervous, and cardiovascular (heart) systems, liver, kidney, and skin. **Primary Entry Routes:** Inhalation, skin and eye contact, and ingestion (rarely). **Acute Effects:** Vapor inhalation can cause eye, nose, and throat irritation, nausea, blurred vision, overexcitement, headache, drunkenness, memory loss, irregular heartbeat (resulting in sudden death), unconsciousness, and death due to cardiac failure. Skin contact with the liquid can cause dryness and cracking and prolonged exposure (generally if the victim is unconscious) can cause blistering. Eye contact can cause irritation and watering, with corneal epithelium injury in some cases. Ingestion of the liquid can cause lip, mouth, and gastrointestinal irritation, irregular heartbeat, nausea and vomiting, diarrhea (possibly blood-stained), drowsiness, and risk of pulmonary edema (fluid in lungs). **Chronic Effects:** Effects may persist for several weeks or months after repeated exposure. Symptoms include giddiness, irritability, headache, digestive disturbances, mental confusion, intolerance to alcohol (degreasers flush), altered color perception, loss or impairment of sense of smell, double vision, and peripheral nervous system function impairment including persistent neuritis, temporary loss of sense of touch, and paralysis of the fingers from direct contact with TCE liquid.

FIRST AID. Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Do not give milk, as its fat content (TCE is lipid soluble) may inhance gastrointestinal absorption of TCE. **Note to Physicians:** TCE elimination seems to be triphasic with half lives at 20 min, 3 hr, and 30 hr. Some success is seen in treating patients with propranolol, atropine, and disulfiram. Monitor urine and blood (lethal level = 3 to 110 µg/mL) metabolites. BEI = 100 mg/g creatinine (trichloroacetic acid) in urine, *sample at end of workweek*. BEI = 4 mg/L (trichloroethanol) in blood, *sample at end of shift at end of the workweek*. These tests are not 100% accurate indicators of exposure; monitor TCE in expired air as a confirmatory test.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable container for later disposal. For large spills, flush to containment area where density stratification will form a bottom TCE layer which can be pumped and containerized. Report any release in excess of 1000 lbs. Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Bluegill sunfish, LC_{50} = 44,700 µg/L/96 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 40.7 mg/L/96 hr. **Environmental Degradation:** In air, TCE is photooxidized with a half-life of 5 days and reported to form phosgene, dichloroacetyl chloride, and formyl chloride. In water it evaporates rapidly in minutes to hours. TCE rapidly evaporates and may leach since it does not absorb to sediment. **Soil Absorption/Mobility:** TCE has a Log K_{oc} of 2, indicating high soil mobility. **Disposal:** Waste TCE can be poured on dry sand and allowed to vaporize in isolated location, purified by distillation, or returned to supplier. A potential candidate for rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C) with an acid scrubber to remove halo acids. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a RCRA Hazardous Waste (40 CFR 261.33 & 261.31): No. U228 & F002 (*spent solvent*)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per RCRA, Sec. 3001, CWA Sec. 311 (b)(4), & CWA Sec. 307 (a)]

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear chemical safety goggles (cup-type or rubber framed, equipped with impact-resistant glass), per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. At any detectable concentration, wear a SCBA with a full facepiece operated in pressure demand or other positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made from Viton or Neoprene to prevent skin contact. *Do not* use natural rubber or polyvinyl chloride (PVC). **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in steel drums, in a cool, dry, well-ventilated area away from sunlight, heat, ignition sources, and incompatibles (Sec. 5). Store large quantities in galvanized iron, black iron, or steel containers; small amounts in dark (amber) colored glass bottles. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Design processes so that the operator is not directly exposed to the solvent or its vapor. Do not use open electric heaters, high-temperature processes, arc-welding or open flames in TCE atmospheres. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers with emphasis on skin, respiratory, cardiac, central and peripheral nervous systems, and liver and kidney function. Employ air and biological monitoring (BEIs). Instruct employees on safe handling of TCE.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Trichloroethylene
DOT Hazard Class: 6.1
ID No.: UN1710
DOT Packing Group: III
DOT Label: Keep Away From Food
DOT Special Provisions (172.102): N36, T1

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar: 60L
b) Cargo Aircraft Only: 220L

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** AC Darlington, MD

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Section 1. Material Identification

Perchloroethylene (C_2Cl_4) Description: By chlorination of hydrocarbons and pyrolysis of the carbon tetrachloride that is formed, or by catalytic oxidation of 1,1,2,2-tetrachloroethane. Used in dry cleaning and textile processing, metal degreasing, insulating fluid and cooling gas in electrical transformers, production of adhesives, aerosols, paints, and coatings; as a chemical intermediate, a solvent for various applications, extractant for pharmaceuticals, a pesticide intermediate, and an antihelminthic (parasitic worm removal) agent in veterinary medicine
Other Designations: CAS No. 127-18-4, Ankilostin, carbon dichloride, Didakene, ethylene tetrachloride, Perchlor, Perclene, Perk, Tetracap, tetrachloroethylene
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list

Cautions: Perchloroethylene is a central nervous system depressant, causes liver and kidney damage (from acute or chronic exposures), and is considered an IARC Class 2B carcinogen (animal sufficient evidence, human inadequate data).

R 1
I 3
S 2*
K 0
* Skin absorption

NFPA
0
2 0
-

HMIS
H 2†
F 0
R 0
PPE‡
† Chronic effects
‡ Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Perchloroethylene, < 99% Impurities include a small amount of amine or phenolic stabilizers.

1991 OSHA PEL
8-hr TWA: 25 ppm (170 mg/m^3)

1990 IDLH Level
500 ppm

1990 NIOSH REL
NIOSH-X Carcinogen
Limit of Quantitation: 0 4 ppm

1992-93 ACGIH TLVs
TWA: 50 ppm (339 mg/m^3)
STEL: 200 ppm (1357 mg/m^3)

1990 DFG (Germany) MAK
TWA: 50 ppm (345 mg/m^3)
Category II: substances with systemic effects
Half-life: < 2 hr
Peak Exposure Limit: 100 ppm, 30 min average value, 4/shift

1985-86 Toxicity Data*
Man, inhalation, TC_{Lo}: 280 ppm/2 hr caused conjunctival irritation and anesthesia
Human, lung: 100 mg/L caused unscheduled DNA synthesis
Rat, oral, LD_{50}: 3005 mg/kg; caused somnolence, tremor, and ataxia.
Rat, inhalation, TC_{Lo}: 200 ppm/6 hr given intermittently over 2 years produced leukemia and testicular tumors.
Rabbit, eye: 162 mg caused mild irritation.
Rabbit, skin: 810 mg/24 hr caused severe irritation.

* See NIOSH, *RTECS* (KX3850000), for additional irritation, mutation, reproductive, tumorigenic, & toxicity data.

Section 3. Physical Data

Boiling Point: 250 °F (121.2 °C)
Freezing Point: -8 °F (-23.35 °C)
Vapor Pressure: 13 mm Hg at 68 °F (20 °C)
Surface Tension: 31.74 dyne/cm at 68 °F (20 °C)
Viscosity: 0.84 cP at 77 °F (25 °C)
Refraction Index: 1.50534 at 68 °F (20 °C)
Molecular Weight: 165 82

Density: 1 6311 at 59 °F (15/4 °C)
Water Solubility: 0.02% at 77 °F (25 °C)
Other Solubilities: Miscible with alcohol, ether, benzene, chloroform, and oils
Odor Threshold: 47 to 71 ppm (poor warning properties since olfactory fatigue is probable)
Evaporation Rate: 0 15 gal/ft^2/day at 77 °F (25 °C)
Saturated Vapor Density (Air = 0.075 lb/ft^3 or 1.2 kg/m^3): 0 081 lb/ft^3 or 1 296 kg/m^3

Appearance and Odor: Colorless liquid with an ether-like odor.

Section 4. Fire and Explosion Data

Flash Point: Nonflammable	Autoignition Temperature: Nonflammable	LEL: None reported	UEL: None reported

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2). For large fires, use water spray, fog, or regular foam.
Unusual Fire or Explosion Hazards: Vapors are heavier than air and collect in low-lying areas.
Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Apply cooling water to sides of container until well after fire is out. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Perchloroethylene is stable up to 932 °F (500 °C) in the absence of catalysts, moisture, and oxygen but deteriorates rapidly in warm, moist climates. It is slowly decomposed by light. Amine or phenolic stabilizers are usually added. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Slowly (faster in presence of water) corrodes aluminum, iron, and zinc. It is incompatible with chemically active metals (i.e., barium, beryllium, and lithium (explodes with lithium shavings), strong oxidizers, sodium hydroxide, caustic soda, potash, and nitric acid. Perchloroethylene forms an explosive mixture with dinitrogen tetraoxide and reacts with activated charcoal at 392 °F (200 °C) to yield hexachloroethane and hexachlorobenzene. **Conditions to Avoid:** Contact with moisture and incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of perchloroethylene can produce carbon dioxide and toxic chlorine, hydrogen chloride, and phosgene gas (also produced by contact with UV light).

Section 6. Health Hazard Data

Carcinogenicity: Perchloroethylene is listed as a carcinogen by The IARC (Group 2B, animal sufficient evidence, human inadequate data),[164] NTP (Class 2, reasonably anticipated as a carcinogen, with limited human evidence and sufficient animal evidence),[169] NIOSH (Class-X, carcinogen defined with no further explanation),[164] and DFG (MAK-B, justifiably suspected of having carcinogenic potential)[164] There is some controversy regarding human carcinogenicity because even though there is an increased number of cancers of the skin, colon, lung, urogenital tract, and lympho-sarcomas; the dry cleaning workers studied were also exposed to other chemicals. **Summary of Risks:** Perchloroethylene is stored in the fatty tissue and slowly metabolized with the loss of chlorine. The half-life of its urinary metabolite (trichloroacetic acid) is 144 hours. Perchloroethylene exerts the majority of its toxicity on the central nervous system causing symptoms ranging from light-headedness and slight 'inebriation' to unconsciousness. Liver damage is possible after severe acute or minor long-term exposure. It has a synergistic effect with toluene.

Continue on next page

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Section 6. Health Hazard Data, *continued*

Medical Conditions Aggravated by Long-Term Exposure: Nervous, liver, kidney, or skin disorders **Target Organs:** Liver, kidney, eyes, upper respiratory tract, skin, and central nervous system **Primary Entry Routes:** Inhalation and skin and eye contact **Acute Effects:** Exposure to high levels can cause liver damage which may take several weeks to develop. Vapor exposure can cause slight smarting of the eyes and throat (in high concentrations). In human studies, exposure to 2000 ppm/5 min caused mild CNS depression; 600 ppm/10 min caused numbness around the mouth, dizziness, and incoordination; 100 ppm/7 hr caused mild eye, nose, and throat irritation, flushing of the face and neck, headache, somnolence, and slurred speech. Skin contact may produce dermatitis because of perchloroethylene's defatting action (more common after repeated exposure). Direct eye contact causes tearing and burning but no permanent damage. Ingestion is rare but can cause irritation of the lips, mouth and gastrointestinal tract, irregular heartbeat, nausea & vomiting, diarrhea (possibly blood stained), drowsiness, unconsciousness, and risk of pulmonary edema (fluid in lungs). **Chronic Effects:** Prolonged exposure can cause impaired memory, extremity (hands, feet) weakness, peripheral neuropathies, impaired vision, muscle cramps, liver damage (fatty degeneration, necrosis, yellow jaundice, and dark urine) and kidney damage (oliguric uremia, conjestion and granular swelling).

FIRST AID ***Rescuers must not enter areas with potentially high perchloroethylene levels without a self-contained breathing apparatus.***
Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. *Never administer adrenalin!* **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Be sure victim's head is positioned to avoid aspiration of vomitus into the lungs. **Note to Physicians:** Monitor level of consciousness, EEG (abnormalaties may indicate chronic toxicity), blood enzyme levels (for 2 to 3 wk after exposure), EKG, adequacy of respirations & oxygenation, and liver and kidney function. *BEIs:* C_2Cl_4 in expired air (10 ppm), sample prior to last shift of work week; C_2Cl_4 in blood (1 mg/L), sample prior to last shift of work week; trichloroacetic acid in urine (7 mg/L), sample at end of workweek.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources (although noncombustible, it forms toxic vapors from thermal decomposition). For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal. For large spills, dike far ahead of spill and await reclamation or disposal. Report any release in excess of 1 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** If released to soil, perchloroethylene evaporates and some leaches to groundwater. It may absorb slightly to soils with heavy organic matter. Biodegradation may be important in anaerobic soils. In water, it is subject to rapid volatilization with an estimated half-life from <1 day to several weeks. In air, it exists mainly in the vapor-phase and is subject to photooxidation with a half-life of 30 minutes to 2 months. **Ecotoxicity Values:** Guppy (*Poecilia reticulata*), LC_{50} = 18 ppm/7 days; fathead minnow (*Pimephales promelas*), LC_{50} = 18.4 mg/L/96 hr, flow through bioassay. **Disposal:** Consider recovery by distillation. A potential candidate for rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C) or fluidized bed incineration at 842 to 1796 °F (450 to 980 °C). Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U210
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per CWA Sec. 307 (a)]
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear a faceshield (8 inch minimum) per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable concentration, use a supplied-air respirator or SCBA with a full facepiece operated in pressure demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made of butyl rubber, Neoprene, or Viton to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from sunlight, and incompatibles. Do not store sludge from vapor degreasers in tightly-sealed containers and keep outside until disposal is arranged. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Check stabilizer levels frequently and ventilation equipment (air velocity, static pressure, air valve) at least every 3 months. Install an air dryer in ventlines to storage tanks to prevent moisture from rusting and weakening the tank and contaminating or discoloring its contents. Purge all tanks before entering for repairs or cleanup. Build a dike around storage tanks capable of containing all the liquid. Ground tanks to prevent static electricity. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize liver, kidney, and nervous system function, and the skin. Alcoholism may be a predisposing factor.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Tetrachloroethylene
DOT Hazard Class: 6.1
ID No.: UN1897
DOT Packing Group: III
DOT Label: Keep away from food
Special Provisions (172.102): N36, T1

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar: 60 L
b) Cargo Aircraft Only: 220 L

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 140, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** W Silverman, MD

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Material Safety Data Sheets Collection:

Sheet No. 467
Automotive Gasoline, Lead-free

Issued: 10/81 Revision: A, 9/91

Section 1. Material Identification

35

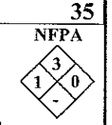
Automotive Gasoline, Lead-free, Description: A mixture of volatile hydrocarbons composed mainly of branched-chain paraffins, cycloparaffins, olefins, naphthenes, and aromatics. In general, gasoline is produced from petroleum, shale oil, Athabasca tar sands, and coal Motor gasolines are made chiefly by cracking processes, which convert heavier petroleum fractions into more volatile fractions by thermal or catalytic decomposition Widely used as fuel in internal combustion engines of the spark-ignited, reciprocating type. Automotive gasoline has an octane number of approximately 90. A high content of aromatic hydrocarbons and a consequent high toxicity are also associated with a high octane rating Some gasolines sold in the US contain a minor proportion of tetraethyllead, which is added in concentrations not exceeding 3 ml per gallon to prevent engine "knock." However, methyl-tert-butyl ether (MTBE) has almost completely replaced tetraethyllead

Other Designations: CAS No. 8006-61-9, benzin, gasoline, gasolene, motor spirits, natural gasoline, petrol

Manufacturer: Contact your supplier or distributor Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

R 1
I 2
S 2*
K 4
* Skin absorption

NFPA



HMIS
H 2
F 3
R 1
PPG†
† Sec 8

Cautions: Inhalation of automotive gasoline vapors can cause intense burning in throat and lungs, central nervous system (CNS) depression, and possible fatal pulmonary edema. Gasoline is a dangerous fire and explosion hazard when exposed to heat and flames.

Section 2. Ingredients and Occupational Exposure Limits

Automotive gasoline, lead-free*

1990 OSHA PELs
8-hr TWA: 300 ppm, 900 mg/m³
15-min STEL: 500 ppm, 1500 mg/m³

1990-91 ACGIH TLVs
TWA: 300 ppm, 890 mg/m³
STEL: 500 ppm, 1480 mg/m³

1990 NIOSH REL
None established

1985-86 Toxicity Data*
Man, inhalation, TC_{Lo}: 900 ppm/1 hr; toxic effects include sense organs and special senses (conjunctiva irritation), behavioral (hallucinations, distorted perceptions), lungs, thorax, or respiration (cough)
Human, eye: 140 ppm/8 hr; toxic effects include mild irritation
Rat, inhalation, LC_{50}: 300 g/m³/5 min

* A typical modern gasoline composition is 80% paraffins, 14% aromatics and 6% olefins. The mean benzene content is approximately 1%. Other additives include sulfur, phosphorus, and MTBE.
† See NIOSH, *RTECS* (LX3300000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: Initially, 102 °F (39 °C); after 10% distilled, 140 °F (60 °C); after 50% distilled, 230 °F (110 °C); after 90% distilled, 338 °F (170 °C); final boiling point, 399 °F (204 °C)
Vapor Density (air = 1): 3 0 to 4.0

Density/Specific Gravity: 0 72 to 0 76 at 60 °F (15.6 °C)
Water Solubility: Insoluble

Appearance and Odor: A clear (gasoline may be colored with dye), mobile liquid with a characteristic odor recognizable at about 10 ppm in air

Section 4. Fire and Explosion Data

Flash Point: -45 °F (-43 °C)	Autoignition Temperature: 536 to 853 °F (280 to 456 °C)	LEL: 1.3% v/v	UEL: 6.0% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, or alcohol foam as extinguishing media. Use of water may be ineffective to extinguish fire, but use water spray to knock down vapors and to cool fire-exposed drums and tanks to prevent pressure rupture. Do not use a solid stream of water since it may spread the fuel.

Unusual Fire or Explosion Hazards: Automobile gasoline is an OSHA Class IB flammable liquid and a dangerous fire and explosion hazard when exposed to heat and flames. Vapors can flow to an ignition source and flash back Automobile gasoline can also react violently with oxidizing agents.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode, and full protective clothing. When the fire is extinguished, use nonsparking tools for cleanup. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Automotive gasoline is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Automotive gasoline can react with oxidizing materials such as peroxides, nitric acid, and perchlorates

Conditions to Avoid: Avoid heat and ignition sources.

Hazardous Products of Decomposition: Thermal oxidative decomposition of automotive gasoline can produce oxides of carbon and partially oxidized hydrocarbons.

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Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC list gasoline as a possible human carcinogen (Group 2B). Although the IARC has assigned an overall evaluation to gasoline, it has not assigned an overall evaluation to specific substances within this group (inadequate human evidence).
Summary of Risks: Gasoline vapors are considered moderately poisonous. Vapor inhalation can cause central nervous system (CNS) depression and mucous membrane and respiratory tract irritation. Brief inhalations of high concentrations can cause a fatal pulmonary edema. Reported responses to gasoline vapor concentrations are: 160 to 270 ppm causes eye and throat irritation in several hours; 500 to 900 ppm causes eye, nose, and throat irritation, and dizziness in 1 hr; and 2000 ppm produces mild anesthesia in 30 min. Higher concentrations are intoxicating in 4 to 10 minutes. If large areas of skin are exposed to gasoline, toxic amounts may be absorbed. Repeated or prolonged skin exposure causes dermatitis. Certain individuals may develop hypersensitivity. Ingestion can cause CNS depression. Pulmonary aspiration after ingestion can cause severe pneumonitis. In adults, ingestion of 20 to 50 g gasoline may produce severe symptoms of poisoning.
Medical Conditions Aggravated by Long-Term Exposure: None reported
Target Organs: Skin, eye, respiratory and central nervous systems.
Primary Entry Routes: Inhalation, ingestion, skin contact.
Acute Effects: Acute inhalation produces intense nose, throat, and lung irritation; headaches; blurred vision; conjunctivitis; flushing of the face; mental confusion; staggering gait; slurred speech; and unconsciousness, sometimes with convulsions. Ingestion causes inebriation (drunkenness), vomiting, dizziness, fever, drowsiness, confusion, and cyanosis (a blue to dark purplish coloration of skin and mucous membrane caused by lack of oxygen). Aspiration causes choking, cough, shortness of breath, increased rate of respiration, excessively rapid heartbeat, fever, bronchitis, and pneumonitis. Other symptoms following acute exposure include acute hemorrhage of the pancreas, fatty degeneration of the liver and kidneys, and passive congestion of spleen.
Chronic Effects: Chronic inhalation results in appetite loss, nausea, weight loss, insomnia, and unusual sensitivity (hyperesthesia) of the distal extremities followed by motor weakness, muscular degeneration, and diminished tendon reflexes and coordination. Repeated skin exposure can cause blistering, drying, and lesions.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* due to aspiration hazard. Give conscious victim a mixture of 2 tablespoons of activated charcoal mixed in 8 oz of water to drink. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Use nonsparking tools. Take up small spills with sand or other noncombustible adsorbent. Dike storage areas to control leaks and spills. Follow applicable OSHA regulations (29 CFR 1910.120).
Aquatic Toxicity: Bluegill, freshwater, LC_{50}, 8 ppm/96 hr.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.21): Characteristic of ignitability
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. There are no specific NIOSH recommendations. However, for vapor concentrations not immediately dangerous to life or health, use chemical cartridge respirator equipped with organic vapor cartridge(s), or a supplied-air respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Materials such as neoprene or polyvinyl alcohol provide excellent/good resistance for protective clothing. **Note:** Resistance of specific materials can vary from product to product.
Ventilation: Provide general and local explosion-proof exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source [103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry, well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. Avoid direct sunlight. Storage must meet requirements of OSHA Class IB liquid. Outside or detached storage preferred.
Engineering Controls: Avoid vapor inhalation and skin or eye contact. Consider a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Indoor use of this material requires explosion-proof exhaust ventilation to remove vapors. Only use gasoline as a fuel source due to its volatility and flammable/explosive nature. Practice good personal hygiene and housekeeping procedures. Wear clean work clothing daily.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Gasoline (*including casing-head and natural*)
DOT Hazard Class: Flammable liquid
ID No.: UN1203
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Gasoline
IMO Hazard Class: 3.1
ID No.: UN1203
IMO Label: Flammable liquid
IMDG Packaging Group: II

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 140, 143, 146, 153, 159
Prepared by: M Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 470
Diesel Fuel Oil No. 2-D

Issued: 10/81 Revision: A, 11/90

Section 1. Material Identification

33

Diesel Fuel Oil No. 2-D Description: Diesel fuel is obtained from the middle distillate in petroleum separation; a distillate oil of low sulfur content. It is composed chiefly of unbranched paraffins. Diesel fuel is available in various grades, one of which is synonymous with fuel oil No. 2-D. This diesel fuel oil requires a minimum Cetane No. (efficiency rating for diesel fuel comparable to octane number ratings for gasoline) of 40 (ASTM D613). Used as a fuel for trucks, ships, and other automotive engines; as mosquito control (coating on breeding waters); and for drilling muds.

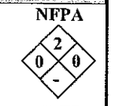
Other Designations: CAS No. 68334-30-5, diesel fuel.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

Cautions: Diesel fuel oil No. 2-D is a skin irritant and central nervous depressant with high mist concentrations. It is an environmental hazard and moderate fire risk.

R	1
I	-
S	2
K	2

NFPA



HMIS
H 0
F 2
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Diesel fuel oil No. 2-D*

1989 OSHA PEL	1990-91 ACGIH TLV	1988 NIOSH REL	1985-86 Toxicity Data‡
None established	Mineral Oil Mist TWA: 5 mg/m³† STEL: 10 mg/m³	None established	Rat, oral, LD_{50}: 9 g/kg produces gastrointestinal (hypermotility, diarrhea) effects

* Diesel fuel No. 2-D tends to be low in aromatics and high in paraffinics. This fuel oil is complex mixture of: 1) >95% paraffinic, olefinic, naphthenic, and aromatic hydrocarbons, 2) sulfur (<0.5%), and 3) benzene (<100 ppm). [A low benzene level reduces carcinogenic risk. Fuel oils can be exempted under the benzene standard (29 CFR 1910.1028)]. Although low in the fuel itself, benzene concentrations are likely to be much higher in processing areas.
† As sampled by nonvapor-collecting method.
‡ Monitor NIOSH, *RTECS* (HZ1800000), for future toxicity data.

Section 3. Physical Data

Boiling Point Range: 340 to 675 °F (171 to 358 °C)
Viscosity: 1.9 to 4.1 centistoke at 104 °F (40 °C)
Specific Gravity: <0.86
Water Solubility: Insoluble

Appearance and Odor: Brown, slightly viscous liquid.

Section 4. Fire and Explosion Data

Flash Point: 125 °F (52 °C) min.	Autoignition Temperature: >500 °F (932 °C)	LEL: 0.6% v/v	UEL: 7.5% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, or foam to fight fire. Use a water spray to cool fire exposed containers. Do not use a forced water spray directly on burning oil since this will scatter the fire. Use a smothering technique for extinguishing fire.

Unusual Fire or Explosion Hazards: Diesel fuel oil No. 2-D is a OSHA Class II combustible liquid. Its volatility is similar to that of gas oil. Vapors may travel to a source of ignition and flash back.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective clothing. If feasible, remove containers from fire. Be aware of runoff from fire control methods. Do not release to sewers or waterways due to pollution and fire or explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Diesel fuel oil No. 2-D is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: It is incompatible with strong oxidizing agents; heating greatly increases the fire hazard.

Conditions to Avoid: Avoid heat and ignition sources.

Hazardous Products of Decomposition: Thermal oxidative decomposition of diesel fuel oil No. 2-D can produce various hydrocarbons and hydrocarbon derivatives, and other partial oxidation products such as carbon dioxide, carbon monoxide, and sulfur dioxide.

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Section 6. Health Hazard Data

Carcinogenicity: Although the IARC has not assigned an overall evaluation to diesel fuels as a group, it has evaluated occupational exposures in petroleum refining as an IARC probable human carcinogen (Group 2A). It has evaluated distillate (light) diesel oils as not classifiable as human carcinogens (Group 3).
Summary of Risks: Although diesel fuel's toxicologic effects should resemble kerosine's, they are somewhat more pronounced due to additives such as sulfurized esters. Excessive inhalation of aerosol or mist can cause respiratory tract irritation, headache, dizziness, nausea, vomiting, and loss of coordination, depending on concentration and exposure time. When removed from exposure area, affected persons usually recover completely. If vomiting occurs after ingestion and if oil is aspirated into the lungs, hemorrhaging and pulmonary edema, progressing to renal involvement and chemical pneumonitis, may result. A comparative ratio of oral to aspirated lethal doses may be 1 pt vs. 5 ml. Aspiration may also result in transient CNS depression or excitement. Secondary effects may include hypoxia (insufficient oxygen in body cells), infection, pneumatocele formation, and chronic lung dysfunction. Inhalation may result in euphoria, cardiac dysrhythmias, respiratory arrest, and CNS toxicity. Prolonged or repeated skin contact may irritate hair follicles and block sebaceous glands, producing a rash of acne pimples and spots, usually on arms and legs.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Central nervous system, skin, and mucous membranes.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: Systemic effects from ingestion include gastrointestinal irritation, vomiting, diarrhea, and in severe cases central nervous system depression, progressing to coma or death. Inhalation of aerosols or mists may result in increased rate of respiration, tachycardia (excessively rapid heart beat), and cyanosis (dark purplish discoloration of the skin and mucous membranes caused by deficient blood oxygenation).
Chronic Effects: Repeated contact with the skin causes dermatitis
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. If large areas of the body have been exposed or if irritation persists, get medical help immediately. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* due to aspiration hazard. Contact a physician immediately. Position to avoid aspiration.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Gastric lavage is contraindicated due to aspiration hazard. Preferred antidotes are charcoal and milk. In cases of severe aspiration pneumonitis, consider monitoring arterial blood gases to ensure adequate ventilation. Observe the patient for 6 hr. If vital signs become abnormal or symptoms develop, obtain a chest x-ray.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate area for large spills, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Clean up spills promptly to reduce fire or vapor hazards. Use a noncombustible absorbent material to pick up small spills or residues. For large spills, dike far ahead to contain. Pick up liquid for reclamation or disposal. Do not release to sewers or waterways due to health and fire and/or explosion hazard. Follow applicable OSHA regulations (29 CFR 1910.120). Diesel fuel oil No. 2-D spills may be environmental hazards. Report large spills.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.21): Ignitable waste
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, use a NIOSH-approved respirator with a mist filter and organic vapor cartridge. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations that promote worker safety and productivity. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Use and storage conditions should be suitable for a OSHA Class II combustible liquid. Store in closed containers in a well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations. Use nonsparking tools and explosion-proof electrical equipment. No smoking in storage or use areas.
Engineering Controls: Avoid vapor or mist inhalation and prolonged skin contact. Wear protective rubber gloves and chemical safety glasses where contact with liquid or high mist concentration may occur. Additional suitable protective clothing may be required depending on working conditions. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Do not wear oil contaminated clothing. At least weekly laundering of work clothes is recommended. Do not put oily rags in pockets. When working with this material, wear gloves or use barrier cream.
Transportation Data (49 CFR 172.101)
DOT Shipping Name: Fuel oil
DOT Hazard Class: Combustible liquid
ID No.: NA1993
DOT Label: None
DOT Packaging Exceptions: 173.118a
DOT Packaging Requirements: None

MSDS Collection **References:** 1, 6, 7, 12, 73, 84, 101, 103, 126, 127, 132, 133, 136, 143, 146
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** AC Darlington, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 703
1,2-Dichloroethylene

Issued: 4/90

Section 1. Material Identification

31

1,2-Dichloroethylene Description: An industrial solvent composed of 60% cis- and 40% trans-isomers. Both isomers, cis and trans, are made by partial chlorination of acetylene. Used as a general solvent for organic materials, lacquers, dye extraction, thermoplastics, organic synthesis, and perfumes. The trans-isomer is more widely used in industry than either the cis-isomer or the mixture. Toxicity also varies between the two isomers.
Other Designations: CAS No. 0540-59-0; $C_2H_2Cl_2$; acetylene dichloride; *cis*-1,2-dichloroethylene; *sym*-dichloroethylene; *trans*-1,2-dichloroethylene, dioform.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list

R 1
I 2
S 2
K 1

NFPA

HMIS
H 2
F 3
R 1
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

1,2-Dichloroethylene, ca 100%

OSHA PEL
8-hr TWA: 790 mg/m³, 200 ppm

ACGIH TLV, 1989-90
TLV-TWA: 790 mg/m³, 200 ppm

NIOSH REL, 1987
790 mg/m³, 200 ppm

Toxicity Data*
Rat, oral, LD_{50}: 770 mg/kg; toxic effects not yet reviewed
Frog, inhalation, TC_{Lo}: 117 mg/m³ inhaled for 1 hr affects the peripheral nerve and sensation (flaccid paralysis without anesthesia); behavior (excitement); lungs, thorax, or respiration (respiratory depression)

* See NIOSH, *RTECS* (KV9360000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: 119 °F/48 °C
Melting Point: -56 to -115 °F/-49 to -82 °C/
Vapor Pressure: 180 to 264 torr at 68 °F/20 °C
Vapor Density (Air = 1): 3.4

Molecular Weight: 96.95 g/mol
Specific Gravity (H_2O = 1 at 39 °F/4 °C): 1.27 at 77 °F/25 °C
Water Solubility: Insoluble

Appearance and Odor: A colorless, low-boiling liquid with a pleasant odor

Section 4. Fire and Explosion Data

Flash Point: 37 °F/2.8 °C, CC	Autoignition Temperature: 860 °F/460 °C	LEL: 5.6% v/v	UEL: 12.8% v/v

Extinguishing Media: Use dry chemical, CO_2, halon, water spray, or standard foam. Water may be ineffective unless used to blanket the fire.
Unusual Fire or Explosion Hazards: This material's vapors are a dangerous fire hazard and moderate explosion hazard when exposed to any heat or ignition source or oxidizer.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and a fully encapsulating suit. Vapors may travel to heat or ignition sources and flash back. Stay upwind and out of low areas. Be aware of runoff from fire control methods. Do not release to sewers or waterways

Section 5. Reactivity Data

Stability/Polymerization: This material is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: This material is incompatible with alkalies, nitrogen tetraoxide, difluoromethylene, strong oxidizers, and dihypofluorite. When in contact with copper or copper alloys or by reaction with potassium hydroxide, explosive chloroacetylene may be released.
Conditions to Avoid: Addition of hot liquid to cold 1,2-dichloroethylene may cause sudden emission of vapor that could flash back to an ignition source.
Hazardous Products of Decomposition: Thermal oxidative decomposition of 1,2-dichloroethylene can produce highly toxic fumes of chlorine (Cl^-).

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Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists 1,2-dichloroethylene as a carcinogen.
Summary of Risks: 1,2-Dichloroethylene's most important effect is its irritation of the central nervous system (CNS) and narcosis. This material is toxic by inhalation, ingestion, and skin contact It is also irritating to the eyes. The trans-isomer at 2200 ppm causes nausea, vertigo, and burning of the eyes. The trans-isomer is twice as potent as the cis-isomer. If renal effects occur, they are transient.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Central nervous system, eyes, respiratory system.
Primary Entry Routes: Inhalation, ingestion, skin and eye contact.
Acute Effects: Inhalation of 1,2-dichloroethylene causes narcosis, respiratory tract irritation, nausea, vomiting, tremor, weakness, central nervous depression, and epigastric (the abdomen's upper midregion) cramps. Contact with the liquid causes eye and skin (on prolonged contact) irritation. Ingestion causes slight depression to deep narcosis.
Chronic Effects: None reported.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed. Have trained personnel administer 100% oxygen, preferably with humidification.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a *conscious* person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Intravenous injections of calcium gluconate may relieve cramps and vomiting. Treat central nervous system effects symptomatically.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a 1 2-dichloroethylene spill control and countermeasure plan (SCCP).* Notify safety personnel, remove all heat and ignition sources, evacuate hazard area, and provide adequate ventilation Cleanup personnel should protect against vapor inhalation and skin or eye contact. Absorb small spills on paper towels. After evaporating the 1,2-dichloroethylene from these paper towels in a fume hood, burn the paper in a suitable location away from combustible material. Collect and atomize large quantities in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33)
Listed as a CERCLA Hazardous Substance* (40 CFR 302 4), Reportable Quantity (RQ): 100 lb (45.4 kg) [* per RCRA, Sec. 3001, per Clean Water Act, Sec. 307(a)]†
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372 65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)
† Listed as 1,2-*trans*-dichloroethylene.

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910 133).
Respirator: Follow OSHA respirator regulations (29 CFR 1910 134) and, if necessary, wear a NIOSH-approved respirator For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact 1,2-dichloroethylene attacks some forms of plastics, rubber, and coatings.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL and ACGIH TLV (Sec 2) Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source [103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, well-ventilated area away from all incompatible materials (Sec. 5) and oxidizing materials Outside or detached storage is preferred. If stored inside, place containers in a standard flammable liquids storage cabinet or room. Protect containers from physical damage.
Engineering Controls: Avoid vapor inhalation and skin and eye contact Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. 1,2-dichloroethylene is a dangerous fire hazard. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Provide preplacement questionnaires which emphasize detecting a history of chronic respiratory disease.
Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection **References:** 7, 26, 38, 73, 84, 85, 87, 88, 100, 101, 103, 109, 126, 127, 136, 137
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

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Whittaker, Clark & Daniels, Inc.

Material Safety Data Sheet

A BRENNTAG Company

Bentonite -

C.A.S. Number: 1302-78-9 / MSDS C.A.S. Code: 0100

SECTION I - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION:

PRODUCT/MATERIAL:	**BENTONITE**
MANUFACTURER/DISTRIBUTOR:	WHITTAKER, CLARK & DANIELS, INC.
ADDRESS:	1000 COOLIDGE STREET SOUTH PLAINFIELD, N.J. 07080
TELEPHONE:	(908) 561-6100

SECTION II - COMPOSITION, INFORMATION ON INGREDIENTS:

CHEMICAL NAME:	BENTONITE
CAS NUMBER:	1302-78-9

HAZARDOUS INGREDIENTS: CRYSTALLINE SILICA (QUARTZ, 14808-60-7) IS PRESENT AT LESS THAN 1.0% AS A NATURALLY OCCURRING COMPONENT NOT REMOVED FROM THE CLAY ORE DURING PROCESSING. SEE SECTION 11 FOR FURTHER INFORMATION.

SECTION III - HAZARDS IDENTIFICATION:

HMIS RATING:

HEALTH	1	(POSSIBLE HAZARD FROM CHRONIC EXPOSURE TO DUST, SEE SECTION 11)
FLAMMABILITY	0	
REACTIVITY	0	
PERSONAL PROTECTION	E	

EMERGENCY OVERVIEW: UNDER NORMAL USAGE OR CONTAINED SPILLS THIS MATERIAL DOES NOT POSE A SIGNIFICANT EMERGENCY RISK. THIS MATERIAL IS VERY SLIPPERY WHEN WETTED WITH WATER. APPROPRIATE PRECAUTIONS SHOULD BE TAKEN TO AVOID SLIPS AND FALLS.

POTENTIAL HEALTH EFFECTS:

EYES: MAY CAUSE SLIGHT EYE IRRITATION. DIRECT CONTACT SHOULD BE AVOIDED TO PREVENT PHYSICAL ABRASION.

Information presented herein is believed to be accurate and reliable but is not intended to meet any specification and does not imply any guarantee or warranty by Whittaker, Clark and Daniels, Inc. (WCD). For more information and assistance, contact Technical Services at 1-800-732-0562

•Whittaker, Clark and Daniels, Inc. • 1000 Coolidge St. • South Plainfield, NJ 07080•

SKIN: NONE KNOWN

INHALATION: SHORT TERM EXPOSURE TO HIGH DUST LEVELS COULD CAUSE MINOR IRRITATION. LONG TERM EXPOSURE TO HIGH CONCENTRATIONS OF DUST SHOULD BE AVOIDED DUE TO THE PRESENCE OF QUARTZ WHICH CAN CAUSE SEVERE AND PERMANENT LUNG DAMAGE WHEN INHALED. CONTROL DUST LEVELS WITH ENGINEERING CONTROLS (LOCAL EXHAUST VENTILATION). PREVENT DUST INHALATION WITH USE OF A NIOSH APPROVED DUST RESPIRATOR IF ENGINEERING CONTROLS ARE INADEQUATE

CARCINOGENICITY: IARC HAS CLASSIFIED CRYSTALLINE SILICA AS A HUMAN CARCINOGEN, CLASS 1.
TARGET ORGAN: LUNGS

SECTION IV - EMERGENCY AND FIRST AID MEASURES:

SKIN: WASH OFF WITH SOAP AND WATER.
EYE: FLUSH WITH TEPID WATER FOR 15 MINUTES. IF IRRITATION OR PAIN PERSISTS, SEEK MEDICAL ATTENTION

INHALATION: REMOVE PERSON TO FRESH AIR. SEEK MEDICAL ATTENTION IF SHORTNESS OF BREATH OR IRRITATION PERSISTS.

INGESTION: COULD RESULT IN INTESTINAL BLOCKAGE. IF LARGE AMOUNTS ARE SWALLOWED SEEK MEDICAL ATTENTION

NOTES TO PHYSICIAN: MIXTURE IS ORALLY NON-TOXIC. SEE SECTION 11 FOR ADDITIONAL TOXICOLOGICAL DATA.

SECTION V - FIRE FIGHTING MEASURES:

FLASHPOINT: NOT APPLICABLE

UPPER EXPLOSIVE LIMIT: NOT APPLICABLE
LOWER EXPLOSIVE LIMIT: NOT APPLICABLE
AUTOIGNITION TEMPERATURE: NOT APPLICABLE
THIN-FILM IGNITION TEMPERATURE: NOT APPLICABLE
HAZARDOUS COMBUSTION PRODUCTS: NONE
BASIC FIRE FIGHTING GUIDANCE: USE APPROPRIATE MEASURES FOR SURROUNDING FIRE.
EXTINGUISHING MEDIA: NOT APPLICABLE

SECTION VI - ACCIDENTAL RELEASE MEASURES:

WET DOWN LARGE SPILLS WITH WATER MIST TO AVOID GENERATING EXCESSIVE DUST LEVELS. CAUTION: THIS MATERIAL IS VERY SLIPPERY WHEN WET. APPROPRIATE PRECAUTIONS SHOULD BE TAKEN TO AVOID SLIPS AND FALLS.

CLEAN-UP PROCEDURES AND EQUIPMENT: USE OF A DUSTLESS VACUUM SYSTEM OR SHOVELING. FLUSHING WITH WATER IS ALSO AN ACCEPTABLE METHOD. AVOID DRY SWEEPING OR OTHER METHODS THAT MAY GENERATE HIGH DUST CONCENTRATIONS. WEAR NIOSH APPROVED DUST RESPIRATOR.

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SECTION VII - HANDLING AND STORAGE:

HANDLING: ADEQUATE VENTILATION IS NECESSARY IN HANDLING AREAS TO PREVENT EXCESSIVE AIR-BORNE DUST.

STORAGE: STORE IN CLOSED CONTAINERS IN A DRY AREA.

SECTION VIII - EXPOSURE CONTROLS, PERSONAL PROTECTION:

ENGINEERING CONTROLS: PROVIDE GENERAL OR LOCAL VENTILATION ADEQUATE TO MAINTAIN AIRBORNE LEVELS BELOW OCCUPATIONAL EXPOSURE LIMITS.

PERSONAL PROTECTION EQUIPMENT:

EYE/FACE: USE SAFETY GLASSES OR GOGGLES

SKIN: NONE

RESPIRATORY: USE A NIOSH APPROVED, AIR PURIFYING DUST RESPIRATOR IF DUST LEVELS ARE ABOVE EXPOSURE LIMITS HALF-MASKS ARE USUALLY SUFFICIENT FOR NORMAL USE

SECTION IX - PHYSICAL AND CHEMICAL PROPERTIES:

APPEARANCE:	TAN POWDER
ODOR:	MILD
PHYSICAL STATE:	SOLID
pH:	NOT APPLICABLE
VAPOR PRESSURE:	NOT APPLICABLE
VAPOR DENSITY:	NOT APPLICABLE
BOILING POINT:	NOT APPLICABLE
MELTING POINT:	NOT APPLICABLE
SOLUBILITY:	NEGLIGIBLE
SPECIFIC GRAVITY:	2.6

SECTION X - STABILITY AND REACTIVITY:

INCOMPATIBILITIES:	NONE
CONDITIONS TO AVOID:	NOT APPLICABLE
STABILITY:	THIS MATERIAL IS STABLE UNDER NORMAL STORAGE AND HANDLING CONDITIONS

HAZARDOUS POLYMERIZATION: NOT APPLICABLE

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SECTION XI -TOXICOLOGICAL INFORMATION:

THE INTERNATIONAL AGENCY FOR RESEARCH ON CANCER HAS DETERMINED THAT OVER-EXPOSURE TO CRYSTALLINE SILICA CAN CAUSE LUNG CANCER AND SILICOSIS, A PROGRESSIVE LUNG DISEASE IN HUMANS HEALTH EFFECTS FROM EXPOSURE TO CRYSTALLINE SILICA OCCUR ONLY WHEN IT IS INHALED.

INHALATION EFFECTS: CRYSTALLINE SILICA HAS BEEN SHOWN TO CAUSE SILICOSIS AND LUNG CANCER. CRYSTALLINE SILICA ONLY CAUSES THESE CONDITIONS WHEN INHALED

SKIN CONTACT: PROLONGED SKIN CONTACT MAY LEAD TO DRYING OR CRACKING OF THE SKIN DUE TO THE ABSORPTION OF MOISTURE.

EYE CONTACT: AS WITH ANY DUST, WILL BE IRRITATING TO THE EYES DUE TO PHYSICAL ABRASION

MEDICAL CONDITIONS AGGREVATED: RESPIRATORY DISORDERS.

OCCUPATIONAL EXPOSURE LIMITS: STUDIES HAVE SHOWN THAT THE CRYSTALLINE SILICA IS EVENLY DISTRIBUTED THROUGHOUT ALL PARTICLE SIZES OF THIS PRODUCT. KEEP DUST LEVELS BELOW PERMISSIBLE LIMITS.

ACGIH TWA:	0 1 mg/cu m (as quartz)
ACGIH STEL:	N.A.
OSHA PEL (respirable):	10 mg/cu-m- / % SiO_2 + 2
OSHA PEL (total dust):	30 mg/cu m / % SiO_2 + 2

SECTION XII - ECOLOGICAL INFORMATION:

ECOTOXICOLOGICAL INFORMATION: NONE KNOWN

SECTION XIII - DISPOSAL CONSIDERATIONS:

DISPOSE OF IN A MANNER IN ACCORDANCE WITH LOCAL AND FEDERAL REGULATIONS. THIS INFORMATION APPLIES TO MATERIAL AS MANUFACTURED; CONTAMINATION OR PROCESSING MAY CHANGE WASTE CHARACTERISTICS AND REQUIREMENTS.

SECTION XIV - TRANSPORTATION INFORMATION:

THIS MATERIAL IS NOT REGULATED BY THE DEPARTMENT OF TRANSPORTATION

SECTION XV - REGULATORY INFORMATION:

SARA 313:	NONE KNOWN
TSCA :	LISTED
EUROPEAN INVENTORY:	LISTED
CANADIAN DSL:	EXEMPT
AUSTRALIAN AICS:	LISTED
JAPANESE ENCS:	ENCS 9 1971

CALIFORNIA PROPOSITION 65: CRYSTALLINE SILICA IN AIRBORNE PARTICLES OF RESPIRABLE SIZE IS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER

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EUROPE: QUARTZ EXPOSURE LIMITS.

BELGIUM:	0 1 mg/cu m. TWA
DENMARK:	0 1 mg/cu m. TWA
SWEDEN:	0 1 mg/cu m. TWA
U.K. :	0.1 mg/cu m. (respirable)
	0 3 mg/cu.m (total dust)
RUSSIA:	14 0 mg/cu m (STEL)
THAILAND:	10 0 mg/cu m (respirable)
	30 0 mg/cu m (total dust)
FINLAND:	0.2 mg/cu.m TWA
GERMANY:	0 2 mg/cu.m. TWA
SWITZERLAND:	0.15 mg/cu.m. TWA

NOTE: DIFFERENT COUNTRIES APPLY QUARTZ OCCUPATIONAL EXPOSURE LIMITS IN DIFFERENT MANNERS, DEPENDING ON HOW THEY DEFINE "RESPIRABLE" FRACTION, AND MASS PERCENTAGE OF A TOTAL MIXTURE; CONSULT LOCAL AUTHORITIES FOR APPLICATION

SECTION XVI - OTHER INFORMATION:

"Although the information and recommendations set forth herein (hereinafter "Information") are presented in good faith and believed to be correct as of the date hereof, Whittaker, Clark & Daniels, Inc. makes no representations as to the completeness or accuracy thereof. Information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for their purposes prior to use. In no event will Whittaker, Clark & Daniels, Inc. be responsible for damages of any nature whatsoever resulting from the use of or reliance upon Information **NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, THAT THE PRODUCTS TO WHICH THE INFORMATION REFERS MAY BE USED WITHOUT INFRINGING THE INTELLECTUAL PROPERTY RIGHTS OF OTHERS, OR OF ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO INFORMATION OR THE PRODUCT TO WHICH INFORMATION REFERS. IN NO CASE SHALL THE INFORMATION BE CONSIDERED A PART OF OUR TERMS AND CONDITIONS OF SALE."**

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No. 16008

RITA CORPORATION
P.O. BOX 1487, WOODSTOCK IL 60098

MATERIAL SAFETY DATA SHEET

PHONE: 815-337-2500 CHEMTREC EMERGENCY HOTLINE: 800-424-9300

SECTION I - NAME & HAZARD SUMMARY

Material Name: **P A I L A C N A L** Dated: 06/24/87

INCI Name: **Sodium Lactate** Updated: 08/12/02

Hazard summary (as defined by OSHA Hazard Communication Standard, 29 CFR 1910.1200):
Physical hazards and Health Hazards: None

SECTION II - INGREDIENTS % TLV (ACGIH)

CAS No.: 72-17-3 ; Sodium Lactate

SECTION III- PHYSICAL DATA

Boiling point:	112 C
Solubility in water:	Soluble
Specific gravity:	1.3100 - 1.3400
pH:	7.5 - 9.0
% Volatile by volume:	40
Appearance:	Colorless to pale yellow liquid
Odor:	Virtually odorless

SECTION IV - FIRE & EXPLOSION HAZARD DATA

Extinguishing media: Not a fire hazard

Special fire fighting protective equipment: None necessary

Unusual fire and explosion hazards: None

SECTION V - REACTIVITY DATA

Stability: Stable

Incompatibility (materials to avoid): Carbon monoxide, carbon dioxide generated on burning

Hazardous polymerization: Will not occur

SECTION VI - HEALTH HAZARD ASSESSMENT

Ingestion: May cause nausea, but should be non-toxic

Eye contact: No irritation is likely to occur

Skin contact: No irritation is likely to occur

Inhalation: No toxic effects are known. Not a likely avenue of entry.

SECTION VI - HEALTH HAZARD ASSESSMENT (continued)

First aid procedures:

Skin: Remove contaminated clothing. Wash skin with soap and water. Wash contaminated clothing before reuse. If irritation develops, consult a physician.

Eyes: Immediately flush with copious amounts of water for at least 15 minutes. If irritation develops, seek medical attention.

Ingestion: Give one or two glasses of water to drink. If gastrointestinal symptoms develop, consult medical personnel **(Never give anything by mouth to an unconscious person).**

SECTION VII - SPILL OR LEAK PROCEDURES

Steps to be taken in case material is released or spilled: Absorb excess and wash spill area with water and flush to a sewer serviced by waste water treatment facility.

Disposal method: Dispose of in landfill or sewer, but in accordance with Federal, State and Local Regulations.

Container disposal: Puncture or otherwise destroy empty container before disposal. Dispose of in accordance with Federal, State and Local Regulations

SECTION VIII - SPECIAL PROTECTION INFORMATION

Ventilation: Not required

Respiratory protection (specify type): Not required

Protective clothing: Not required

Eye protection: Recommend wearing chemical goggles or safety glasses meeting the specifications of ANSI Standard Z87.1.

Other protective equipment: Eyewash station and safety shower in the work area.

SECTION IX - SPECIAL PRECAUTIONS OR OTHER COMMENTS

STORAGE & HANDLING: Store under normal conditions. The container should be kept tightly sealed. Avoid exposure to direct sunlight for prolonged periods. After usage, return containers to normal storage, as product discolorization could occur. When stored under these conditions shelf life on this material is at least twelve months.

The information herein is given in good faith, but no warranty, expressed or implied is made.

ATTACHMENT 2

ACTIVITY HAZARD ANALYSES (AHAs)

ACTIVITY HAZARD ANALYSIS #1

Activity: Mobilization and Site Setup **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Set up work areas	Potential exposure to chemical hazards.	• Delineate exclusion zones and use PPE specified in SHSP. • Visual observation shall be used to verify selection of PPE. • Identify all chemical hazards and receive training (MSDS) regarding safe handling of chemicals. The SHSS will file copies of all MSDSs at the site.
	Noise exposure.	• Hearing protection is required when sound levels exceed 84 dBA continuously.
	Biological hazards such as snakes, insects, or spiders could cause injury or bites.	• Wear PPE. • Look carefully for snakes, insects, and spiders before stepping into any area or before placing hands near the ground. • Use insect repellent as necessary.
	Slip, trip, and fall hazards.	• Work areas shall be visually inspected and slip, trip, and fall hazards shall be marked, barricaded, or eliminated, if feasible. Use care in work area; look for depressions and obstructions. • Employees shall only be allowed to work on walking/working surfaces which have the strength and integrity to support employees safely. Walking/working surfaces for this requirement include the edges of trenches. • Employees performing work on a walking/working surface with an unprotected side or edge, which is 6 feet or more above a lower level, shall be protected from falling by the use of guardrail systems, safety net systems, or personal fall arrest systems. • Openings of 18 inches or more in diameter must be covered and marked. All openings less than 18 inches in diameter and all holes must be marked or barricaded.
	Sharp objects/punctures.	• Wear cut-resistant work gloves when sharp edges or other objects may cause the possibility of lacerations or other injury. When possible, sharp edges will be blunted. • Workers should not stand or walk on equipment or supplies.

ACTIVITY HAZARD ANALYSIS #1

Activity: Mobilization and Site Setup **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Set up work areas (continued)	Strains from manually moving materials and equipment.	• Personnel will be trained to use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use of hand truck shall be encouraged. • Employees will not lift more than 50 pounds. • Pre-employment back evaluations are recommended for craft workers who may be at a greater risk of developing low back pain or low back injury. This evaluation may be requested by contacting TtFW's CMC and may be performed by the local medical provider under the approval and direction of the TtFW CMC. • Surveys shall be performed by qualified persons to identify and evaluate tasks that might result in injuries due to ergonomic hazards. The focus of the surveys will be operations which involve the manual lifting and moving of objects of excessive weight or asymmetric size. • Hand tools shall be selected to minimize the following stressors: chronic muscle contraction or steady force, extreme or awkward finger/hand/arm positions, repetitive forceful motions, and excessive gripping, pinching, or pressing with hand and fingers.
	Exposure to extreme temperatures.	• Monitor for heat stress in accordance with EHS Procedure 4-6, Temperature Extremes. Provide fluids and rest breaks during warm weather and while wearing impermeable protective clothing. • Use sunscreen to prevent sunburn.
	Eye hazards.	• Safety glasses are the minimum required eye protection for all work areas.
	Lack of communication in widely dispersed areas.	• Ensure that each work team has a telephone or a 2-way radio or access to a telephone for communication. • If more than one team at a time is working, ensure there is communication between the work teams and project management. Workers must work in teams of two or more. Each team must use the "buddy" system.

ACTIVITY HAZARD ANALYSIS #1

Activity: Mobilization and Site Setup **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Set up work areas (continued)	Struck by or against vehicles.	• Wear high-visibility reflective vests at all times in work area. • Make eye contact with operators of vehicles. • Understand and review posted hand signals. Traffic barricades, signs, flags, and backup spotters will be used during field activities, as necessary.
	Power and hand tools.	• Inspect all tools before each use. Discard or tag out any tool that is not safe, has broken handles, patched handles, missing guards, and so forth. • Personnel will be trained in the proper use of hand and power tools. • If power tools are connected to power sources other than batteries, the tools will be grounded or double-insulated and connected to a GFCI outlet. [Refer to Station-Wide Plan (Section 4), regarding electrical safety].
	Material handling.	• Identify and avoid pinch points. • Maintain communication with others involved in material handling. • Use appropriate PPE.

Equipment to be Used	Inspection Requirements	Training Requirements
Vehicles, equipment, hand tools	Daily and before use.	• Only DMV-licensed personnel will operate vehicles. • Specific training for power tools and hand tools will be provided.

Notes:

CIH – Certified Industrial Hygienist
CMC – Corporate Medical Consultant
dBA – decibels, A-scale
DMV – Department of Motor Vehicles
EHS – Environmental Health and Safety
GFCI – ground fault circuit interrupter
MSDS – Material Safety Data Sheet
PPE – personal protective equipment
SHSP – Site-Specific Health and Safety Plan
SHSS – Site Health and Safety Specialist
TtFW – Tetra Tech FW, Inc.

ACTIVITY HAZARD ANALYSIS #2

Activity: Geophysical Survey **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Conduct geophysical survey	Locations not properly selected.	• Ensure area is "white lined" before survey and that USA (800) 227- 2600 has been contacted and conducted their survey (if needed) prior to our survey. Ensure that all "as-builts" in the area have been reviewed.
	Slips, trips, and falls.	• Work areas shall be visually inspected, and slip, trip, and fall hazards shall be marked, barricaded, or eliminated, if feasible. Use care in work area; look for depressions and obstructions. • Employees shall only be allowed to work on walking/working surfaces that have the strength and integrity to support employees safely. • Look out for ground squirrel holes. • Openings 18 inches or more in diameter must be covered and marked. All openings less than 18 inches in diameter and all holes must be marked or barricaded. • Do not walk on grating that covers the trenches surrounding the hangar.
	Struck by vehicles in traffic area.	• Wear high-visibility reflective vest. • Post an observer, as needed, when surveyor is using instruments. (A surveyor is often focused on the task and may not be aware of nearby traffic.) • Use traffic control or barricades, if necessary, to keep traffic away from workers.
	Handling of instruments can cause strain to worker.	• Carry instruments as required by the manufacturer of the instrument. • Use straps when provided and adjust for comfort. • Use care when walking so that there are no sudden jerks or mis-steps that can cause the worker to strain to maintain control of the instrument. • Get assistance from other workers if several instruments must be carried.
	Use of spray paint to mark underground utilities and anomalies could expose employees to paint fumes or the paint itself.	• Follow manufacturers' instructions on use of paint. • Review MSDS. • Never point spray paint canister at another person.

ACTIVITY HAZARD ANALYSIS #2

Activity: Geophysical Survey **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Conduct geophysical survey (continued)	Mismarking utilities could create unknown hazards.	• Use following universal color codes for utilities: Blue – Water; Red – Electrical; Yellow – Gas; Green – Sewer.

Equipment to be Used	Inspection Requirements	Training Requirements
Vehicles, equipment, hand tools	Daily and before use. Use the equipment safety checklist found in the Station-Wide Plan.	• Only Department of Motor Vehicles-licensed personnel will operate vehicles. • Specific training for power tools and hand tools will be provided. • Specific training on use of survey instruments.

Notes:

CIH – Certified Industrial Hygienist
MSDS – Material Safety Data Sheet
USA – Underground Service Alert

ACTIVITY HAZARD ANALYSIS #3

Activity: Land Survey **Analyzed By/Date:** Carl Jones, 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Conduct Survey	Slips, trips, and falls.	• Work areas shall be visually inspected, and slip, trip, and fall hazards shall be marked, barricaded, or eliminated, if feasible. Use care in work area; look for depressions and obstructions. • Employees shall only be allowed to work on walking/working surfaces that have the strength and integrity to support employees safely. • Look out for ground squirrel holes. • Openings 18 inches or more in diameter must be covered and marked. All openings less than 18 inches in diameter and all holes must be marked or barricaded. • Do not walk on grating that covers the trenches surrounding the hangar.
	Struck by vehicles in traffic area.	• Wear high-visibility reflective vest. • Post an observer, as needed, when surveyor is using instruments. (A surveyor is often focused on the task and may not be aware of nearby traffic.) • Use traffic control or barricades, if necessary, to keep traffic away from workers.
	Handling of instruments can cause strain to worker.	• Carry instruments as required by the manufacturer of the instrument. • Use straps when provided and adjust for comfort. • Use care when walking so that there are no sudden jerks or mis-steps that can cause the worker to strain to maintain control of the instrument. • Get assistance from other workers if several instruments must be carried.
	When carrying stakes, worker could trip and impale body.	• Carry stakes in leather or canvas bag that is puncture-proof, and carry bag to side of body. Ensure that all tips are pointed toward ground at all times.
	Installation of wooden stakes presents puncture and splinter hazards.	• Keep stake tip pointed at ground. Wear leather gloves. Use caution when using tools to pound stake in.

ACTIVITY HAZARD ANALYSIS #3

Activity: Land Survey **Analyzed By/Date:** Carl Jones, 09/02/04 **Reviewed By:** Roger Margotto, CIH

Equipment to be Used	Inspection Requirements	Training Requirements
Vehicles, equipment, hand tools	Daily and before use. Use the equipment safety checklist found in the Station-Wide Plan.	• Only Department of Motor Vehicles-licensed personnel will operate vehicles. • Specific training for power tools and hand tools will be provided. • Specific training on use of survey instruments.

Notes:

CIH – Certified Industrial Hygienist

ACTIVITY HAZARD ANALYSIS #4

Activity: Well Installation **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Survey site	Slips, trips, and falls from various agents.	• Work areas will be visually inspected and pre-existing slip, trip, and fall hazards will be marked, barricaded, or eliminated as is feasible. • Work areas will be kept neat and in an orderly state of housekeeping. • Proper illumination will be maintained in work areas.
	Failure to properly survey site could cause exposures to electrical hazards and ground hazards.	• Conduct survey properly to identify all overhead electrical hazards, including electrical hazards in the path of the equipment as it being transported. • Ensure that ground has no hazards such as unstable soil, UXO, or underground utilities. • Ensure that the findings of the survey and controls for all potential hazards become part of this hazard analysis.
Drilling operations – inspection of drill rig	Improper inspection of rig could cause workers to be exposed to hazards associated with operating rig and mechanical devices.	• Ensure that ROICC has been notified at least 2 days prior to delivery of rig. Unit will be inspected by operator, SHSS and superintendent. ROICC may want to inspect at this time. • The rig and all associated equipment will be inspected by a competent mechanic and be certified to be in safe operating condition. • Equipment will be inspected before use and at the beginning of each shift. • Faulty or unsafe equipment will be tagged and removed from service. No faulty equipment or damaged items will be allowed in the work area. • Verify the emergency shutdown system that consists of trip wire located at the right and left rear of the drill (located on each side – one for the driller and one for the driller's helper). Ensure that each wire shuts down the system when the trip wire is pulled or pushed. • Inspect the brakes and tire pressure on the drill rig. • Inspect all cables on the rig. • Inspect all hydraulic and pneumatic hoses.

ACTIVITY HAZARD ANALYSIS #4

Activity: Well Installation **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Drilling operations – set up work area and move rig into position	Failure to review site layout plan could cause exposure to potential hazards such as electrocution, damaging of underground utilities, and tipping over of rig in unstable soil conditions.	• A site layout plan will become part of this hazard analysis as soon as it is completed. • The drilling rig will not be moved into any work area until the site layout plan has been completed and the route of travel to any work site has been assessed for hazards (overhead lines, stability of roads and ground). • The site layout plan and the analysis of the route of travel will be covered at the pre-activity safety briefing along with this activity hazard analysis.
	Damage to existing utilities.	• Personnel will contact the service facilities engineer before working near utilities. • Permit will be obtained prior to any drilling. • Ensure that weight of rig on ground is evenly distributed and is not so heavy as to damage any underground lines that may be near the surface.
	Rig could contact overhead lines, including power lines if it is transported with rig raised.	• Never move rig when mast is extended.
	Vehicle may move if not properly set up.	• Use spotter to properly position vehicle. • Set brakes and place wheel chocks under front wheels of mobile rig. • Extend stabilizer jacks and ensure that footing is sound. • Vehicle must be level to the vertical and horizontal planes.
	When raising rig, rig may not install properly due to the condition of rig and connecting cables.	• Inspect all components of rig to determine condition. • Make all repairs before raising rig.

ACTIVITY HAZARD ANALYSIS #4

Activity: Well Installation **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Drilling operations – set up work area and move rig into position (continued)	When raising rig, mast could come in contact with or proximity to overhead power lines causing electrocution of workers.	• Mast and other equipment must be at least 15 feet from any overhead utility lines. • Verify the voltage of any overhead power lines. If any lines are above 50kV, the clearance distance must be greater. Refer to the EM 385-1-1, Section 11, Table 11-3 for clearance required for voltages above 50kV.
	Worker may become pinned between rig and other truck components or worker could be pinned under truck rig if servicing of rig from under the truck is required.	• When any part of the rig or equipment is in motion, workers will stand a sufficient distance from the moving parts so that the worker is not pinned between the moving parts. • Workers will not manually "guide" any moving part of the rig when it is raised up. • Workers will not work under the rig or the truck. If work must be done under the truck or rig, the drill crew supervisor will contact the SHSS to ascertain a safe method for lockout of the equipment to ensure that adequate blocking is installed.
	High winds could destabilize rig. Mast could act as a conductor during a thunderstorm.	• Check weather conditions and forecasts to determine if conditions are acceptable for use of rig. • Do not operate the rig if winds exceed manufacturer's recommended tolerances.
	Noise.	• Earplugs will be worn whenever drill rig is in operation.
	Pinch points.	• Avoid placing hands in places close to moving machinery. • Wear gloves, as appropriate.
	Traffic in area of drilling.	• Wear reflective safety vests. • Barricade and mark drilling sites for visibility. Use a flag person, if necessary, to direct traffic away from drilling areas. • Coordinate with flight line operations as necessary.

ACTIVITY HAZARD ANALYSIS #4

Activity: Well Installation **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Drilling operations – start up drill and perform drilling	Pressurized hydraulic lines could rupture causing release of hot hydraulic fluid. Hot fluid can ignite if contact is made with engine. Hot fluid can burn workers. Fluid can cause environmental contamination.	• Personnel will have been trained in the use of drilling equipment. • Inspect all hydraulic lines before placing rig in service. Any damaged hoses or connections must be replaced before unit is used. • Immediately shut down the equipment. • Ensure that first aid kit is readily available to treat injured workers. • Ensure that a 20-pound dry chemical ABC fire extinguisher is readily available. • A spill control kit consisting of shovel, absorbent material, and disposal drum must be available at the drilling location. • As quickly as possible, berm the liquid to minimize the area over which the liquid spreads. • Loose protective clothing will be restrained with duct tape to prevent entanglement in moving parts.
	Air hoses or hydraulic hoses under pressure could suddenly release, whip, and hit workers causing severe injury.	• Do not disconnect air hoses and compressors until hose line has been bled. • Visually inspect all connections of any lines under pressure. Use safety clamps to connect each side of connection to the other in the event the connection breaks. (The safety clamps will keep the hoses from whipping under the sudden release of pressure). • Tie back or attach hoses wherever possible to minimize the length of hose that could whip around in the event that there is a sudden release of pressure.

ACTIVITY HAZARD ANALYSIS #4

Activity: Well Installation **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Drilling operations – start up drill and perform drilling (continued)	Strains from manually moving materials, equipment, and drums.	• Personnel will be directed to use proper lifting techniques such as keeping back straight, lifting with legs, limiting twisting, and getting help in moving bulky/heavy materials and equipment. • Mechanical equipment will be used as much as possible. • Use care when handling augers or drill rods. • Avoid standing under any load. • Get help with lifting any item that weighs 50-pounds or more. • Follow EHS 3-1, Ergonomics.
	Atmospheric and contact hazards from chemical agents.	• Ambient air/visual monitoring will be used to verify selection of PPE. • An MSDS for any drilling fluids will be obtained/reviewed with workers. • Decontaminate drilling implements after use (or cover contaminated parts when moving to the next drilling site). • Avoid exposure to dust. Use dust control as necessary and when possible. • PPE will be used. Drum and label all soil cuttings. • Determine if PPE is contaminated (based on exposure to contaminants). Place contaminated PPE in a separate, properly labeled container. Discard other PPE as approved by the Project Manager and PESM.

ACTIVITY HAZARD ANALYSIS #4

Activity: Well Installation **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Drilling operations – start up drill and perform drilling (continued)	Sometimes workers use plastic sheeting in the area where they are drilling to protect the surrounding ground. This sheeting becomes very slippery when drilling muds are placed on it.	• Avoid using plastic sheeting, if possible. Many drillers today build a small bermed area where they place the drilling muds. It is easier to clean up the surface of the soil than to have workers slip on plastic sheeting. • If plastic sheeting must be used, dig out a small depression, place the plastic on the ground and cover the plastic with the removed soil. This way the plastic sheeting should not become too slippery as it will be covered by the removed soil. (This creates a larger volume of soil to be disposed, but it is a safer method then working on slippery plastic.)
	The mast could b e used to lift other objects as it is being raised causing potential failure of the mast.	• Masts shall be used in a manner specified by the manufacturer and should never be loaded beyond their capacity.
	Workers could climb drill mast and expose themselves to a fall hazard.	• Climbing on the mast is not allowed.
	Workers could place hands into moving parts of the rig or loose clothing could become entangled in moving machine parts, either of which, could injure a worker.	• Chains, sprockets, and moving parts will be guarded. • Workers will not wear loose clothing or any jewelry. • Workers will not place their hands or any part of their body between the drill auger or rod and the drill plate. Workers should never place themselves in a position where they can come in contact with the moving drill rods or augers. • The operator will verbally alert all workers and visually ensure that all workers are clear from dangerous parts of equipment before starting or engaging equipment. • Workers will avoid contact with any moving auger. Means will be provided to guard against employee contact with auger. (For example, use barricade of perimeter of auger or electronic brake activated by a presence-sensing device.)

ACTIVITY HAZARD ANALYSIS #4

Activity: Well Installation **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Drilling operations – start up drill and perform drilling (continued)	Workers could injure themselves by cleaning the augers while they are rotating.	• Augers will be cleaned only when they are stopped and in neutral. They will not be restarted until the worker has given a verbal all clear to the operator and the operator has visually determined that the worker is clear of the auger. • Only long handled shovels will be used to move cutting from the auger.
	Workers could trip or fall by the borehole.	• Cap and flag open boreholes. • All open boreholes will be protected as any open excavation if they are left unattended.
	Pinch points.	• Avoid placing hands in places close to moving machinery. • Wear gloves, as appropriate. • Keep constantly alert.
Drilling operations – work during hours of darkness and reduced lighting	Inability to see the work area and the operating equipment could cause workers to trip over lines, object and equipment or get caught in between equipment or operating machinery.	• Ensure that adequate lighting of the work area and the walkways within the work area is used. The general work area will have a minimum of 3 foot-candles (33 lux). The area of the operating drill rig will have an average 30 foot-candles (325 lux) with special lighting attention in the area of the controls for the drill rig and in areas where there are moving parts. These latter two areas should have lighting that is at a minimum of 30 foot-candles (not averaged). • Workers must have ready access to flashlights and lanterns. A flashlight will be available for emergency use at the control panel for the drill rig. • EM 385-1-1, Section 7, requires that illumination is arranged so that failure of any single lighting unit will not leave any area in total darkness.
	Inability to see other workers in the area could cause those workers to be struck by moving equipment.	• All workers will wear reflective safety vests. • Workers will follow the buddy system and maintain communications with other workers. • Each worker will have a flashlight.

ACTIVITY HAZARD ANALYSIS #4

Activity: Well Installation **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Drilling operations – work during hours of darkness and reduced lighting (continued)	Shift work puts additional strain on workers who must change work hours from a daytime schedule, causing workers to be more likely to have errors in judgement and safely operating equipment.	• Allow time for workers to acclimate to the shift schedule, by assigning less demanding duties at the beginning of the project. • Supervisors must observe more closely the performance of workers and verify that workers are fit for performance of the work. • Take breaks as necessary to renew focus and energy. • Instruct workers to rest as much as possible during their off shift hours.

Equipment to be Used	Inspection Requirements	Training Requirements
Drilling rig, hand tools, power tools	Daily or before use. Use inspection checklist. Complete form and sign. An operators' manual for the drill rig must be available at the job site.	• Only trained equipment operators may operate heavy equipment; only Department of Motor Vehicles-licensed personnel will operate trucks. • All drillers and drillers' helpers must have documented training on use of rig.

Notes:

CIH – Certified Industrial Hygienist
EHS – Environmental Health and Safety
EM – Engineer Manual
kV – kilovolt
MSDS – Material Safety Data Sheet
PESM – Project Environmental Safety Manager
PPE – personal protective equipment
ROICC – Resident Officer in Charge of Construction
SHSS – Site Health and Safety Specialist
UXO – unexploded ordnance

ACTIVITY HAZARD ANALYSIS #5

Activity: Collection of Groundwater Samples/Purging Wells **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Collecting groundwater samples	Back strains.	• Pre-employment back evaluations are recommended for craft workers, who may be at greater risk of developing low back pain or low back injury. This evaluation may be requested by contacting our CMC and may be performed by the local medical provider under the approval and direction of our CMC. • Surveys shall be performed by qualified persons to identify and evaluate tasks that might result in injuries due to ergonomic hazards. The focus of the surveys will be operations that involve manual lifting of and moving excessively heavy or asymmetric objects. • Hand tools shall be selected to minimize the following stressors: chronic muscle contraction or steady force, extreme or awkward finger/hand/arm positions, repetitive forceful motions, excessive gripping, pinching, and/or pressing with hand and fingers. • Do not lift more than 50 pounds. • Avoid prolonged repetitive motion. Rotate job tasks with other workers. • Get help or use mechanical lifting devices for heavy loads. • When lifting box covers, get help if cover is too heavy or is too difficult to handle because cover is wedged or impaired.
	Struck by well cover when inside box to collect sample.	• Ensure that cover cannot fall when worker is inside well vault by using a block or by tying the cover to a stationary object to prevent cover from falling on worker.
	Exposure to chemical contaminants.	• Wear required PPE and respiratory protection, as specified in the SHSP. • Remove PPE properly and wash hands.
	Slips, trips, and falls.	• Maintain good housekeeping as per EHS Procedure 3-8, Fall Protection. • Mark or remove all identified trip and slip hazards. • Maintain proper illumination in work areas.

ACTIVITY HAZARD ANALYSIS #5

Activity: Collection of Groundwater Samples/Purging Wells **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Collecting groundwater samples (continued)	Worker can get hand caught between cover and the box when lifting or replacing covers.	• Use care when lifting covers. • Wear leather gloves when handling covers.
	Strains from use of tools such as extension poles, hand pumps, or pry bars.	• Inspect all tools for damage before use. • Do not use damaged tools, and tag them "out of service." • Maintain steady pace, and follow the rest periods given on the job. • Use appropriate tools for the task, and maintain them in good condition.
	Vehicular traffic in areas of sampling can expose workers to traffic hazards.	• All workers working in all areas will wear high-visibility safety vests as required by Cal-OSHA 8CCR 1598: "Employees (on foot) exposed to the hazard of vehicular traffic shall wear orange, strong yellow-green, or fluorescent versions of these colored warning garments such as vests, jackets, or shirts. During rainy weather, employees exposed to the hazard of vehicular traffic may wear orange, strong yellow-green, or yellow rainwear." Where wells are open, workers will place barricades or traffic cones to direct drivers away from the work area. If work is on streets, signs should be posted warning drivers that workers are ahead. Follow the requirements of Cal-OSHA 8CCR 1598: "*Where a hazard exists to employees because of traffic or haulage conditions at work sites that encroach upon public streets or highways, a system of traffic controls in conformance with the "Manual of Traffic Controls for Construction and Maintenance Work Zones--1996" which is herein incorporated by reference and referred to as the "Manual", published by the State Department of Transportation, shall be required so as to abate the hazard.*"

ACTIVITY HAZARD ANALYSIS #5

Activity: Collection of Groundwater Samples/Purging Wells **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Collecting groundwater samples (continued)		If a flagger is used to direct traffic away from workers, ensure that the person is trained as required by Cal-OSHA 8CCR 1599: *"Flaggers shall be trained in the proper fundamentals of flagging moving traffic before being assigned as flaggers. Signaling directions used by flaggers shall conform to the "Manual". The training and instructions shall be based on the "Manual" and work site conditions and also include the following:* *1) flagger equipment which must be used,* *2) layout of the work zone and flagging station,* *3) methods to signal traffic to stop, proceed or slow down,* *4) methods of one-way traffic control,* *5) trainee demonstration of proper flagging methodology and operations,* *6) emergency vehicles traveling through the work zone,* *7) handling emergency situations,* *8) methods of dealing with hostile drivers,* *9) flagging procedures when a single flagger is used (when applicable),* *Documentation of the training shall be maintained as required by Section 3203, Injury Illness and Prevention Program of the General Industry Safety Orders."*
	Wells covers and openings to ground and vault areas may have insects such as black widows, brown recluse spiders, and scorpions.	• Wear leather gloves when opening well covers. • Inspect opening or vault for insects. If insects are present, avoid them, or remove them while wearing gloves. • Have first aid kit available to treat insect stings. [If allergic to any insect bites, notify SHSS. If possible, a person not allergic to insect bites should be open covers.]

ACTIVITY HAZARD ANALYSIS #5

Activity: Collection of Groundwater Samples/Purging Wells **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Collecting groundwater samples (continued)	Well vaults, although not more than 4 feet deep, could have atmospheric hazards if well has off-gassed, and the vault space has not cleared, thus exposing worker to vapors.	• Consider space as a non-permit-required confined space. [No permit is required, but the following procedure must be used.] • If possible, place a probe through a small opening in or around the vault cover before lifting it, and measure the air inside using a PID or FID. If the reading is lower than 10 ppm, open the well cover and proceed with work activities. If the reading is higher than 10 ppm, open the well cover slowly, secure the cover, and stand back. • If it is not possible to monitor the air inside the vault before opening the cover, carefully open it, secure it, **do not enter the vault**, and monitor the air inside the vault. If it lower than 10 ppm using a PID or FID, enter the vault. • If air monitoring shows levels above 10 ppm, do not enter the vault, stand back from the vault, allow the opened vault to ventilate with the outside air, and measure the air inside again after 5 minutes. If readings are still above 10 ppm, contact the SHSS.
Sample handling	Atmospheric and contact hazards from contaminated soil or water.	• Wear required PPE and respiratory protection. • Visual inspection and ambient air monitoring will determine selection of PPE and respiratory protection. • Decontaminate exteriors of sample containers. Avoid spills. Ensure that spill cleanup supplies are available. *Note: The intent of PPE is to prevent contact with groundwater that may have low levels of contaminants. [Although these contaminants are low in concentration, they still can be absorbed by the skin or cause irritation to the skin.]*
Gauge handling	Contaminated or potentially contaminated gauge line comes in contact with technician exposing technician to contaminants.	• Wear specified PPE, especially hand protection and chemical protective gloves, as specified in the PPE matrix. • Decontaminate the gauge line by rinsing with clean water.
	Contaminated or potentially contaminated gauge line comes in contact with the environment (ground, other equipment, or another well).	• Decontaminate the gauge line before placing the line on the ground or on top of other equipment or surfaces. • Decontaminate the gauge line before proceeding to next well.

ACTIVITY HAZARD ANALYSIS #5

Activity: Collection of Groundwater Samples/Purging Wells **Analyzed By/Date:** Carl Jones 09/02/04 **Reviewed By:** Roger Margotto, CIH

Equipment to be Used	Inspection Requirements	Training Requirements
Flagging equipment - flags, signs	None.	• Provide flagger training using the CalTrans Flagging Handbook.
Pressure washer, if used	Daily and before use.	• Refer to AHA for safe use of pressure washer. Follow the manufacturers' requirements for inspection and use.

Notes:

AHA – Activity Hazard Analysis
Cal-OSHA – California Occupational Safety and Health Administration
CalTrans – California Department of Transportation
CIH – Certified Industrial Hygienist
CCR – California Code of Regulations
CMC – Corporate Medical Consultant
EHS – Environmental Health and Safety
FID – flame ionization detector
PID – photoionization detector
PPE – personal protective equipment
ppm – parts per million
SHSP – Site-Specific Health and Safety Plan
SHSS – Site Health and Safety Specialist

ACTIVITY HAZARD ANALYSIS #6

Activity: Lactate Injection **Analyzed By/Date:** Carl Jones 09/07/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Installation of injection system – delivery of injector and system plumbing	Back strains.	• Follow EHS Procedure 3-1, Ergonomics. • Avoid prolonged, repetitive motion. Rotate job tasks with other workers. • Do not lift more than 50 pounds. • Get help or use mechanical lifting devices for heavy loads.
	Failure to inspect injection equipment could lead to faulty operation.	• Inspect all items upon arrival. • Follow operating instructions.
	Exposure to chemicals (sodium lactate, other chemicals brought on site, contaminated groundwater).	• Wear required PPE as specified in the SHSP. • Review MSDSs of chemicals brought on site. • Visual inspection and ambient air monitoring will determine selection of PPE and respiratory protection. • Remove PPE properly and wash hands.
	Slips, trips, and falls.	• Maintain good housekeeping in work area. • Mark or remove all identified trip and slip hazards from equipment in the area. • Work only during daylight hours.
	Strains from use of tools such as wrenches.	• Inspect all tools for damage before use. • Do not use damaged tools. Tag them as "out of service" or discard them. • Maintain steady pace and follow the rest periods given on the job. • Use appropriate tools for the task and maintain them in good condition.
	Sharp edges on pieces of metal and other objects.	• Avoid handling objects with sharp edges. • Wear leather work gloves.
Staging of drums of sodium lactate	Drum handling hazards.	• See AHA on drum handling.

ACTIVITY HAZARD ANALYSIS #6

Activity: Lactate Injection **Analyzed By/Date:** Carl Jones 09/07/04 **Reviewed By:** Roger Margotto, CIH

Principal Steps	Potential Hazards	Recommended Controls
Installation of temporary security fence	Traffic could interfere with operations or injure workers.	• Wear reflective safety vests at all times, especially when exposed to traffic. • Use a flag person, if necessary, to direct traffic away from fence install area.
	Lifting of fence sections could injure workers.	• Use two people to handle fence sections. • Follow safe lifting techniques. Never raise a load above shoulder height.
	Workers could injure their hands on loose or cut wires.	• Bend all "open" wires so they do not pose a puncture hazard. • Wear leather work gloves when handling fence section.
	Fence not readily seen especially at night. Lack of signs could mean inadvertent intrusion into area.	• Ensure that fence is marked with reflective signs or tape if the fence is near traffic. • Place appropriate warning signs and the phone number of an emergency contact.
Connection of plumbing to injection well	Exposure to tool handling hazard.	• Be sure to use the right tool for the job. • Inspect all tools before use and discard tools that are defective. • Wear hand protection as appropriate. • Always wear safety glasses.
	Potential exposure to moving parts or pressurized line.	• Visually inspect all connections. • Avoid placing hands anywhere near moving parts.
Lactate injection	Contact with the sodium lactate.	• Wear required PPE and respiratory protection as required. • Selection of PPE and respiratory protection will be determined by visual inspection and ambient air monitoring. • Review the MSDS for the solution and follow the requirements for protection. • Avoid spills. Ensure that spill cleanup supplies are available.
	Spills or leaks.	• Inspect system routinely. • Have spill containment materials readily available.

ACTIVITY HAZARD ANALYSIS #6

Activity: Lactate Injection **Analyzed By/Date:** Carl Jones 09/07/04 **Reviewed By:** Roger Margotto, CIH

Equipment to be Used	Inspection Requirements	Training Requirements
Hand tools	Daily and before use	• Specific training for hand tools is required.

Notes:

CIH – Certified Industrial Hygienist
EHS – Environmental Health and Safety
MSDS – Material Safety Data Sheet
PPE – personal protective equipment
SHSP – Site-Specific Health and Safety Plan

ACTIVITY HAZARD ANALYSIS #7

Activity: Drum Handling **Analyzed By/Date:** Carl Jones 09/07/04 **Reviewed By:** Roger Margotto, CIH

Principle Steps	Potential Hazards	Recommended Controls
Handling drums of sodium lactate	Slips, trips, or falls on pads and surrounding work surfaces.	• Maintain clean work areas by following good housekeeping procedures. • Be alert for uneven surfaces, trip hazards, hazards from pallets. • Wear slip-resistant foot wear when walking/working on slippery surfaces. • Refer to EHS Program EHS 6-7, Drum and Container Handling.
	Eye injury due to flying particulate or liquid splash.	• Safety glasses with side shields will be worn. • Avoid using tools or techniques that would cause material to pop out or fly out of container being opened. • If material gets into employee's eye, the eye should be flushed for 15 minutes at an emergency eye wash station immediately.
	Spills and releases.	• Ensure that rings and lids are tightened down and secured on intact drums. • Inspect for bulging and/or leaking drums. • Handle drums slowly when unloading or loading onto trailer or truck – avoid swinging of drums.
	Back injury from lifting heavy loads.	• Site personnel will be instructed on proper lifting techniques. • Drum lifting devices should be used to reduce manual handling of materials. • Team lifting should be used if mechanical devices are not available. • Follow procedures outlined in Section 2.14 of Project Work Rules booklet. • Use proper drum handling procedure when moving a drum manually. Use a drum dolly. • If moving drums manually by "break and roll" method use care to not tip the drum to close to your body so that it could fall on you. Remember if the drum starts falling, jump back! It is better to let the drum fall than to risk injury to yourself with a 400-pound drum.

ACTIVITY HAZARD ANALYSIS #7

Activity: Drum Handling **Analyzed By/Date:** Carl Jones 09/07/04 **Reviewed By:** Roger Margotto, CIH

Principle Steps	Potential Hazards	Recommended Controls
Handling drums of sodium lactate (continued)	Pinch points/ crush potential.	• Wear leather gloves. • Avoid tipping drums while in congested areas. • Be cautious when placing drums into trailer or into place on pad. • Do not stand between drums when lowering onto truck – guide from the side.
	Heavy equipment.	• Site personnel will be instructed on heavy equipment awareness. • Brightly colored safety vests shall be donned at all times for personnel working around heavy equipment. • Stay free of travel paths. • Ensure that eye contact has been established with operator before walking/ working around heavy equipment. • Do not stand under drums being lifted by forklift.
	Exposure to high noise from heavy equipment and power tools.	• SHSS will determine the need for hearing protection and conduct monitoring, if needed. • Hearing protection will be worn while operating or working near heavy equipment. • All equipment will be equipped with manufacturer's required mufflers.
Opening of drums	Dropped objects.	• Steel-toe boots meeting ANSI Standard Z41 will be worn.
	Biological hazards.	• Personnel will avoid contact with wildlife. • Be cautious of snakes and spiders around drums.
	Use of bung wrench or 15/16" ratchet wrench to open drum could cause a pinch hazard or strain to worker.	• Do not use excessive force when using tool. Often times it is best gradually "bump" the bung or the bolt to "break" the seal and eventually the opening becomes easier. • Wear leather work gloves when handling tool.

ACTIVITY HAZARD ANALYSIS #7

Activity: Drum Handling **Analyzed By/Date:** Carl Jones 09/07/04 **Reviewed By:** Roger Margotto, CIH

Principle Steps	Potential Hazards	Recommended Controls
Emptying drums	Visitor traffic.	• Set up exclusion zone.
	Severe pinch points/crush potential.	• When using drum tipper – ensure hands are completely removed from rotation arm (if used). • Use leather gloves at all times! • Do not stand directly in front of drum tipper or under drums.
	Exposure to sodium lactate solution.	• Review MSDS for each product. • Personnel will wear PPE specified in the SHSP.

Equipment to be Used	Inspection Requirements	Training Requirements
Hand tools	Daily and before use.	• Specific training for hand tools.
Forklifts, drum lifters, drum dollies	Daily and before use.	• Only trained equipment operators may operate heavy equipment; only Department of Motor Vehicles-licensed personnel will operate trucks.

Notes:

ANSI – American National Standards Institute
CIH – Certified Industrial Hygienist
EHS – Environmental Health and Safety
MSDS – material safety data sheet
PPE – personal protective equipment
SHSP – Site-Specific Health and Safety Plan
SHSS – Site Health and Safety Specialist

APPENDIX D

DAILY AND WEEKLY INSPECTION FORMS

Daily Tank Inspection Log (40 CFR 265.201)
Hazardous Waste

Project Name _____
Project Number _____
Contact _____ Month _____
Phone _____ Year _____

No.	Date	Time	Inspector	Tank labeled? (daily)	Overfill control equipment in good working order? (*daily*)	Data from monitor and leak detection equipment per tank design? (*daily*)	Above-ground portions of tank construction free of leaks? (*weekly*)	Containment area and structure sound and free of releases? (*weekly*)	Deficient Items corrected?	Comments
1.										
2.										
3.										
4.										
5.										
6.										
7.										
8.										
9.										
10.										
11.										
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13.										
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15.										

Notes:

1. This checklist reflects federal requirements. State criteria may differ.
2. Uncovered tanks must be inspected daily for freeboard to prevent overtopping by wave or wind action or by precipitation.
3. NFPA recommends that tanks containing ignitable (D001) hazardous waste should be marked with the words "Flammable-Keep Fire and Flame Away." this is in addition to marking with the words "Hazardous Waste", required by 40 CFR 262.34(a)(3).
4. LQGs - For tanks with cathodic protection systems, all sources of impressed current must be inspected and/or tested at lest bimonthly.

Weekly Container/Drum Inspection Log - Hazardous Waste

Project Name _____
Project Number _____
Contact _____ Month _____
Phone _____ Year _____

Date	Time	Inspector	No. drums "full" in storage	No. drums satellite accum.	Drums marked and labeled?	Lids/bungs closed and labeled?	Signs of leakage	Overall condition?	Deficient items corrected	Comments

Notes:

1. Federal regulations required that large quantity generators (LQG) maintain a 50-feet buffer zone from property lines for ignitable (D001) and reactive (D003) waste (40 CFR 265.176). Small quantity generators (SQG) are not subject to this requirement. State criteria may differ.
2. Adequate aisle space must be maintained in drum storage areas for unobstructed movement of personnel and fire/spill/decon equipment during an emergency (40 CFR 265.35).

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