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COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
Northern and Central California, Nevada, and Utah
Contract No. N62474-94-D-7609
Contract Task Order No. 136

Prepared For

DEPARTMENT OF THE NAVY
David Godsey, Remedial Project Manager
Southwest Division
Naval Facilities Engineering Command
San Diego, California

FINAL
QUALITY ASSURANCE PROJECT PLAN

ADDITIONAL SAMPLING
INVESTIGATION AREA F2
INSTALLATION RESTORATION SITE 04

MARE ISLAND
VALLEJO, CALIFORNIA

DS.0136.17362

July 2001

Prepared By

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FOR
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INSTALLATION RESTORATION SITE 04
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Prepared for:
DEPARTMENT OF THE NAVY

REVIEW AND APPROVALS

TtEMI Program
Quality Assurance Manager: _____ Date: 9/28/01
Greg Swanson
TtEMI San Diego

Navy Quality Assurance Officer: _____ Date: 10/01/01
Narciso Ancog

RESPONSE TO AGENCY COMMENT ON THE DRAFT SAMPLING AND ANALYSIS PLAN AND QUALITY ASSURANCE PROJECT PLAN, ADDITIONAL SAMPLING, INVESTIGATION AREA F2, INSTALLATION RESTORATION SITE 04, MARE ISLAND, VALLEJO, CALIFORNIA

This document presents the response to the U.S. Environmental Protection Agency, Region IX comment on the Draft Sampling Analysis Plan and Quality Assurance Project Plan for Investigation Area F2, Installation Restoration Site 04, Mare Island, Vallejo, California, dated July 24, 2001. The comment addressed below was received from Emily Roth, EPA Project Manager, on September 7, 2001.

RESPONSES TO MS. ROTH

1. **Comment:** **Our review of this draft of the Navy's Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) for Investigation Area F2, July 24, 2001, is complete and we are satisfied with the planned sampling as described in the documents with one exception. We disagree with your response to our comment #3A. The response does not adequately address the issue. It has been shown that previous methods for sampling and preservation of soil samples for VAC analyses can have wide error margins. Hence, an argument of comparability does not make sense. The Navy has agreed to the use of EPA's Regional Interim Policy for Determination of Volatile Organic Compound (VOC) Concentrations in Soil and Solid Matrices as found on EPA's website and attached to the email version of this letter. Please indicate your intentions with respect to our VOC Sampling protocol and this sampling event.**

   Response: The SAP has been revised to propose 100% EnCore methodology for the collection of soil samples that will be analyzed for VOCs. This methodology is in accordance with U.S. Environmental Protection Agency Region IX Interim Policy for Determination of Volatile Organic Compound Concentrations in Soil and Solid Matrices.

TETRA TECH EM INC.

TRANSMITTAL/DELIVERABLE RECEIPT

Contract No. N62474-94-D-7609 Document Control No. DS . 0136 . 17362

TO: Mr. Ron Fuller, Code 02R1.RF
Contracting Officer
Naval Facilities Engineering Command
Southwest Division
1230 Columbia Street, Suite 1100
San Diego, CA 92101-8517

DATE: 10/26/01
CTO: 0136
LOCATION:
Mare Island Naval Shipyard, Vallejo

FROM: Bam c Chow
Daniel Chow, Program Manager

DOCUMENT TITLE AND DATE:
FINAL QUALITY ASSURANCE PROJECT PLAN, ADDITIONAL SAMPLING, INVESTIGATION AREA F2, INSTALLATION RESTORATION SITE 04, JULY 2001

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Tetra Tech EM Inc.

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October 31, 2001

Mr. David Godsey
Remedial Project Manager
Southwest Division
Naval Facilities Engineering Command
1230 Columbia Street, Suite 1100
San Diego, CA 92101-8517

Subject: **Final Quality Assurance Project Plan, Additional Sampling, Investigation Area F2, Installation Restoration Site 04, Mare Island, Vallejo, California**
CLEAN II Contract No. N62474-94-D-7609, Contract Task Order 136

Dear Mr. Godsey:

Tetra Tech EM Inc. is pleased to submit for your review, the "Final Quality Assurance Project Plan, Additional Sampling, Investigation Area F2, Installation Restoration Site 04, Mare Island, Vallejo, California," dated September 2001. Copies of the document will be distributed as indicated on the attached transmittal form.

If you have any questions, please call me at (415) 222-8321 or Kevin Bricknell at (415) 222-8306.

Sincerely,

Sharon Tobias for

Caitlin Gorman
Project Manager

Enclosures

cc: Distribution

DS.0136.17362

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ABBREVIATIONS AND ACRONYMS

bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CA LUFT	California Leaking Underground Fuel Tank
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Environmental Action Navy
CLP	Contract Laboratory Program
CPR	Cardiopulmonary resuscitation
CRDL	Contract-required detection limit
CRQL	Contract-required quantitation limit
CTO	Contract Task Order
CVAA	Cold vapor atomic absorption
DQO	Data quality objective
E&E	Ecology and Environment, Inc.
EDD	Electronic data deliverable
EFA WEST	Naval Facilities Engineering Command, Engineering Field Activity West
EPA	U.S. Environmental Protection Agency
EWI	Environmental Work Instruction
FAA	Flame atomic absorption
FSAP	Field sampling and analysis plan
GC/MS	Gas chromatography and mass spectometry
GFAA	Graphite furnace atomic absorption
GPC	Gel permeation chromatography
HHRA	Human health risk assessment
HSP	Health and safety plan
HSPM	Health and safety plan manager
IA	Investigation Area
IC	Installation Coordinator
ICP	Inductively coupled plasma
ICPES	Inductively coupled plasma emission spectroscopy
ID	Identification
IDL	Instrument detection limit
IR	Installation Restoration
IT	International Technology Corporation
IW	Industrial wastewater
LCS	Laboratory control spike

ABBREVIATIONS AND ACRONYMS (Continued)

LIMS	Laboratory information management system
MDL	Method detection limit
MINS	Mare Island Naval Shipyard
MS	Matrix spike
MSD	Matrix spike duplicate
msl	Mean sea level
Navy	U.S. Department of the Navy
NEDTS	Navy electronic data transfer standards
NFESC	Naval Facilities Engineering Support Center
PARCC	Precision, accuracy, representativeness, completeness, and comparability
PPE	Personal protective equipment
PRC	PRC Environmental Management, Inc.
QA	Quality assurance
QAO	Quality assurance officer
QAPP	Quality assurance project plan
QC	Quality control
QCSR	Quality control summary report
RI	Remedial investigation
RPD	Relative percent difference
RPM	Remedial project manager
SBM	Spent sandblast material
SDG	Sample delivery group
SOP	Standard operating procedure
SOW	Statement of work
SQL	Sample quantitation limit
SSO	Site safety office
SVOC	Semivolatile organic compound
SWDIV	U.S. Department of the Navy Southwest Division
TCL	Target compound list
TIC	Tentatively identified compounds
TOC	Total organic carbon
TPH-e	Total petroleum hydrocarbon-extractables
TtEMI	Tetra Tech EM Inc.
U&A	Uribe & Associates
VOC	Volatile organic compound
WESTON	Roy F. Weston, Inc.

A1 INTRODUCTION

The U.S. Department of the Navy (Navy) is conducting a data gap assessment to complete the delineation of volatile organic compounds (VOC), total petroleum hydrocarbon-extractables (TPH-e), and metals contamination at Installation Restoration Site (IR) 04 (Investigation Area [IA] F2) at the former Mare Island Naval Shipyard under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62474-94-D-7609 (CLEAN II), Contract Task Order (CTO) No. 136.

The "Field Sampling and Analysis Plan for Additional Sampling, Investigation Area F2, Installation Restoration Site 04" (FSAP) presents the background details, rationale for the design of additional sampling, and the approach for evaluating existing and new data collected during the data gap assessment at IR04 (Tetra Tech EM Inc. [TtEMI] and Uribe & Associates (U&A) 2000). This quality assurance project plan (QAPP) documents policies, project organization, and quality assurance (QA) and quality control (QC) to be implemented for field sampling activities conducted to support the data gap assessment.

The U.S. Environmental Protection Agency (EPA) requires an EPA-approved QAPP for monitoring and measurement projects that are mandated or supported by EPA. This document has been developed in accordance with EPA guidelines, and with guidance from the Naval Facilities Engineering Command, Southwest Division (SWDIV).

Section A1.1 describes the document format, Section A1.2 presents the data quality objectives (DQO), and Section A1.3 describes the manner in which this document is to be used. Section A1.4 reviews the background of IR04 at the former Mare Island Naval Shipyard (Mare Island), including site location, history, geology, and hydrogeology.

A1.1 DOCUMENT REQUIREMENTS AND FORMAT

The format of this QAPP was developed using the "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations," (EPA 1997). The requirements for a QAPP include (1) evaluating the DQOs for the project, (2) ensuring that intended measurements and data acquisitions are appropriate, (3) ensuring that QA and QC procedures are sufficient for confirming data quality, and (4) identifying limitations on the use of the data. The elements contained in this QAPP are summarized in Table A-1 and are addressed in the following sections.

TABLE A-1

QUALITY ASSURANCE PROJECT PLAN ELEMENTS

A. Project Management	
Element/Content	**Report Section**
A1 Title and approval sheet	--
A2 Table of contents	--
A3 Project/task organization	A2
A4 Problem definition/background	A3
A5 Project/task description	A4
A6 Quality objectives and criteria for measuring data	A5
A7 Special training requirements and certification	A2.3
A8 Documentation and records	A6
A9 Data package format	A6.3
A10 Data management scheme	A6.4.1
B. Measurement/Data Acquisition	
Element/Content	**Report Section**
B1 Sampling process design (experimental design)	B2
B2 Sampling methods requirements	B3
B3 Sample handling and custody requirements	B4
B4 Analytical methods requirements	B5
B5 Quality control requirements	B6
B6 Instrument/equipment testing, inspection, and maintenance requirements	B7
B7 Instrument calibration and frequency	B8
B8 Inspection/acceptance requirements	B9
C. Assessment/Oversight	
Element/Content	**Report Section**
C1 Assessments and response actions	C1
C2 Reports to management	C1.3
D. Data Validation and Usability	
Element/Content	**Report Section**
D1 Data review, validation, and verification requirements	D1.1
D2 Validation and verification methods	D1.2
D3 Reconciliation with DQOs	D2

A1.2 BACKGROUND

The following sections provide information on the description, history, and physical characteristics of IR04.

A1.2.1 Site Description

The Mare Island peninsula is located in Solano County, California, approximately 25 miles northeast of San Francisco (Figure 1 in FSAP [TtEMI and U&A 2000]). The Napa River (Mare Island Strait) lies to the east and separates the peninsula form the city of Vallejo; the remainder of the peninsula is surrounded by Carquinez Strait to the south, San Pablo Bay to the west, and Highway 37 to the north. A bridge crosses the Napa River and connects the island to Vallejo at Tennessee Street in Vallejo. A second access is located at the north end of the island, where Railroad and Walnut avenues connect to Highway 37. Mare Island is within the incorporated boundaries of the city of Vallejo.

IR04 is located on the southeastern portion of Mare Island and has been subdivided into five subareas: Subareas 1 through 3, the spent sandblast material (SBM) Subarea, and the Other IR04 Subarea. The site comprises an area of approximately 18.6 acres, about half of which is paved with asphalt, although much of the pavement is severely cracked and rutted. The remaining half of IR04 is comprised of unpaved soils, an upland area, tidal wetland, intertidal mudflats, and an offshore area.

The site is underlain by either artificial fill soils or by spent SBM overlying artificial fill. The ground surface generally slopes from west to east, and surface elevations range from approximately 15 feet above mean sea level (msl) on the west to sea level on the east side of the site. Utility lines in and around the area include fresh and storm water pipelines. In addition, three sets of railroad tracks enter the site from the west and run across the site. Portions of these tracks have been removed.

IR04 presently includes Buildings 778, 782, 900, 918, and 1300 as well as two electrical transmission towers, a sandblast recycling area, and a sandblasting yard partially enclosed by a 15-foot high, corrugated metal fence. Buildings and structures currently in use include Building 778 and the associated electrical transmission tower, Building 782, and Building 918. Building 778 is the main electrical power substation for Mare Island and contains numerous transformers. Building 778 and the adjacent electrical transmission tower are located in the southern portion of the site and are enclosed by separate chain-link fences. The second electrical transmission tower is located in the intertidal mudflats near the southern edge of the site. Building 782, located near the northern edge of the site, is an

electrical distribution center containing a transformer within the building and an adjacent concrete pad formerly used to store piles of spent SBM before recycling. Building 918, located east of Building 778, is currently being used as a sanitary sewer pump station. The remaining structures and buildings within the IR04 site boundary, including Buildings 900 and 1300, the sandblast recycling area, and sandblasting yard, are not currently in use.

Buildings and structures adjacent to the site include Buildings A215, A220, A221, A222, A223, in the ordnance manufacturing area (IA F1), Berth 24, and Building 724 in IA C2, and Building A917 in IA E. None of these buildings or structures is currently in use. Buildings A215 and A220 through A223 were historically used for ordnance production and storage; these buildings are presently under investigation as part of the IA F1 RI. Building 724 (in IA C2) was historically used for storage of hazardous wastes and materials and Building A917 (in IA E) was an electrical distribution building.

IR04, the boundaries of which coincide exactly with IA F2, has been designated for reuse as open space.

A1.2.2 Site History

IR04 was used by the Navy for sandblasting and painting operations from the early 1950s until 1992. The following sections describe the history of these activities.

Construction Activities

Before the 1900s, the area presently designated IR04 was primarily tidal wetland along the original eastern shoreline of Mare Island (Navy 1883, 1911). By 1932, the ground surface for most of the area had been raised to elevations ranging between 2 and 12 feet above msl using imported fill material (dredge spoils or upland fill). Two dikes, a levee, and several sets of railroad tracks had been constructed adjacent to the shoreline. Also at this time, the northwestern portion of the site was being used for storage of lumber, anchors, and buoys (Navy 1932).

By mid-1941, railroad tracks, formerly located on the northern half of the site, had been removed and a fence was constructed running east to west through the center of the site (Navy 1940, 1941). By 1944, Buildings 778 and 782, additional sets of railroad tracks, and two electrical transmission towers were constructed, portions of the tidal wetland had been filled with imported fill material, and various areas were paved (Navy 1944). In the 1950s, Buildings 852, 860, 684, and 900 were constructed (Navy 1953; PRC Environmental Management, Inc. [PRC] 1995). By 1960, Buildings 852, 860, and 684 had been demolished and Building 918 had been constructed (Navy 1960).

Between 1963 and 1970, Buildings 1286 and 1288 were constructed. These buildings were demolished between 1993 and 1997. In 1975, a 15-foot corrugated steel fence enclosure and Buildings 1300 and 1316 were built. Building 1316 was demolished before 1989.

Abrasive-Blasting and Painting Activities

From at least the early 1950s through the 1980s, abrasive blasting and/or repainting activities were conducted within IR04. As part of these activities, components of ships and submarines were routinely treated with abrasive blast material (of which SBM is a subset) to remove old or corroding paint prior to repainting. Two types of paint were generally removed from and applied to marine vessels: anticorrosion paint, which was applied to metal surfaces, and antifouling paint, which was applied over the anticorrosion paint when protection from marine fouling organisms (that is, plants, such as marine grass and animals, such as barnacles) was necessary (Naval Facilities Engineering Command, Engineering Field Activity West [EFA WEST] 1998a).

Disposal of Abrasive-Blasting Materials

Several different abrasive-blast materials were used between the 1950s and 1980s. Monterey sand was used from the early 1950s to the late 1960s. At that time, occupational health issues were raised concerning the potential for workers to contract silicosis from materials with a high silicon content. As a result, Monterey sand was then replaced by a nickel slag material, commercially known as Green Diamond®. Green Diamond® was the only abrasive-blast material used at Mare Island throughout the 1970s and well into the 1980s when the shipyard switched to Kleen Blast®, a copper slag material (EFA WEST 1998b). During this transition period, both Green Diamond® and Kleen Blast® were used in large quantities; however, Kleen Blast® was the preferred material because of its superior results.

Approximately 400 cubic yards of spent SBM were generated each year (Ecology and Environment, Inc. [E&E] 1983). MINS personnel and file information suggests that sandblast operations were not always confined to the vicinity of the current sandblast enclosure. Both spent and unused SBM were stored in piles on paved and unpaved areas throughout the site. From the early 1950s until 1975, spent SBM was disposed by dumping the material on the ground surface throughout the site, along the existing shoreline of Mare Island Strait, and directly into the Strait (E&E 1983). Spent SBM was apparently used as fill to extend the shoreline eastward at the northern portion of the site. The spent abrasive was also reportedly used as pipe bedding material for expansion of the industrial waste (IW) collection system between 1972 and 1976 (E&E 1983). Mare Island personnel have stated that spent SBM may be present beneath many

paved areas of the site. In addition, tidal action over the years may have redistributed the spent SBM throughout the tidal wetland and intertidal mudflat areas (E&E 1983).

In 1975, the Navy built an enclosure for the sandblast area and imposed controls on the disposal of spent SBM, which was subsequently taken to the facility landfill. Spent SBM was collected periodically and placed in 3-cubic-yard containers and on the foundation next to Building 782 to either be transported to the landfill or screened for recovery and reuse. Approximately 16 percent of the spent SBM was recovered annually. By 1992, sandblasting operations had been moved to Building 750, approximately 3,000 feet north of the site.

Disposal of Painting Materials

Painting operations were conducted at IR04 between 1949 and 1992. Building 900 housed a free-standing, recirculation, water-curtain paint spray booth at its southern end that was used for painting large, metal submarine parts and equipment (E&E 1983). Wastes generated by the paint spray booths included paints, chromate, red lead, epoxy, vinyls, thinners, and contaminated water (PRC 1995). During operations, the spray booths produced approximately 1,000 gallons per day of wastewater contaminated with waste paint and thinner, discharged to the IW collection system via a concrete trough located below the paint spray booths. Water curtain sumps were dumped once a week, yielding an additional 1,500 gallons per week of wastewater. Paint sludges were periodically removed from the spray booths (at a rate of approximately 120 cubic yards per year) and disposed at the MINS landfill (E&E 1983). In 1990, painting methods changed, and the paint spray booth overflow drain and sump were capped. The paint grit and sludge from the overflow drain and sump were removed and most likely disposed at the facility landfill (PRC 1995). Painting methods used at Building 900 from 1990 until 1992 involved a dry filter system that did not produce contaminated wastewater (PRC 1995).

Building 1300 housed a paint shed used for large items such as vehicles, railroad cars, and small buildings. Paint spraying operations were also conducted in an open asphalt-paved area outside Building 1300. On the southeastern and southwestern sides of Building 1300, a series of iron dip tanks containing cleansers, deoxidizers, acids, caustics, Alodine and Irridite (brand-name solutions used in a chemical chromate conversion process that prepares copper and aluminum surfaces for painting), and rinse waters were used to prepare sandblasted surfaces for painting. Rinsewater from the dip tanks was discharged to the IW collection system at about 1,000 gallons per day. The chemical solutions from the tanks were also disposed into the IW collection system four times a year for a total of approximately

12,000 gallons per year (E&E 1983). By 1992, painting operations, along with the sandblasting operations, had been moved off site to Building 750.

Use of Paints

Two common anticorrosion paints applied to Navy vessels were a zinc-chromate formulation (F117) and a lead-based formulation (F119). The lead- and zinc-chromate-based paints were phased out of the Navy's painting inventory starting in the late 1980s and were replaced by nonlead and nonchromate-containing formulations for all shipboard uses.

The primary antifouling paints used by the Navy until the late 1980s were F121 and F129 (EFA WEST 1998a). Antifoulant paints, like most other marine paints, consist of a film-forming material (matrix, binder, resin, and medium), a pigment, and a biocide that kills or repels fouling organisms. The biocide used in paints F121 and F129 was cuprous oxide. F121 and F129 were conventional, or free association-type, antifoulant paints, in which the biocide is physically mixed into a resin which dissolves slowly in sea water. Antifoulant paints operate by releasing a small amount of the biocide at the paint surface, which then kills or repels the settling stages of fouling organisms. However, the release rate of the biocide from the paint decreases exponentially rather than linearly, such that the biocide release from the resin is initially high but then steadily declines, resulting in diminishing performance of the antifouling paint over time. In the late 1980s, the Navy began using a copper-based paint that provided a more controlled release of the biocide.

Navy records indicate that organotin compounds were, at one time, considered for use as a biocide on a fleet-wide basis. As a result, the Navy experimented with the use of organotin-based antifoulant paint on a limited number of vessels, including the USS Thomas Edison at Mare Island in 1973 (EFA WEST 1999). The use of organotin-based antifoulants was prohibited by Congress in 1986 (MINS 1988).

Recent Activities

Roy F. Weston, Inc. (WESTON) (formerly Supervisor of Shipbuilding at the Portsmouth Shipyard, Environmental Detachment, Mare Island, Vallejo [SSPORTS]) recently conducted work at IR04 to remove metallic anomalies at the site. During the activities, portions of the SBM Subarea were regraded. The result has been a change in the topography of SBM and surficial soil at IR04 as well as the removal of surface sample locations collected in the area.

A1.2.3 Physical Setting

The following subsections describe the geology and hydrogeology of IR04. The potential beneficial uses of groundwater as well as the ecology of IR04 are also included in these subsections. The information presented in the following section is based on results of previous investigations and the data gap investigation.

Geology

Geologic units have been identified based on a review of cross sections and area-specific lithologic data from direct-push borings, hand-auger borings, and cone penetrometer test data. Four geologic units have been identified at IR04. These include (1) the sandblast material, (2) the heterogeneous unconsolidated material, (3) the fine-grained homogeneous unconsolidated materials (referred to as the silty clay unit), and (4) the bedrock. The lower portion of the silty clay unit appears to represent the unconsolidated natural deposits unit, referred to as Younger Bay Mud. These geologic units are described in detail in the following subsections.

Sandblast Material

The sandblast material unit is artificial fill that primarily consists of spent SBM generated during sandblasting activities at Mare Island. The sandblast material unit is comprised of varying amounts of sand, silt, and clay that have mixed with spent SBM over the years. Paint flakes present in spent SBM are reportedly either physically attached to the sand grains or loosely intermixed with the material (International Technology Corporation [IT] 1992).

As discussed in Section 1.2.2.3, three types of sandblast abrasive were historically used at the site: Monterey sand, Green Diamond® abrasive, and Kleen Blast® abrasive. Monterey sand and Green Diamond® were the most abundant types encountered in the subsurface, while Kleen Blast® abrasive was primarily observed as a thin veneer on the ground surface and in cracks in the asphalt in the area surrounding former Building 1286. The spent SBM identified as Green Diamond® is characteristically dusky yellowish green to dusky green, medium- to coarse-grained and poorly graded, or fine- to coarse-grained and well graded, subrounded to angular sand. Spent SBM identified as Monterey sand is characteristically pale yellow to yellowish gray to grayish black, poorly graded, coarse- to very-coarse grained, and angular. Spent SBM identified as Kleen Blast® is characteristically speckled dull blackish gray, poorly graded, fine- to medium-grained, and angular.

The SBM unit consists of a north trending, irregular shaped, elongated body of sand (occasionally mixed with silt and clay) approximately 700 feet long by 85 to 265 feet wide in the upland area of IR04. The SBM unit was encountered at the ground surface in some areas while in the northern portion of the SBM unit it was not encountered until depths of 6.5 feet below ground surface (bgs) (location IR04GB138 on Figure 2 in FSAP [TtEMI and U&A 2000]). In general, spent SBM is encountered at the surface in the southern portion of the SBM unit and is covered by the heterogeneous unconsolidated material in the northern portion of the SBM unit. The SBM unit ranges from less than 1 foot thick in the vicinity of former Building 1286 (location IR04GB164 on Figure 2 in FSAP) to at least 16 feet thick (location IR04GB345 on Figure 2 in FSAP) in the northern portion of the SBM unit. With the exception of a few isolated areas where surface piles are still present, the sandblast material unit is not present in the paved western half of the upland area.

The lithology of the lower portion of the sandblast abrasive unit in this area indicates that this portion of the unit represents spent Monterey sand abrasive, which correlates well with the early use of Monterey sandblast material at the site. The lithology of the upper portion of the sandblast material unit indicates that this portion of the unit represents spent Green Diamond®, which also correlates well with the later use of Green Diamond® at the site. In the tidal wetland area, it appears that tidal action may have moved and mixed the spent SBM with silt and clay, redistributing the spent SBM along the present-day shoreline area.

Heterogeneous Unconsolidated Material

The heterogeneous unconsolidated material, present throughout the upland portion of the site, consists of clay, silt, sand, gravel, and debris in varying proportions and largely represents artificial fill material. This fill material generally overlies either the sandblast material or silty clay unit, but it is also found below the sandblast material unit at some locations (for example, at locations IR04GB051 and IR04BG74 on Figure 2 in FSAP [TtEMI and U&A 2000]). The heterogeneous unconsolidated material is characterized by abrupt and unpredictable changes in lithology over short lateral and vertical distances. Debris encountered within the unit includes fragments of asphalt, concrete, wood, brick, metal, and glass. The unit primarily consists of (1) clayey silt to sandy silt, (2) sand to silty sand, and (3) silty to sandy gravel. The clayey silt to sandy silt varies from grayish brown to dark gray or greenish gray material, and occasionally contains gravel. The sand to silty sand varies from yellowish brown to grayish brown to olive gray, and is poorly sorted. The silty to sandy gravel is gray to grayish brown and is encountered at the surface as well as the subsurface.

The heterogeneous unconsolidated material was observed throughout the upland portion of the site and was encountered from the ground surface to a maximum depth of approximately 15 feet bgs at location IR04GB346 (Figure 2 in FSAP [TtEMI and U&A 2000]). The thickness of the heterogeneous unconsolidated material varies from a minimum of about 1 to 2 feet to a maximum of at least 10 feet as observed at location IR04GB162 (Figure 2 in FSAP).

Silty Clay Unit

The silty clay unit that underlies the heterogeneous unconsolidated material and the sandblast abrasive unit consist primarily of gray to olive gray silty clay to clay, but also includes localized zones of sandy and gravely material.

The silty clay unit observed in most areas of the upland portion of the site is generally encountered at depths ranging from 2 and 8 feet bgs, but it was first encountered as deep as 18 feet bgs at location IR04GB137 (Figure 2 in FSAP [TtEMI and U&A 2000]). This unit generally ranges from 40 to 105 feet in thickness throughout the base (IT 1992), but at IR04, it thins westward towards the bedrock ridge. The increasing thickness of the silty clay unit to the east reflects the sharp declination of the bedrock surface towards Mare Island Strait to the east. Zones of sandy material included in this unit were encountered at a few locations (for example, location IR04GB098 on Figure 2 in FSAP). At some locations (for example, location IR04GB257 on Figure 2 in FSAP), the clay contains varying amounts of organic material, including plant fragments and wood particulates that are collectively referred to as "organics." In addition, a few locations (for example, location IR04GB335 on Figure 2 in FSAP) contain 1 to 2.5 feet thick, brown to dark reddish brown peat beds that are composed of 80 to 100 percent organic material. Most of the silty clay unit encountered in the eastern and southern portion of IR04, which may largely represent marshy and subtidal depositional environments, appears to correlate to the Younger Bay Mud in other areas of San Francisco Bay.

The tidal wetland, intertidal mudflat, and offshore areas are composed almost exclusively of the silty clay unit. As with the upland area, these silty clay deposits appear to correlate to the Younger Bay Mud.

Bedrock

The bedrock at IR04 consists of steeply dipping, yellowish brown, light olive brown, interbedded sandstone, siltstone, mudstone, and claystone. Moderately to highly weathered bedrock was encountered in borings in the western one-fourth of the site, north and south of Building 900, and in offshore borings

IR04VC012, IR04VC014, IR04VC016, and IR04VC017. The bedrock encountered at IR04 most likely correlates with the bedrock outcrops in the hilly area at the south end of the peninsula that is now occupied by a golf course, ammunition bunkers, and a residential area along Mesa Avenue. The exposed bedrock at Mare Island is assigned to the undifferentiated Great Valley Sequence (Wagner and Bortungo 1982), and more specifically, the Cretaceous Panoche Formation (Dibblee 1981).

Hydrogeology

The hydrogeology of IR04, including the identification of hydrogeologic units, groundwater flow patterns and rates, and tidal influence, is presented in the following subsections.

Hydrogeologic Units

Based on the geologic materials present at the site, three hydrogeologic units have been identified. The uppermost unit consists of artificial fill, which includes the sandblast material and heterogeneous unconsolidated material geologic units. Well IR04W02 is completed within the SBM unit. The second hydrogeologic unit is the underlying silty clay, where well IR04W01 is completed. Well IR04W03 is completed partially within both the sandblast material unit and the silty clay. Both the artificial fill and silty clay units are consistent with the island-wide shallow water-bearing zone. The third unit is the underlying bedrock; no wells at IR04 are completed in this unit.

A slug test was performed on well IR04W01 in September 1999. The calculated hydraulic conductivity using the Bouwer-Rice method (Bouwer and Rice 1976; Bouwer 1989) was 4.18×10^{-4} meters/day (1.37×10^{-3} feet/day). This conductivity falls within the expected range of conductivities for silt and clay reported by Freeze and Cherry (Freeze and Cherry 1979). Slug tests have not been performed on wells IR04W02 and IR04W03.

Groundwater Flow Patterns and Rates

Groundwater flow patterns and rates at IR04 were evaluated based on water-level information recorded during quarterly sampling events. Groundwater at IR04 was encountered at depths between approximately 1.29 to 4.39 feet bgs (1.41 to 3.94 feet msl). Because of limited data, potential seasonal water-level variations cannot be evaluated at this time; however, a comparison of water-level elevations in each of the three monitoring wells, measured in early April and early June 1999, indicated a slight decreasing trend as the dry season progressed.

The primary flow direction at IR04 is to the northeast, towards Mare Island Strait.

Static water elevations measured on May 26, 1999, were used to evaluate the horizontal hydraulic gradient for the shallow water-bearing zone. In May 1999, the estimated hydraulic gradient in the direction of groundwater flow varied from a low of 0.005 in the northern portion of IR04 to a high of approximately 0.06 (based on calculated gradients using IR04 and Building A215 monitoring wells) in the southwest portion of the site.

A seepage velocity at IR04 was calculated using the following estimated parameters: an effective porosity of 0.05 (Todd 1980) was estimated for the fine-grained material (silt and silty clay) in well IR04W01; a hydraulic gradient of 0.005 (based on static water elevations measured on May 29, 1999) was used to calculate the seepage velocity in the vicinity of well IR04W01. Based on these values, a seepage velocity of 4.18×10^{-5} meters/day (1.37×10^{-4} feet/day) was calculated for the fine-grained material in well IR04W01. This value does not account for retardation or dispersion, and therefore would be considered an upper bound estimate for the evaluation of analyte transport velocities in the immediate area of well IR04W01.

A1.3 DATA QUALITY OBJECTIVES

The development of DQOs provides a decision-making framework to evaluate potential contamination at IR04. DQOs were developed using the seven-step process outlined in U.S. Environmental Protection Agency (EPA) guidance documents (EPA 1993, 1994, 1999a, 2000), as discussed in the following text and summarized in Table 1.

A1.3.1 Step 1 - State the Problem

Development of the problem statement includes the following three items:

- Site history and summary of data gaps
- Problem statement
- Stakeholder identification

TABLE A-2

DATA QUALITY OBJECTIVES PROCESS STEPS
INVESTIGATION AREA F2
MARE ISLAND, CALIFORNIA

1	2	3	4	5	6	7
State the Problem	**Identify the Decisions**	**Identify Inputs to the Decisions**	**Define the Study Boundaries**	**Develop Decision Rules**	**Specify Tolerable Limits on Decision Errors**	**Optimize the Design for Obtaining Data**
1. TPH-e contamination at the SBM Subarea has not been fully delineated. 2. Metals contamination at the SBM Subarea should be recharacterized following metallic anomaly removal activities. 3. VOC contamination in soil at Pit 4-M4 and its potential migration to groundwater has not been delineated. 4. VOC contamination posing a potential human health concern has not been delineated.	1. Has the extent of TPH-e contamination in soil at the SBM Subarea been fully delineated? Is there a correlation between TPH-e concentrations and semivolatile organic compounds (SVOC) concentrations and/or benzene, toluene, ethylbenzene, and xylene (BTEX) concentrations? 2. Has the extent of metals contamination in soil been adequately characterized considering recent metallic anomaly removal activities? 3. Has the extent of VOC contamination in soil caused by buried paint cans been fully delineated? Is there a potential for migration of VOCs into groundwater? If so, has the extent of contamination been delineated? 4. Has the extent of VOC contamination in the Other IR04 Subarea been fully delineated?	Validated and defensible data for: 1. Direct push borings to delineate the lateral and vertical extent of TPH-e contamination and to establish a correlation between TPH-e concentrations and/or SVOC and BTEX concentrations. 2. Hand auger and direct-push borings to characterize the extent of metals contamination in surface soil subsequent to removal activities. 3. Direct-push borings to delineate VOC contamination near the formerly buried paint cans. Soil and grab groundwater samples to delineate the extent of VOC contamination in soil and potential migration to groundwater. 4. Hand-auger borings to delineate VOC contamination in the Other IR04 Subarea.	Upland and limited tidal wetland areas of IR04.	1. If TPH-e concentrations are below the alternate comparison criterion, then the extent of TPH-e contamination has been sufficiently delineated. If TPH-e concentrations exceed the alternate comparison criterion, then additional step-out sampling may be required to adequately delineate the extent of contamination. If SVOC and BTEX concentrations are detected below their respective comparison criteria at locations where TPH-e concentrations exceed the alternate comparison criterion, then there is no correlation between TPH-e and BTEX and/or SVOC concentrations. If SVOC and BTEX concentrations are detected above their respective comparison criteria at locations where elevated TPH-e concentrations have been detected, then there may be a potential correlation between TPH-e and BTEX and/or SVOC concentrations, and further evaluation may be necessary. 2. Soil samples collected to recharacterize surface soil in the area where metallic anomaly removal activities were conducted will be included in an evaluation of risk to human health and the environment. 3. If VOC concentrations detected in soil samples collected to delineate the extent of contamination associated with the buried paint cans are below the comparison criteria, then the area has been adequately characterized. If VOC concentrations in these soil samples exceed the comparison criteria, then the site has not been fully characterized, and further investigation may be required. If VOC concentrations detected in grab groundwater samples are below the comparison criteria, then VOC contamination in groundwater surrounding this area has been delineated. If VOC concentrations exceed the comparison criteria, then further investigation may be required, and monitoring wells may need to be installed. 4. If VOC concentrations detected in soil samples collected from hand-auger borings to delineate the extent of VOC contamination posing a potential human health concern are below the comparison criteria, then the extent of contamination has been sufficiently delineated. If VOC concentrations detected in soil samples collected from these borings are above the comparison criteria, then additional step-out sampling is needed to adequately delineate the extent of contamination.	No tolerable decision error rates were set because the judgmental sampling approach does not allow for the assessment of whether or not specific error rate limits have been attained.	Proposed sample locations have been based on detailed analysis of previous investigations and have been selected to evaluate extent of contamination. Targeted sampling is planned in most locations.

Sources:

U.S. Environmental Protection Agency (EPA). 1993. "Data Quality Process for Superfund, Interim Final Guidance, Pre-publication Copy." EPA/540/G-93/071. September.

EPA. 1994. "Final Guidance for the Data Quality Objectives Process." EPA QA/G4. September.

EPA. 1999a. "Data Quality Objective Process for Hazardous Waste Site Investigations, Peer Review Draft." EPA QA/G-4HW. June.

EPA. 2000. "Data Quality Objectives Process for Hazardous Waste Site Investigations. Final." EPA QA/G4HQ. January.

Site History and Summary of Data Gaps

From the early 1950s to 1992, the site was used for sandblasting and painting activities. Spent sandblast material (SBM) was and still is clearly visible at various locations at the site. Between 1983 and 1999, an RI was conducted. TPH-e was detected at concentrations exceeding the comparison criterion in soil at the SBM Subarea. The extent of TPH-e contamination was not fully delineated. Metals contamination was also identified at the SBM Subarea. Although the extent of the contamination was delineated during the RI, the area needs to be reevaluated because of recent changes in topography as a result of metallic anomaly removal activities and disruption of surface soil.

Following the RI, buried paint cans were discovered during metallic anomaly removal activities. The area was excavated and the paint cans and surrounding soil (Pit 4-M4) were removed. During confirmation sampling, VOCs were detected at concentrations exceeding comparison criteria and Pit 4-M4 was further excavated. No soil has been excavated since the final round of confirmation sampling on February 3, 2000. Pit 4-M4 has not yet been backfilled. The extent of soil contamination and potential for VOC migration to groundwater has not been delineated.

VOCs were detected at one location in the Other IR04 Subarea at concentrations that were considered to be a potential human health concern based on the results of the initial HHRA. The extent of contamination has not been delineated.

Problem Statements

Based on the site history and data gap identification, the following problem statements have been developed for IR04 at Mare Island:

1. TPH-e contamination at the SBM Subarea has not been fully delineated.
2. Metals contamination at the SBM Subarea should be recharacterized following metallic anomaly removal activities.
3. VOC contamination in soil at Pit 4-M4 and its potential migration to groundwater has not been delineated.
4. VOC contamination posing a potential human health concern has not been delineated.

Stakeholders

For IR04, the following stakeholders have been identified:

- U.S. Navy

- Regulatory agencies (primarily the State of California's Department of Toxic Substances Control)
- Community Members (including the Restoration Advisory Board [RAB])
- City of Vallejo

A1.3.2 Step 2 - Identify the Decisions

The purpose of Step 2 is to define a decision statement that combines the key questions the investigator is attempting to resolve and the alternative actions that may be taken (EPA 2000). Study questions are first used to narrow the scope of the search for information needed to address the problem. Alternative actions corresponding to the study question are then identified; alternative actions help achieve the goal of protecting human health and the environment. Finally, the alternative actions and study questions are combined into a decision statement that presents a choice among alternative actions (EPA 1999a).

Study Questions

Based on the problem statement established in Step 1, the following study questions have been developed for IR04:

1. Has the extent of TPH-e contamination in soil at the SBM Subarea been fully delineated? Is there a correlation between TPH-e concentrations and SVOC concentrations and/or BTEX concentrations?
2. Has the extent of metals contamination in soil been adequately characterized considering recent metallic anomaly removal activities?
3. Has the extent of VOC contamination in soil caused by buried paint cans been fully delineated? Is there a potential for migration of VOCs into groundwater? If so, has the extent of contamination been delineated?
4. Has the extent of VOC contamination in the Other IR04 Subarea been fully delineated?

Alternative Actions

Based on the study questions, the following alternative actions have been developed:

- Sufficient data have been collected to characterize the contamination both laterally and vertically; sampling is complete.
- Sufficient data have not been collected to characterize the site; additional sampling is necessary.

Decision Statements

Based on both the study questions and alternative actions, the following decision statements have been developed for IR04:

1. Evaluate whether TPH-e contamination in soil at the SBM Subarea has been fully delineated. Evaluate the possible correlation between TPH-e concentrations and SVOC concentrations and/or BTEX concentrations.

2. Evaluate whether metals contamination has been adequately characterized at the SBM Subarea

3. Delineate VOC contamination in soil and groundwater.

4. Evaluate whether VOC contamination at the Other IR04 Subarea has been fully delineated.

A1.3.3 Step 3 - Identify Inputs to the Decisions

Informational inputs needed to support the decision statements are defensible chemical data with sufficient detection limits to support future risk assessment for both soil and groundwater.

A1.3.4 Step 4 - Define the Study Boundaries

The spatial boundary of the proposed investigation at IR04 includes the upland portion of the site with some additional sampling required in the tidal wetland area. Based on the results of this data gap investigation, subarea boundaries will most likely be redefined in the RI.

A1.3.5 Step 5 - Develop a Decision Rule

Step 5 of the DQO process continues to build on the decision-making framework established in Steps 1 through 4. The purpose of this step is to develop logical "if...then" statements that define the conditions to facilitate choices among alternative actions (EPA 1999a). In this step, comparison criteria and decision rules are established. Comparison criteria are numerical values derived from applicable or relevant and appropriate requirements or risk-based methodologies that, when applied to site-specific conditions, can be used as criteria for evaluating whether contamination levels pose a potential risk to human health or the environment. The comparison criteria are then combined with the decision statements established in Step 2 to come up with "if...then" decision rules.

Comparison criteria

The comparison criteria compiled for chemical characterization include:

- National Oceanic and Atmospheric Administration (NOAA) effects-range low values for sediment.
- U.S. Environmental Protection Agency (EPA) Preliminary Remediation Goals (PRG) for residential use
- Ambient levels for metals
- Alternative comparison criteria developed for the Group II/III investigation
- Ambient water quality criteria (AWQC)
- Ecological benchmark criteria for soil

Decision Rules

The following "if ... then" statements have been developed to address the study questions and decision statements derived during Step 2 of the DQO process:

1. If TPH-e concentrations are below the alternate comparison criterion, then the extent of TPH-e contamination has been sufficiently delineated. If TPH-e concentrations exceed the alternate comparison criterion, then additional step-out sampling may be required to adequately delineate the extent of contamination.

   If SVOC and BTEX concentrations are detected below their respective comparison criteria at locations where TPH-e concentrations exceed the alternate comparison criterion, then there is no correlation between TPH-e and BTEX and/or SVOC concentrations. If SVOC and BTEX concentrations are detected above their respective comparison criteria at locations where elevated TPH-e concentrations have been detected, then there may be a potential correlation between TPH-e and BTEX and/or SVOC concentrations, and further evaluation may be necessary.

2. Soil samples collected to recharacterize surface soil in the area where metallic anomaly removal activities were conducted will be included in an evaluation of risk to human health and the environment.

3. If VOC concentrations detected in soil samples collected to delineate the extent of contamination associated with the buried paint cans are below the comparison criteria, then the area has been adequately characterized. If VOC concentrations in these soil samples exceed the comparison criteria, then the site has not been fully characterized, and further investigation may be required.

   If VOC concentrations detected in grab groundwater samples are below the comparison criteria, then VOC contamination in groundwater surrounding this area has been delineated. If VOC concentrations exceed the comparison criteria, then further investigation may be required, and monitoring wells may need to be installed.

4. If VOC concentrations detected in soil samples collected from hand-auger borings to delineate the extent of VOC contamination posing a potential human health concern are below the comparison criteria, then the extent of contamination has been sufficiently delineated. If VOC concentrations detected in soil samples collected from these borings are above the comparison criteria, then additional step-out sampling is needed to adequately delineate the extent of contamination.

A1.3.6 Step 6 - Specify Limits on Decision Errors

No tolerable decision error rates were set because the judgmental sampling approach does not allow for the assessment of whether or not specific error rate limits have been attained.

A1.3.7 Step 7 - Optimize the Design for Obtaining Data

The data collection design at IR04 was optimized as presented below.

1. TPH-e contamination at the SBM Subarea:
   (a) Data gap sampling will be conducted for nondelineated areas only.
   (b) Co-located borings will be advanced only at locations where previous samples contained elevated concentrations of TPH-e to assess correlation with BTEX and/or SVOC concentrations.

2. Metals contamination at the SBM Subarea:
   Reevaluation of disturbed soils via grid sampling.

3. Pit 4-M4/Buried Paint Can Area:
   Direct-push borings with multiple depth grab groundwater samples will be collected to evaluate the extent of VOC contamination in soil and its potential migration to groundwater. Multiple depth groundwater sampling intervals will be used specifically to provide insight as to where to screen future monitoring wells, if necessary.

4. VOC contamination posing potential human health risk:
   Data gap sampling will be conducted at nondelineated areas only.

A1.4 USE OF THE QUALITY ASSURANCE PROJECT PLAN

In this document, each QAPP element is discussed in detail as it pertains to the investigation of IR04. The purpose of the QAPP is to provide specific guidance and QA/QC criteria for collecting, evaluating, and submitting data collected for IR04. Personnel working on the project are required to read and comply with the procedures defined in this document to ensure the quality and usability of the data collected.

A2 PROJECT AND TASK ORGANIZATION

This section discusses management of the additional sampling at IR04. A well organized project team possessing adequate experience and proper training will ensure consistent quality throughout the field investigations at MINS. Sections A2.1 and A2.2 present the task organization for the project, including specific roles and responsibilities of project participants. Sections A2.3 and Section A2.4 discuss training requirements for project members and the schedule for work to be conducted at IR04.

A2.1 PROJECT ORGANIZATION AND PERSONNEL

The following personnel are involved in the IR04 project. In some cases, more than one responsibility has been assigned to a given person.

Name	Responsibility	Location	Telephone
David Godsey	Navy Remedial Project Manager (RPM)	Naval Facilities Engineering Command, San Diego, CA	(619) 532-0976
Narciso A. Ancog	Navy QA Officer (QAO)	Naval Facilities Engineering Command, San Diego, CA	(619) 532-2540
Daniel Chow	TtEMI Program Manager	TtEMI, San Francisco, CA	(415) 222-8222
Greg Swanson	TtEMI QA Program Manager	TtEMI, San Diego, CA	(619) 525-7188
Conrad Sherman	TtEMI Health and Safety Program Manager (HSPM)	TtEMI, San Francisco, CA	(415) 222-8377
Michael Foster	TtEMI Installation Coordinator (IC)	TtEMI, San Diego, CA	(619) 525-7188
Caitlin Gorman	TtEMI Project Manager	TtEMI, San Francisco, CA	(415) 222-8319
Ron Ohta	TtEMI Project QA Manager	TtEMI, Sacramento, CA	(916) 853-4506
Sara Woolley	TtEMI Analytical Coordinator	TtEMI, San Francisco, CA	(415) 222-8311
Lynne Srinivasan	Uribe &Associates (U&A) Project Manager	U&A, Oakland, CA	(510) 832-2233
Kent Baugh	U&A Project Health and Safety Coordinator	U&A, Oakland, CA	(510) 832-2233
Mike Barnes	U&A Field Team Leader	U&A, Oakland, CA	(510) 832-2233
Doug Sterling	TtEMI Field Team Leader	TtEMI, San Francisco, CA	(415) 222-8270
Mike Barnes	U&A Site Safety Officer (SSO)	U&A, Oakland, CA	(510) 832-2233
Wing Tse	TtEMI Database Manager	TtEMI, San Francisco, CA	(415) 222-8326

The remainder of the project team will consist of technical specialists listed as follows.

Name	Responsibility	Location	Telephone
Brenda McConathy	Ecological Risk Assessor	TtEMI, San Francisco, CA	(415) 222-8338
John Beach	Human Health Risk Assessor	TtEMI, San Francisco, CA	(415) 222-8318

Victor Early	Hydrogeologist	TtEMI, San Francisco, CA	(415) 222-8332
Marie Rainwater	Community Relations	TtEMI, San Francisco, CA	(415) 222-8279

An organization flowchart is presented in Figure A-1.

A2.2 PROJECT TEAM RESPONSIBILITIES

Descriptions of the roles and key responsibilities of each project team member are presented in the following subsections.

Navy Remedial Project Manager

The Navy RPM has overall responsibility for the Installation Restoration Program. The Navy RPM is directly responsible for project execution and coordination with base representatives, regulatory agencies, and the SWDIV management team.

The Navy RPM is responsible for the following:

- Providing site information and history
- Providing logistical assistance
- Specifying sites requiring investigation
- Reviewing results and recommendations and providing management and technical oversight
- Verifying proper review and distribution of documents
- Communicating comments from technical reviewers to contractors
- Verifying that contractors address comments and take appropriate corrective actions

Coordinating with regulatory agencies

Navy Quality Assurance Officer

The Navy QAO is responsible for QA issues for Navy CLEAN II work. The Navy QAO provides government oversight of the QA program, including review and sign-off on QAPPs and FSAPs. The QAO provides quality-related direction through the contract technical representative to the quality manager. The QAO has authority to suspend affected project or site activities if SWDIV-approved quality requirements are not adequately met.

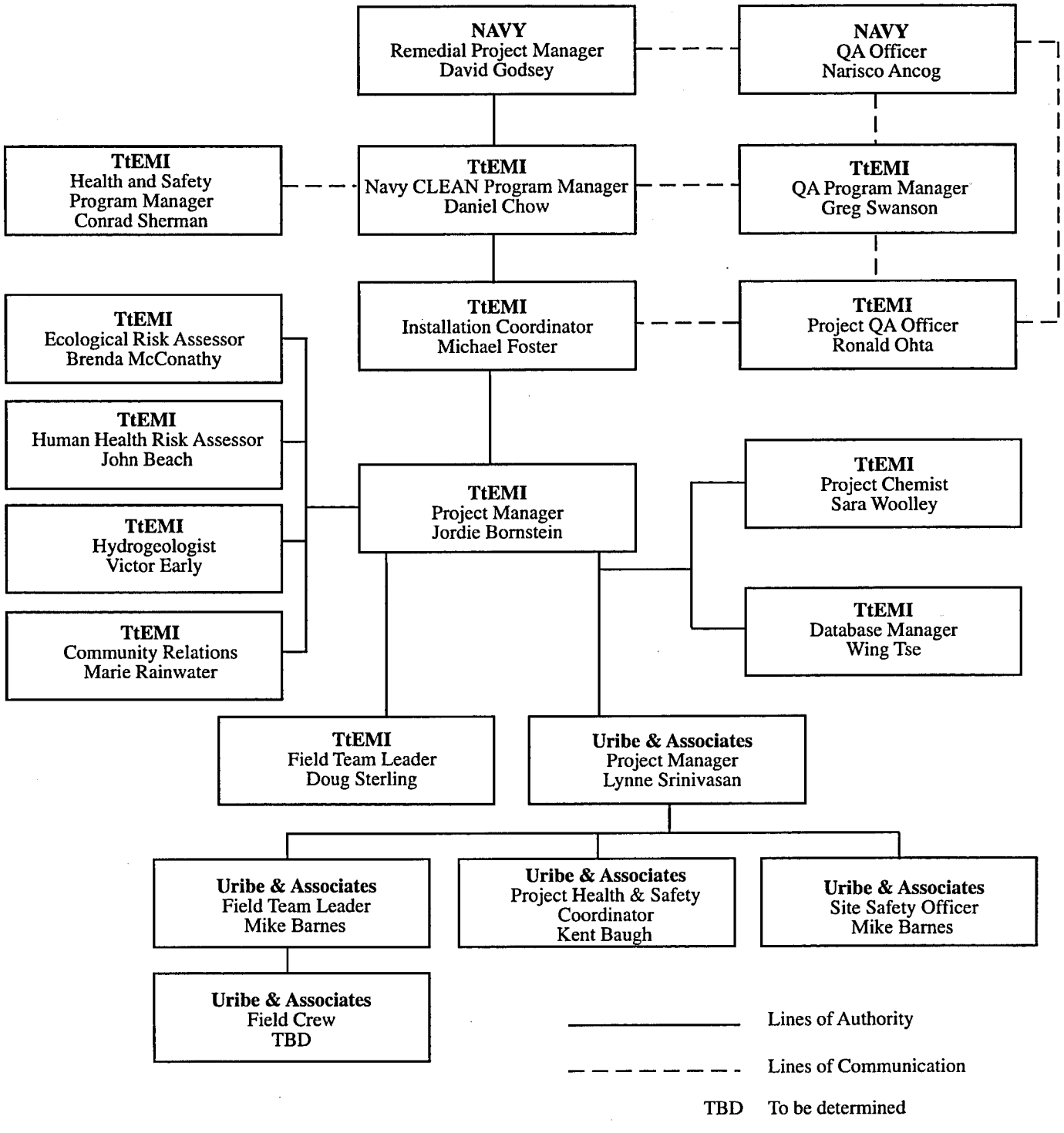

Figure A-1
Organization Flowchart

TtEMI Program Manager

The TtEMI Navy CLEAN II program manager is responsible for and has authority over work performed by personnel assigned to the Navy CLEAN II program. The program manager establishes program policies and procedures, monitors costs and performance, delegates authority, and resolves conflicts and problems. The TtEMI program manager is responsible for the following:

- Verifying that contract requirements are met
- Providing necessary resources to the project team to allow adequate response to requirements of the investigation
- Maintaining consistency in procedures and work products with other task orders
- Establishing and maintaining communication among the RPM, QA manager, health and safety program manager, and project managers
- Providing technical oversight and review of the final project report
- Providing guidance to the project managers
- Assisting the CLEAN II QA program manager in resolving QA issues that cannot be handled at the CTO project manager or QC coordinator level
- Assisting the CLEAN II QA program manager in resolving issues with subcontractors
- Monitoring compliance of CTO project managers with orders and recommendations
- Establishing and supporting continuous quality improvement problem-solving teams and process improvement groups to follow through with program-specific quality and process improvement opportunities identified by the CLEAN II QA program manager and QC coordinator
- Providing TtEMI CTO project managers with revised standard operating procedures (SOP) received from the CLEAN II QA program manager and ensuring that these improved SOPs are followed

TtEMI QA Program Manager

The QA program manager is responsible for the quality of work completed by TtEMI and its subcontractors under the Navy CLEAN II program. The QA program manager develops and maintains a comprehensive QA program and is responsible for audits, reviews of work performed, and recommendations to technical staff and management regarding quality. The QA program manager has the following specific responsibilities:

- Developing and revising the TtEMI Navy CLEAN II QA program
- Assigning qualified personnel to serve as QC coordinators
- Implementing and supervising the QA program with the assistance of QC coordinators and subcontractor QA managers
- Coordinating and auditing the review of QC documentation and technical operations, as required
- Identifying nonconformance situations to the CLEAN II program manager and corporate QA manager
- Providing guidance to CTO technical staff for QC program development and correcting nonconformance situations
- Preparing, revising , and providing SOPs to CTO project managers and technical staff
- Interacting with the Navy's appointed QAO about certification of laboratories and coordinating QA and technical staff compliance with requirements
- Ensuring compliance with orders and making recommendations to the CLEAN II program manager and CTO project managers regarding corrective action
- Approving the waiver of requirements for a written QC procedure when SOPs are specified by the Navy and available for use
- Communicating regularly with the CLEAN II program manager and providing a summary of quality improvement opportunities to the CLEAN II program manager for further action
- Communicating regularly with and supervising QA responsibilities of QC coordinators as well as coordinating and compiling quality improvement opportunities identified by QC coordinators
- Updating the TtEMI corporate QA manager on newly identified, ongoing, and completed program-specific quality improvement opportunities
- Communicating TtEMI-identified quality improvement opportunities to subcontractor QA managers and assisting subcontractor QA managers in pursuing quality improvement opportunities that will benefit the overall program QA effort
- Meeting regularly with the program managers, project managers, and QA managers
- Reviewing and approving the QAPP
- Conducting field audits to ensure that sampling activities are performed in accordance with the QAPP

The QA program manager reports, as necessary, to the corporate QA manager and consults frequently with the program manager and the QC coordinators. The QA program manager refers Navy CLEAN II program QA issues or disputes that cannot be resolved to the TtEMI corporate QA manager.

TtEMI Health and Safety Program Manager

The HSPM is responsible for developing health and safety standards, implementing health and safety policies, and providing consultation to management for the Navy CLEAN program. Specific responsibilities are as follows:

- Informing management of the status of the Navy CLEAN II health and safety program
- Providing consultation on health and safety policy and procedural issues
- Participating in audits to evaluate compliance with the health and safety plan (HSP) and the Navy CLEAN II health and safety program
- Reviewing the HSP for technical content and compliance with Navy CLEAN II health and safety program requirements
- Developing, implementing, and assessing the needs of the Navy CLEAN II health and safety program and informing the project health and safety coordinators of changes that occur in this program
- Providing consultation on health and safety policy and procedural issues as they relate to the Navy CLEAN II health and safety program.

TtEMI Installation Coordinator

The TtEMI IC has overall responsibility for TtEMI activities at the installation. These activities are divided into CTOs. The IC is responsible for overseeing project activities and coordinating with subcontractors.

TtEMI Project Manager

The project manager is responsible for overseeing project activities and coordinating with subcontractors. The project manager is ultimately responsible for the timely completion of the project. The responsibilities of the project manager are as follows:

- Verifying that QC requirements are fulfilled by team members
- Supervising the document control process

- Approving deliverables and associated documents before they are transmitted
- Establishing and maintaining communication among technical staff, program managers, QA officers, health and safety coordinators, and regulatory agencies
- Implementing programs and protocols related to the project
- Developing work plans that define the scope of major activities at the level of defensibility, documentation, and QC required for environmental measurements
- Developing specific QC procedures for major activities that produce or use environmental data
- Defining, reporting, and maintaining documentation of the precision, accuracy, representatives, completeness, and comparability (PARCC) of data
- Working with program management, QC coordinators, and other CTO project managers to develop, revise, and implement mechanisms, as needed, to identify QA problems and expedite corrective actions
- Verifying that data processing procedures are documented, routinely reviewed, and revised
- Verifying that the CTO project team fulfills QC requirements of the work plan
- Maintaining and regularly reviewing QA records and forwarding copies to the QC coordinator and CLEAN II QA program manager
- Overseeing the technical review and QC check for deliverables and approving data, reports, specifications, drawings, and documentation before they are transmitted
- Establishing and maintaining communication among the CTO technical staff, the TtEMI QC coordinator, and CLEAN II QA program manager
- Preparing QAPPs for CTOs that involve field data collection activities, such as sample collection, including the specification of acceptance criteria for the quality of data
- Verifying by personal observation that appropriate sampling, field testing, and field analysis procedures, as specified in the work plan and QAPP, are followed and that correct QC checks are made
- Working with QC coordinators to implement quality improvements identified during audit and review of ongoing work
- Implementing and following approved SOPs received from the TtEMI program manager
- Controlling the identification and handling of documentation until it is turned over to designated document-control personnel

TtEMI Project QA Manager

A senior technical staff member will serve as project QA manager and will be responsible for review of work completed by TtEMI. The project QA manager will audit and review work performed and provide recommendations about quality to the project manager and technical staff. The project QA manager will also regularly communicate with the CLEAN II QA program manager to discuss QA problems and resolutions. Specific responsibilities of project QA manager are as follows:

- Meeting regularly with the CLEAN II QA program manager
- Recommending revisions to the QA program, as such revisions are identified
- Reviewing deliverables before they are released to ensure conformance with QA/QC procedures and quality of work product
- Providing recommendations to the QA program manager, as required, for corrective action regarding aspects of work that do not meet program standards
- Providing guidance to project teams for QC program development and for correcting nonconformance situations
- Coordinating QC and technical staff compliance with specific QC requirements
- Ensuring compliance with orders and making recommendations to CTO project managers regarding corrective action
- Identifying quality improvement opportunities as part of the audit and review function
- Communicating quality improvement opportunities to the QA program manager or CTO project managers as appropriate
- Ensuring QAPPs are prepared in accordance with EPA guidance documents
- Ensuring that requirements described in the QAPP are met
- Providing guidance or assistance in resolving problems on QA/QC matters
- Verifying that the specified data collection methods comply with QA/QC requirements and will yield data of the desired quality and integrity
- Reviewing, evaluating, and approving quality-related changes to the FSAP and project work plan
- Ensuring that nonconformances are identified and appropriate corrective actions are taken, providing assistance to the project managers with regard to corrective action, and soliciting involvement by the program manager and QA program manager as necessary

- Conducting laboratory evaluations and audits to ensure that analyses are performed in accordance with the QAPP
- Communicating regularly with the project manager, QA program manager, and analytical coordinator to ensure the progress of QA tasks for the remedial investigation (RI) and feasibility study
- Serving as the main contact for project QA matters and providing guidance on appropriate procedures to the project managers and support personnel

TtEMI Analytical Coordinator

The TtEMI analytical coordinator works with the task manager during preparation of the FSAP and QAPP. The analytical coordinator coordinates the analytical tests with the information required from the field activity, sets up the contract laboratories to conduct the required analyses, coordinates validation of analytical results, and provides the procurement office with the information required to procure special analysis. The specific responsibilities of the analytical coordinator are as follows:

- Verifying that the laboratory implements the requirements of the FSAP and QAPP
- Coordinating with the contract laboratory on pickup and delivery schedules and QA/QC matters
- Conducting laboratory evaluations and audits
- Reviewing laboratory data prior to release
- Coordinating data validation activities
- Providing updates on the project to project QA officers and managers with regard to the QA/QC data

U&A Project Manager

The U&A project manager is responsible for overseeing U&A project activities and coordinating with subcontractors. The U&A project manager is ultimately responsible for the timely completion of the U&A project activities. The responsibilities of the project manager include the following:

- Assigning technical staff
- Ensuring the completion of QC requirements by U&A team members
- Supervising the document control process
- Approving deliverables and associated documents prior to transmittal

- Establishing and maintaining communication between technical staff, TtEMI project manager, U&A project health and safety coordinator, and U&A SSO
- Implementing programs and protocols related to the project
- Preparing the site-specific HSP

U&A Project Health and Safety Coordinator

The U&A project health and safety coordinator is responsible for developing, instituting, coordinating, and supervising the health and safety program. The project health and safety coordinator's responsibilities are as follows:

- Reviewing the HSP
- Providing assistance to the HSPM for health and safety program development, preparing training sessions, conducting accident investigations, and providing recommendations to prevent future accident occurrences
- Ensuring that the HSP complies with federal, state, and local health requirements
- Coordinating with the SSO during modifications to the HSP and providing consultation, when required
- Preparing materials to be used in the training program and ensuring that SSOs are knowledgeable in requirements of the HSP
- Conducting periodic on-site visits to verify that site personnel adhere to site safety requirements
- Establishing and maintaining communication among SSOs, project managers, and the TtEMI HSPM
- Providing guidance on appropriate corrective action procedures to the project managers and support personnel

U&A Field Team Leader

The field team leader is responsible for the field activities. The field team leader will direct on-site activities, including those of subcontractors, and will ensure that the field team adheres to procedures described in the FSAP. The field team leader will also be the liaison between U&A and on-site Navy personnel during the duration of the fieldwork.

U&A Site Safety Officer

The SSO is responsible for field implementation of the HSP and has the authority to correct and change site control measures and the required level of health and safety protection. The SSO officer has primary on-site enforcement authority, as delegated by the project manager, for the policies and provisions of the health and safety program and the HSP. Responsibilities of the SSO are as follows:

- Serving as the initial contact for site-specific health and safety activities
- Conducting briefing sessions for and providing documentation to TtEMI, U&A, and subcontractor personnel concerning site-specific hazards, emergency procedures, and symptoms associated with exposure to specific site contaminants
- Documenting health and safety briefings, meetings, and training completed in the field
- Identifying the required personal level of protection based on guidance given in the site-specific HSP and based on actual on-site operations
- Conducting air monitoring to be used in the selection of appropriate personal protective equipment (PPE) based on the required personal level of protection, evaluating changes in on-site operations and necessary changes in the personal level of protection, and documenting air-monitoring operations and results
- Establishing, enforcing, and documenting decontamination operations for personnel and sampling equipment, sample containers, and heavy equipment
- Suspending any operation that threatens the health or safety of team members or the surrounding population and immediately notifying the project manager
- Identifying and posting locations and routes to medical facilities, arranging for emergency transportation to medical facilities, and posting emergency service telephone numbers
- Assuming the lead role for U&A during medical emergency
- Providing on-site cardiopulmonary resuscitation (CPR) and first aid, as necessary

TtEMI Database Manager

The database manager coordinates the loading and checking of data in the database. The TtEMI database manager is also responsible for coordination with the analytical coordinator during preparation of the field sampling plan and QAPP to coordinate sample identification issues. In addition, the database manager is responsible for working with the analytical coordinator and the field team leader to prepare for the field sampling effort. The project database manager is responsible for developing and monitoring the database under the guidance of the project manager, as follows:

- Designing the database
- Selecting software
- Coordinating with data submitters
- Logging and transferring data
- Entering and verifying data
- Developing screen and report format
- Archiving data
- Assisting users in accessing and retrieving data
- Documenting the database
- Distributing the database
- Verifying software verification and change approvals
- Verifying and documenting changes to the existing data

TtEMI Technical Specialist

TtEMI technical specialists will be responsible to the CTO project manager and QC coordinator for completing project activities in compliance with approved SOPs, the QAPP, and other program and project QC guidelines and requirements. The technical specialists have the following specific responsibilities:

- Collecting and generating field and laboratory data by carrying out activities consistent with the quality management plan
- Generating control and calibration data so that the quality and usability of field and laboratory data can be evaluated
- Documenting sample control and data management procedures
- Documenting the sources of information acquired, including manual and computer calculations, engineering drawings, and equipment specifications
- Evaluating data and preparing documents referencing sources of information acquired and methods of data evaluation

A2.3 SPECIAL TRAINING REQUIREMENTS AND CERTIFICATION

Personnel who work at a hazardous-waste project site are required to meet the health and safety training requirements of Title 29 of the *Code of Federal Regulations* (CFR) Part 1910.120(e), as described in the following sections. Depending on individual responsibilities in the field and the complexity of a particular project, on-site personnel may have to meet special training requirements defined in the work plan for the CTO. The following sections describe the training requirements for TtEMI and U&A personnel and subcontractors.

A2.3.1 Personnel Health and Safety Training

TtEMI and U&A personnel working on hazardous-waste project sites who are responsible for the project or site activities are required to undergo specific training before participating in, managing, or supervising field activities. This training will thoroughly cover the following areas:

- Names of personnel and alternates responsible for health and safety at a hazardous-waste project site
- Health, safety, and hazards present on site
- Selection of the appropriate personal levels of protection
- Correct use of PPE
- Work practices to minimize risks from hazards
- Safe use of engineering controls and equipment on site
- Medical surveillance requirements, including recognition of symptoms and signs that might indicate overexposure to hazardous substances
- Contents of the site-specific HSP

TtEMI and U&A personnel engaged in activities that expose or potentially expose workers to hazardous substances and health hazards at a hazardous-waste site will receive a minimum of 40 hours of formal instruction off site and a minimum of 3 days of actual field experience on site under the supervision of a trained, experienced field supervisor. Field personnel directly responsible for or who supervise employees engaged in hazardous-waste operations, including the U&A project health and safety coordinator, will also receive at least 8 additional hours of specialized supervisor training. The specialized training will include the requirements of the CLEAN II health and safety program, training requirements, the PPE and personal level of protection programs, spill containment program, and

health-hazard monitoring procedures and techniques. Project health and safety coordinators will also receive additional health and safety training, including training in operating monitoring instrumentation.

Written certificates will be given to employees who successfully complete this training. A letter documenting 24 hours (3 days) of supervised on-site experience will be provided. TtEMI and U&A employees engaged in work at hazardous-waste sites also are required to undergo 8 hours of annual refresher training to maintain certification.

The U&A field team leader, who is the on-site manager with authority delegated by the project manager to direct field operations, will be fully trained in hazardous-waste field operations and will ensure that necessary preparation and coordination is complete before on-site work begins. This preparation generally consists of drafting project documents, such as the work plan, FSAP, QAPP, and requests for bids, and assisting in the preparation of the site-specific HSP under the guidance of the project manager. In some instances, a field team leader trains for this position by working on site as a team member before replacing the original field team leader.

At least one member of each field team will maintain current certification in the American Red Cross "Multimedia First Aid" and "Cardiopulmonary Resuscitation Modular" or equivalent. The HSPM is responsible for providing on-site CPR as necessary. In the event that the HSPM is not on site, at least one other member of the field team will be able to administer CPR as necessary. The HSPM ensures that appropriate field personnel maintain current certification in both first aid and CPR.

Copies of field personnel health and safety training records, including course completion certifications for the initial health and safety training, first aid, CPR, and refresher training, will be maintained in project files. The HSPM implements the training requirements by notifying employees when they are due for recertification, disseminating information about appropriate courses, conducting or assisting in refresher training, and performing other such tasks.

A2.3.2 Subcontractor Training

Subcontractors that work on site will certify that their employees have been trained for work on hazardous waste project sites. The training will meet the Occupational Safety and Health Administration training requirements of 29 CFR Part 1910.120(e). Before beginning work at the project site, the subcontractors will submit to the HSPM certification of training for each employee who will be involved in fieldwork. Subcontractors also will ensure that these employees attend a preentry safety briefing.

The preentry safety briefing is designed to inform subcontractor employees of the potential risks of working with hazardous materials, site-specific hazards, the required level of personal protection, and the correct use of PPE. This safety briefing is conducted by the U&A health and safety coordinator or other qualified person designated by the HSPM. Employees of associate and professional services firms and technical services subcontractors will attend a safety briefing and complete the "Safety Meeting Sign-Off Sheet" before conducting on-site work. Construction service subcontractors are responsible for conducting their own safety briefings. TtEMI or U&A personnel may audit these briefings.

A2.4 PROJECT SCHEDULE

The anticipated schedule for the data gap investigation at IR04 is summarized in the following table, which shows a schedule of the major milestones of the project:

TABLE A-3

ADDITIONAL SAMPLING AND REPORTING TENTATIVE SCHEDULE
INVESTIGATION AREA F2
INSTALLATION RESTORATION SITE 04
MARE ISLAND, CALIFORNIA

Activity	Schedule
Draft FSAP and QAPP	January 17, 2001
Agency review and comment period	January 17, 2001 to February 21, 2001
FINAL FSAP and QAPP and responses to comments	July 23, 2001
Agency review and comment period	July 23, 2001 to August 31, 2001
Final FSAP and QAPP	September 14, 2001
Field work	September 17, 2000 through October 19, 2000
Draft RI submitted to agencies	April 17, 2001

A3 PROBLEM DEFINITION AND BACKGROUND

Additional sampling is proposed at IR04. The rationale for the proposed additional sampling is discussed in the following sections.

A3.1 PURPOSE OF INVESTIGATION

The field activities proposed in this QAPP are designed to fill the data gaps described in Section A4.1.

A3.2 PREVIOUS INVESTIGATION OF CONTAMINANT MIGRATION AND EXISTING SOURCES

As part of the RI, IR04 was divided into five subareas: Subareas 1 through 3, established for purposes of evaluating data gaps identified during the initial data review for the site; the SBM Subarea, established to include the area which contained visible sandblast abrasive material at the surface; and the Other IR04 Subarea, which covered the remainder of the site not located within Subareas 1 through 3 or the SBM Subarea (Figure 2 in FSAP [TtEMI and U&A 2000]). Subarea 2 is completely contained within the SBM Subarea.

Although the general distribution of VOC and TPH-e contamination within IR04 was characterized during the RI, individual areas where concentrations of these compounds exceeded comparison criteria have not been specifically delineated within the Other IR04 Subarea and the SBM Subarea, respectively. In addition, a correlation between detected concentrations of TPH-e and other petroleum-related constituents (that is, VOCs and semivolatile organic compounds [SVOC]) has not been conducted.

Although metals contamination was identified and delineated within the SBM Subarea during the RI, recent metallic anomaly removal activities conducted by WESTON have invalidated the previously defined surficial extent of metals contamination in a portion of the SBM Subarea.

Additionally, subsequent to the submission of the internal draft RI report (December 1999), several paint cans were detected beneath the ground surface in Subarea 3. During the removal of the paint cans, significant VOC contamination was detected and contaminated soil was excavated (Pit 4-M4). The extent of the remaining VOC contamination in soil and its potential migration to groundwater has not yet been delineated.

A4 PROJECT AND TASK DESCRIPTION

The following section summarizes the primary objectives and the tasks necessary to implement the additional sampling at IR04. The primary objectives, types of data to be collected, quality standards and criteria for those data, and project documentation are discussed in the following text. The DQO steps for the sampling are presented in Table A-2 of this QAPP. A general discussion of DQO steps is provided in Section A1.2 of this QAPP.

A4.1 PROJECT OBJECTIVE

The primary objectives of this investigation are to as follows:

1. Delineate the lateral and vertical extent of TPH-e contamination in soil resulting from historical abrasive-blasting and painting activities in the SBM Subarea (proposed sample locations are shown on Figure 2 of the FSAP in green [TtEMI and U&A 2000]) and to evaluate the possible correlation between TPH-e and SVOC and/or benzene, toluene, ethylbenzene, and xylene (BTEX) concentrations.

2. Reevaluate the extent of metals contamination in surface soil at the SBM Subarea (proposed sample locations are shown on Figure 2 of the FSAP in blue [TtEMI and U&A 2000]). Although the area had previously been characterized, reevaluation is necessary because of recent changes in topography resulting from metallic anomaly removal activities conducted by WESTON.

3. Delineate the lateral and vertical extent of VOC contamination in soil and groundwater associated with the buried paint cans at Pit 4-M4 in Subarea 3 (proposed sample locations are shown on Figure 2 of the FSAP in red [TtEMI and U&A 2000]).

4. Delineate the single VOC detection (in the Other IR04 Subarea) that was identified in the internal draft human health risk assessment (HHRA) as posing a potential human health concern (proposed sample locations are shown on Figure 2 of the FSAP in purple [TtEMI and U&A 2000]).

A4.2 PROJECT MEASUREMENTS

The steps to meet the objectives of the investigation are as follows:

1. To delineate the lateral and vertical extent of TPH-e contamination at the SBM Subarea and to evaluate the potential correlation between TPH-e and BTEX and/or SVOC concentrations at the site, 13 direct-push borings will be advanced. Seven of these borings will be installed in new locations, while six will be co-located with previous borings. A total of 48 soil samples will be collected from these borings and analyzed for TPH-e, SVOCs, and BTEX.

2. To characterize the extent of metals contamination in surface soil at the SBM Subarea subsequent to WESTON's removal activities, 22 hand auger borings and 10 direct-push borings will be advanced. A total of 52 soil samples will be collected from these borings and analyzed for CLP metals.

3. To delineate VOC contamination near the formerly buried paint cans (Pit 4-M4) in Subarea 3, four direct-push borings will be advanced. A total of 36 soil samples and 20 discrete-depth grab groundwater samples will be collected from these borings and analyzed for VOCs. Two soil samples collected from each boring will also be analyzed for total organic carbon (TOC) for purposes of future anticipated fate and transport modeling. Additionally, because of the proximity of one of the proposed borings (3-52, Figure 2 in FSAP [TtEMI and U&A 2000]) to the TPH-e contamination at the SBM Subarea, three soil samples from this boring (3-52, Figure 2 in FSAP [TtEMI and U&A 2000]) will additionally be analyzed for SVOCs and TPH-e to evalute the potential correlation between TPH-e, BTEX, and SVOC concentrations and to delineate the extent of TPH-e contamination at the SBM Subarea.

4. To delineate VOC contamination identified in the HHRA as posing a potential human health concern, three hand-auger borings will be advanced. A total of six soil samples will be collected from these borings and analyzed for VOCs.

A4.3 PROJECT QUALITY STANDARDS AND CRITERIA

To promote quality and consistency of data acquisition and evaluation during sampling, project activities will be conducted in accordance with this QAPP and the accompanying FSAP [TtEMI and U&A 2000]. This QAPP describes the project technical and quality objectives, the intended data collection methods for achieving project objectives, the assessment procedures to obtain data of the type and quality needed and expected, and any identified limitations on the use of the data.

Analytical data generated from this sampling will undergo validation and verification to ensure defensibility and acceptable quality. Data validation and usability are further discussed in Section D1 of this QAPP. Data will be validated in accordance with EPA Functional Guidelines (EPA 1994a, 1999b) by an independent third-party contractor. Analytical data will undergo cursory validation. At a minimum, 10 percent of the analytical data will be randomly selected and fully validated.

Assessment tools used to verify that data quality is maintained throughout the study activities include QC reviews on project documents, such as technical, editorial, and QC coordinator reviews; performance and system audits; and laboratory QA/QC procedures. Project audits are further described in Section C1.1 of this QAPP. Laboratory QA/QC procedures are addressed in Section B6 of this QAPP.

A4.4 PROJECT DOCUMENTATION

The following sections describe how field documentation and records are maintained. The sample handling and custody requirements for samples taken at MINS are also discussed in this section of the QAPP. Additional information on sample and location nomenclature is provided in Section 4.0 of the accompanying FSAP [TtEMI and U&A 2000]. Sample documentation including sample labels, chain-of-custody procedures and forms, and packaging and shipping is discussed in Section B3.2 of this QAPP and Section 7.0 of the FSAP (TtEMI and U&A 2000).

The following field forms will be maintained for field activities at MINS as appropriate:

- Chain-of-custody forms
- Descriptive logs of the stratigraphy and soil type for the soil borings.

The following general guidelines for maintaining field documentation will be used:

- Documentation will be completed in permanent black ink.
- Entries will be legible.
- Errors will be corrected by crossing out with a single line; the correction will be dated and initialed.
- Serialized documents, such as the daily site logs or the daily tailgate safety meetings form, will be maintained on site and referenced in the site logbook.

Field personnel will use bound field logbooks with sequentially numbered pages to maintain field records. The front cover of the logbook will list the contract name and number, the CTO number, the site name, names of subcontractors, the client, and the name of the project manager. At a minimum, the following information will be recorded daily in the field logbook:

- Name and affiliation of personnel or visitors on site
- Weather conditions during the field activity
- Log and summary of daily activities and significant events
- Notes of conversations with coordinating officials
- Identification numbers of instruments used
- Results of calibrations and field measurements

- Documentation of sampling activities
- Decontamination episodes
- Reference to other field logbooks or forms that contain specific information
- Discussion of problems encountered and their resolution
- Discussion of deviations from the FSAP, QAPP, or other governing documents
- Description of photographs taken

A5 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

The seven-step DQO process described by EPA (EPA 1994c) was used to develop quality objectives for this event (see Table A-2). The specific quality objectives and criteria for measurement data as they apply to additional sampling for IR04 are also discussed in the following sections.

A5.1 PROJECT SCOPE AND ENVIRONMENTAL MEDIA

Twenty-seven direct-push borings and 24 hand auger borings will be used to delineate the four areas of contamination at IR04. A maximum of 140 soil samples and 20 groundwater samples will be collected for laboratory analysis. (Note that these total numbers of samples do not include field QC samples). The exact location of the sampling points at each site may be modified during the field effort, based on field data obtained during the operation.

A5.2 INTENDED DATA USERS AND USES

Data users include stakeholders, such as regulatory agencies, the Navy and subcontractors to the Navy, and the general public. Data will be used to delineate TPH-e contamination, examine the correlation of TPH-e, BTEX, and SVOCs in site soils, characterize metals contamination in surficial soils, and delineate VOC contamination in soil and groundwater.

A5.3 DATA TYPE AND QUANTITY

Step 3 of the DQO process is to identify inputs to the decision. Samples will be analyzed for metals, VOCs (including BTEX), SVOCs, and TPH-e. The analytical results obtained from the samples will be used to support the delineation of contamination at IA F2.

The samples will be analyzed by using EPA-approved methodology by California-certified laboratories that have been approved by the Navy. QA/QC elements required for definitive data are as follows:

- Sample documentation (location, date and time collected, and batch)
- Chain-of-custody forms (when appropriate)
- Sampling design (systematic, simple or stratified random, or judgmental)
- Initial and continuing calibration
- Determination and documentation of detection limits
- Analyte identification
- Analyte qualification
- QC blanks (method and rinsate)
- Matrix spike (MS) recoveries
- Performance evaluation samples
- Matrix duplicate or determination of analytical error, when using two or more aliquots
- Field duplicates or determination of total measurement error

Determination of analytical error or the matrix duplicate measures precision of an analytical method. An appropriate number of replicate aliquots, as specified in this QAPP, are collected from at least one thoroughly homogenized sample. Standard laboratory QC parameters are calculated and compared to method-specific performance requirements defined in this QAPP. Field duplicates or determination of total measurement error provide a measure of the overall precision of the measurement system, from sample acquisition through analysis. Relative percent difference (RPD) values are calculated for each matrix under investigation.

QC samples are collected in addition to field samples and are used in conjunction with laboratory QC samples to evaluate the quality of the data produced from the field sampling program. QC samples serve DQO criteria by meeting the established acceptance criteria for the Contract Laboratory Program (CLP). QC samples that do not meet the criteria may serve as indicators of unacceptable data, resulting in the implementation of corrective action procedures or in the data being qualified. The specific requirements for field and laboratory QC are provided in Section B6 of this QAPP.

A5.4 ACCEPTABLE LEVEL OF CONFIDENCE IN THE DATA

Determining acceptable limits on decision errors (DQO Step 6) will limit the uncertainty in the data set obtained from this sampling. Optimizing the study design (DQO Step 7) was addressed in choosing

sample size for this project. The sample size represents the highest level of confidence that could be achieved, given the variability of existing data and the budget constraints for this investigation. A smaller sample population would result in decreased confidence in the data.

A5.5 SPECIFYING PERFORMANCE CRITERIA: PRECISION, ACCURACY, REPRESENTATIVENESS, COMPLETENESS, AND COMPARABILITY PARAMETERS

Analytical results will be assessed according to PARCC parameters as described as follows.

A5.5.1 Precision

Precision is the degree of mutual agreement between individual measurements of the same property under prescribed similar conditions. Data precision is a function of field sampling precision and laboratory analytical precision. It is evaluated by collecting and analyzing field duplicates at a frequency of 10 percent. Laboratory analytical precision is evaluated by analyzing laboratory duplicates at a rate of 5 percent of the total samples collected. The results of the duplicate analysis are used to calculate the RPD used for evaluating precision.

$$RPD = \frac{|A-B|}{(A+B)/2} \times 100\%$$

where:

A = first duplicate concentration

B = second duplicate concentration

The evaluation of field measurement precision will be based on the results of field duplicate measurements. Four factors may impair the precision of duplicate data: matrix interference, laboratory imprecision, sample heterogeneity, and the nature of the RPD calculation. Matrix interference is caused by chemical constituents present in the field sample that interfere with the accurate quantification of the target analytes. Laboratory imprecision is a result of laboratory inconsistency in the preparation and analysis of the samples. Heterogeneity of soil samples is inherent because of the heterogeneous nature of natural materials, and the subsequent difficulty in collecting a homogenous sample. In cases where the duplicate samples have extremely high or low concentrations of the target analyte, the RPD calculation may indicate high variances that do not reflect analytical precision. The data will be qualified as estimated in cases where the duplicates do not meet acceptance criteria and where matrix interference or laboratory imprecision is determined to be the cause.

The control limits for precision on field duplicates and laboratory MSs are set at 25 percent RPD for water samples and 35 percent RPD for soil samples. A greater variance between concentrations measured in duplicate samples is commonly associated with soil duplicate results because of the difficulty in collecting homogeneous field samples. These control limits are provided using professional judgment and are intended as guidelines for precision in the field and laboratory for definitive data.

A5.5.2 Accuracy

Accuracy is the degree of agreement between an analytical measurement and a reference accepted as a true value. The accuracy of a measurement system is affected by errors introduced through the sampling process by field contamination, sample preservation, sample handling, sample matrix, sample preparation, and analytical techniques. Evaluation of sampling accuracy will be based on the results of the analysis of field blanks, including trip and source-water blanks. A program of sample spiking will be conducted by the analytical laboratory to evaluate laboratory accuracy. This program includes analysis of the MS samples, laboratory control spikes (LCS) (blank spikes), and method blanks. MS samples are prepared and analyzed at a frequency of 5 percent. LCS samples are analyzed at a frequency of 5 percent. The results of the spiked samples are used to calculate the percent recovery for evaluating accuracy.

$$\text{Percent Recovery} = \frac{S-C}{T} \times 100\%$$

where:

S = Measured spike sample concentration

C = Sample concentration

T = True or actual concentration of the spike

Acceptable recoveries are summarized in Section B6.3.1. Results that fall outside of the acceptance range will be further evaluated on the basis of other QC samples.

A5.5.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, parameter variations at a sampling point, or an environmental condition that they are intended to represent. For this project, representative data will be obtained through careful selection of sampling sites and analytical parameters. Representative data will also be obtained through proper collection and handling of samples to avoid interference and minimize contamination.

Representativeness of data will be ensured through the use of established field and laboratory procedures and their consistent application. To aid in the evaluation of the representativeness of the sample, field and laboratory blank samples will be evaluated for the presence of contaminants. Data determined to be nonrepresentative through a comparison with the existing data will be used only if accompanied by appropriate qualifiers and limits of uncertainty.

A5.5.4 Completeness

Completeness is a measure of the percentage of project-specific data that are valid. Valid data are obtained when samples are collected and analyzed in accordance with QC procedures outlined in this QAPP and when none of the QC criteria that affect data usability are significantly exceeded. The project completeness value will be evaluated when data validation is completed. Completeness will be calculated by dividing the number of usable sample results by the total number of sample results for this sampling. The completeness goal for the additional sampling at IR04 is 90 percent.

A5.5.5 Comparability

The comparability objective assesses whether analytical conditions are sufficiently uniform for each analytical run to ensure that the reported data will be consistent. Uniformity requires adherence to specified analytical methods and to laboratory and field procedures. Comparability is ensured through the use of standard units of measurement in reporting of analytical data. Analytical techniques that will be used for this field investigation are comparable to techniques used by previous investigators at IR04.

A5.6 DETECTION AND QUANTITATION LIMITS

The instrument detection limit is the minimum concentration of an analyte that can be distinguished from the normal electronic noise of an analytical instrument. The quantitation limit represents the lowest concentration at which an analyte can be accurately and reproducibly quantified and accounts for sample preparation and matrix effects. Contract-required detection limits (CRDL) and contract-required quantitation limits (CRQL) are the minimum detection or quantitation limits that are contractually required for analyses performed using CLP methods.

For this project, samples analyzed for metals using the CLP inorganic statement of work (SOW) (EPA 1995) will be reported as estimated values if concentrations are less than CRDLs but greater than instrument detection limits (IDL). The IDL for each analyte will be given as the detection limit in the laboratory's electronic data deliverable (EDD); otherwise, the statistical evaluations may be biased by high-value nondetect results if the CRDL is reported as the detection limit.

The CRDLs for low-level CLP metals in soil are listed in Table A-4. The CRDL values are listed as guidance because matrix effects or interferences that cannot be anticipated may render these levels unachievable.

The CRQLs for CLP VOCs and low-level CLP VOCs in groundwater and soil, ecological comparison criteria for groundwater, and benchmark toxicity values for soil are listed in Table A-5.

The CRQLs for CLP SVOCs and low-level CLP SVOCs in groundwater and soil, ecological comparison criteria for groundwater, and benchmark toxicity values for soil are listed in Table A-6.

The CRQLs for TPH-e in groundwater and soil, ecological comparison criteria for groundwater, and benchmark toxicity values for soil are listed in Table A-7. Table A-8 presents the CRDLs for TOC and moisture measurements; there are no comparison criteria for these parameters at IR04.

A6 DOCUMENTATION AND RECORDS

Documentation is critical for evaluating the success of activities. The following sections discuss the requirements of laboratories for preparing definitive data packages.

A6.1 SUMMARY DATA PACKAGE

CLP and CLP-type summary data packages will be required for all analyses and will contain sample results (Form I) and all QA/QC summary forms (Forms II through X for organic compounds and Forms II through XIV for inorganic compounds) for all associated samples in a sample delivery group (SDG). Form I will include all sample results, corrected for dilution and soil moisture, as appropriate. If the client sample identification (ID) has been truncated because of software limitations, the complete sample ID will appear on Form I, either in the comments section or hand-printed after the truncated ID.

An SDG is a group of 20 or fewer samples for the same project, received over a period of 14 days or less. An SDG is mainly a reporting format and is not limited to sample receipt groups, preparation batches, or analytical batches. The SDG name will be a unique number that is not an actual sample ID or a part of an actual sample ID. Data for all samples in the SDG will be submitted concurrently by the laboratory. Partial submittals are unacceptable. The laboratory will provide TtEMI with two copies of the summary data package within 35 days after receiving the last sample in the SDG. This package will be part of the standard analytical service.

The laboratory will prepare summary data packages in accordance with instructions provided in Section II.D, Exhibit B, in the CLP SOW for organic analysis and inorganic analysis (EPA 1994b, 1995). For ease of use, summary data packages should not be bound and should be separated by analysis. The summary data package will consist of a case narrative, copies of all associated chain-of-custody forms, sample results, and QA/QC summaries. The case narrative will include the following information:

- Subcontractor name, project name, CTO (project) number, project order number, SDG number, and a table that cross-references client and laboratory sample IDs
- Detailed documentation of all sample shipping and receiving, preparation, analytical, and quality deficiencies, including analyses performed without an A2LA-certified standard
- Copies of all associated nonconformance and corrective action forms that will describe the nature of the deficiency and the corrective action taken
- Copies of all associated sample receipt notices

A6.1.1 Organic Analysis

The following outline describes the format of the summary data package for organic analysis:

Section I **Case Narrative**

1. Case narrative
2. Copies of nonconformance and corrective action forms
3. Chain-of-custody forms
4. Copies of sample receipt notices
5. Internal tracking documents, as applicable

Section II **Sample Results** - Form I for the following:

1. Environmental samples, including dilutions and re-analysis
2. Tentatively identified compounds (TIC) for VOCs and SVOCs

Section III **QA/QC Summaries** - Forms II through XI for the following:

1. System monitoring compound and surrogate recoveries (Form II)
2. MS and matrix spike duplicates (MSD) recoveries and RPD (forms I and III)
3. Blank spike or LCS recoveries (forms I and III-Z)
4. Method blanks (forms I and IV)
5. Performance check (Form V)
6. Initial calibrations with retention time information (Form VI)
7. Continuing calibrations with retention time information (Form VII)
8. Quantitation limit standard (Form VII-Z)
9. Internal standard areas and retention times (Form VIII)
10. Analytical sequence (forms VIII-D and VIII-Z)
11. Gel permeation chromatography (GPC) calibration (Form IX)
12. Single component analyte identification (Form X)
13. Multicomponent analyte identification (Form X-Z)
14. Matrix-specific method detection limit (MDL) (Form XI-Z)

TABLE A-4

METALS IN SOIL, LOW-LEVEL ANALYSES CONTRACT-REQUIRED DETECTION LIMITS AND TOXICITY BENCHMARK VALUES INVESTIGATION AREA F2 INSTALLATION RESTORATION SITE 04 MARE ISLAND, CALIFORNIA

Analyte	Soil[a] CRDL (mg/kg)	Plant Toxicity Benchmark (mg/kg)	Earthworm Toxicity Benchmark (mg/kg)	PRG or Group II/III Comparison Value (mg/kg)
Aluminum	10	--	--	75,000
Antimony	1.2	5	--	30
Arsenic	2.0	--	--	0.38[b]
Barium	40	500	--	5,200
Beryllium	0.8	10	--	120
Cadmium	1.0	4	20	9
Calcium	1,050	--	--	NP
Chromium	2.0	1	0.4	77,000
Cobalt	10	20	--	3,300
Copper	0.8	100	50	2,800
Iron	20	--	--	22,000
Lead	1.0	50	500	242
Magnesium	1,000	--	--	NP
Manganese	3.0	500	--	3,100
Mercury	0.1	0.3	0.1	22
Molybdenum	1.0	2	--	370
Nickel	1.6	30	200	150
Potassium	1,000	--	--	NP
Selenium	1.0	1	70	370
Silver	0.4	2	--	370
Sodium	1,000	--	--	NP
Thallium	0.4	--	--	5.2
Vanadium	10	2	--	520
Zinc	4.0	50	200	22,000

Notes:

a Quantitation limits listed for soil analysis are based on dry weight.

b The CRDL (reporting limit) is greater than the comparison criterion. On an individual analyte basis, the laboratory will be asked to provide a project-required reporting limit (PRRL) lower than the CRDL and the comparison criterion for the analyte. The target levels for any PRRLs will be specified during the procurement process and will be set in conjunction with the laboratory. If a laboratory capable of achieving a sufficiently low PRRL cannot be procured, an explanation will be provided in the RI report. If matrix effects interfere with the laboratory's ability to achieve a selected PRRL, an explanation will also be provided in the RI report and supported by the laboratory report.

CRDL Contract-required detection limit

mg/kg Milligrams per kilogram

NP No PRG has been established

PRG U.S. Environmental Protection Agency Region IX residential soil PRG (EPA 1998).

-- Toxicity Benchmark has not been established.

Comparison-level references:

RWQCB 1998a

Efroymson and others 1997a

Efroymson and others 1997b

PRC 1997

TABLE A-5

LOW-LEVEL VOLATILE ORGANIC COMPOUNDS CONTRACT-REQUIRED QUANTITATION LIMITS AND ECOLOGICAL COMPARISON LEVELS INVESTIGATION AREA F2 INSTALLATION RESTORATION SITE 04 MARE ISLAND, CALIFORNIA

Volatiles	Water CRQL (µg/L)	Ecological Water Quality Criteria (µg/L)	Soil[a] CRQL (µg/kg)	Soil Toxicity Benchmark, (µg/kg)	PRG or Group II/III Comparison Value (µg/kg)
Chloromethane	2	6,400	10	--	1,200
Bromomethane	2	6,400	10	--	3,800
Vinyl Chloride	2	--	10	--	21
Chloroethane	0.5	--	10	--	NP
Methylene Chloride	2	6,400	10	--	8,500
Acetone	2	--	10	--	1,400,000
Carbon Disulfide	2	--	10	--	350,000
1,1-Dichloroethene	2	1,600	10	--	52
1,1-Dichloroethane	2	--	10	--	570,000
1,2-Dichloroethene	2	1,600	10	--	42,000
Chloroform	2	1,240	10	--	240
1,2-Dichloroethane	0.5	20,000	10	--	340
2-Butanone	2	--	10	--	NP
1,1,1-Trichloroethane	2	1,800	10	--	680,000
Carbon Tetrachloride	0.5	6,400	10	--	230
Bromodichloromethane	2	6,400	10	--	980
1,2-Dichloropropane	2	3,040	10	--	340
cis-1,3-Dichloropropene	0.5	244	10	--	81
Trichloroethene	2	200	10	--	2,700
Dibromochloromethane	2	6,400	10	--	5,300
1,1,2-Trichloroethane	2	9,400	10	--	820
Benzene	0.5	510	10	--	620
trans-1,3-Dichloropropene	0.5	244	10	--	81
Bromoform	2	6,400	10	--	56,000
4-Methyl-2-pentanone	2	--	10	--	NP
2-Hexanone	2	438	10	--	NP
Tetrachloroethene	2	450	10	--	4,700
Toluene	2	5,000	10	--	520,000

TABLE A-5 (Continued)

LOW-LEVEL VOLATILE ORGANIC COMPOUNDS CONTRACT-REQUIRED QUANTITATION LIMITS AND ECOLOGICAL SCREENING LEVELS INVESTIGATION AREA F2 INSTALLATION RESTORATION SITE 04 MARE ISLAND, CALIFORNIA

Volatiles	Water CRQL (µg/L)	Ecological Water Quality Criteria (µg/L)	Soil[a] CRQL (µg/kg)	Soil Toxicity Benchmark, (µg/kg)	PRG or Group II/III Comparison Value (µg/kg)
1,1,2,2-Tetrachloroethane	2	2,400	10	--	360
Chlorobenzene	2	129	10	--	54,000
Ethylbenzene	2	43	10	--	230,000
Styrene	2	--	10	--	1,700,000
Total Xylenes	2	--	10	--	210,000

Notes:

a Quantitation limits for soil analysis based on wet weight. Quantitation limits reported by the laboratory for soil calculated on dry weight basis, as required by the contract, will be higher.

CRQL Contract-required quantitation limit

NP No PRG has been established

PRG U.S. Environmental Protection Agency (EPA) Region IX residential soil preliminary remediation goal (EPA 1998).

µg/kg Micrograms per kilogram

µg/L Micrograms per liter

Comparison-level references:

RWQCB 1998a

PRC 1997

TABLE A-6

SEMIVOLATILE ORGANIC COMPOUNDS CONTRACT-REQUIRED QUANTITATION LIMITS AND ECOLOGICAL COMPARISON LEVELS INVESTIGATION AREA F2 INSTALLATION RESTORATION SITE 04 MARE ISLAND, CALIFORNIA

Semivolatiles	Soil[a] CRQL (µg/kg)	Soil Toxicity Benchmark, (µg/kg)	PRG or Group II/III Comparison Value (µg/kg)
Phenol	330	70,000/30,000[b]	33,000,000
bis(2-Chloroethyl)ether	330	--	180[c]
2-Chlorophenol	330	--	59,000
1,3-Dichlorobenzene	160	--	41,000
1,4-Dichlorobenzene	160	--	3,000
1,2-Dichlorobenzene	160	--	370,000
2-Methylphenol	330	--	2,700,000
2,2'-oxybis(1-Chloropropane)	330	--	NP
4-Methylphenol	330	--	270,000
n-Nitroso-di-n-propylamine	330	--	63[c]
Hexachloroethane	330	--	32,000
Nitrobenzene	330	--	16,000
Isophorone	330	--	470,000
2-Nitrophenol	330	--	NP
2,4-Dimethylphenol	330	--	1,100,000
bis(2-Chloroethoxy)methane	330	--	NP
2,4-Dichlorophenol	330	--	160,000
1,2,4-Trichlorobenzene	330	--	480,000
Naphthalene	330	--	55,000
4-Chloroaniline	330	--	220,000
Hexachlorobutadiene	330	--	5,700
4-Chloro-3-methylphenol	330	--	NP
2-Methylnaphthalene	330	--	NP
Hexachlorocyclopentadiene	330	--	380,000
2,4,6-Trichlorophenol	330	--	40,000
2,4,5-Trichlorophenol	800	--	5,500,000
2-Chloronaphthalene	330	--	NP
2-Nitroaniline	800	--	3,300
Dimethylphthalate	330	--	1.0E+08

TABLE A-6 (Continued)

SEMIVOLATILE ORGANIC COMPOUNDS
CONTRACT-REQUIRED QUANTITATION LIMITS
AND ECOLOGICAL COMPARISON LEVELS
INVESTIGATION AREA F2
INSTALLATION RESTORATION SITE 04
MARE ISLAND, CALIFORNIA

Semivolatiles	Soil[a] CRQL (µg/kg)	Soil Toxicity Benchmark, (µg/kg)	PRG or Group II/III Comparison Value (µg/kg)
Acenaphthylene	330	--	NP
2,6-Dinitrotoluene	330	--	55,000
3-Nitroaniline	800	--	NP
Acenaphthene	330	--	2,600,000
2,4-Dinitrophenol	800	--	110,000
4-Nitrophenol	800	--	3,400,000
Dibenzofuran	330	--	210,000
2,4-Dinitrotoluene	330	--	110,000
Diethylphthalate	330	--	4.4E+07
4-Chlorophenyl phenyl ether	330	--	NP
Fluorene	330	--	1,800,000
4-Nitroaniline	800	--	NP
4,6-Dinitro-2-methylphenol	800	--	NP
n-Nitrosodiphenylamine	330	--	91,000
4-Bromophenyl phenyl ether	330	--	NP
Hexachlorobenzene	330	--	280[c]
Pentachlorophenol	800	--	2,500
Phenanthrene	330	--	NP
Anthracene	330	--	14,000,000
Carbazole	330	--	22,000
Di-n-butylphthalate	330	--	NP
Fluoranthene	330	--	2,000,000
Pyrene	330	--	1,500,000
Butylbenzylphthalate	330	--	930,000
3,3'-Dichlorobenzidine	330	--	990
Benzo(a)anthracene	330	--	560
Chrysene	330	--	6,100
bis(2-Ethylhexyl)phthalate	130	--	32,000
Di-n-octylphthalate	330	--	NP

TABLE A-6 (Continued)

SEMIVOLATILE ORGANIC COMPOUNDS CONTRACT-REQUIRED QUANTITATION LIMITS AND ECOLOGICAL COMPARISON LEVELS INVESTIGATION AREA F2 INSTALLATION RESTORATION SITE 04 MARE ISLAND, CALIFORNIA

Semivolatiles	Soil[a] CRQL (µg/kg)	Soil Toxicity Benchmark, (µg/kg)	PRG or Group II/III Comparison Value (µg/kg)
Benzo(b)fluoranthene	330	--	560
Benzo(k)fluoranthene	330	--	610
Benzo(a)pyrene	330	--	56[c]
Indeno(1,2,3-cd)pyrene	330	--	560
Dibenzo(a,h)anthracene	330	--	56[c]
Benzo(g,h,i)perylene	330	--	NP

Notes:

a Quantitation limits listed for soil analysis are based on wet weight. The quantitation limits reported by the laboratory for soil and other solid matrices, calculated on dry-weight basis as required by the contract, will be higher.

b Plant Toxicity Benchmark of 70,000 µg/kg. Earthwork Toxicity Benchmark of 30,000 µg/kg.

c Detection limit is greater than comparison criterion. An attempt to negotiate a CRDL which is lower than the comparison criterion will be made on an individual analyte basis with the laboratory. If a lower CRDL is not negotiated, it will be indicated in the report.

-- Ecological Comparison Criterion or Toxicity Benchmark has not been established.

CRQL Contract-required quantitation limit

NP No PRG has been established

PRG U.S. Environmental Protection Agency (EPA) Region IX residential soil preliminary remediation goal (EPA 1998).

µg/kg Micrograms per kilogram

µg/L Micrograms per liter

Comparison-level references:

RWQCB 1998a

Efroymson and others 1997a

Efroymson and others 1997b

PRC 1997

TABLE A-7

TOTAL PETROLEUM HYDROCARBON EXTRACTABLES ANALYSES CONTRACT-REQUIRED QUANTITATION LIMITS AND ECOLOGICAL COMPARISON LEVELS INVESTIGATION AREA F2 INSTALLATION RESTORATION SITE 04 MARE ISLAND, CALIFORNIA

Analyte	Soil[a] CRQL (mg/kg)	Soil Toxicity Benchmark, (mg/kg)	PRG or Group II/III Comparison Value (mg/kg)
TPH-e	10	--	400

Notes:

a Quantitation Limits listed for soil are based on wet weight. The quantitation limits reported by the laboratory or soil and other solid matrices, calculated on a dry weight basis as required by the contract, will be higher.

CRQL Contract-required quantitation limit.
mg/kg Milligrams per kilogram
PRG U.S. Environmental Protection Agency (EPA) Region IX residential soil preliminary remediation goal (EPA 1998).
TPH-e Total petroleum hydrocarbon extractables
-- Toxicity Benchmark has not been established.

Comparison-level references:

PRC 1997.

TABLE A-8

MISCELLANEOUS ANALYSES
CONTRACT-REQUIRED DETECTION LIMITS
INVESTIGATION AREA F2
INSTALLATION RESTORATION SITE 04
MARE ISLAND, CALIFORNIA

Analyte	Soil CRDL	Water CRDL
TOC (See Appendix for method)	0.1 percent	NA
Percent Moisture (EPA CLP SOW)	0.1 percent	NA

Notes:

EPA U.S. Environmental Protection Agency Method
CRDL Contract-required detection limit
TOC Total organic carbon
SOW Statement of work

A6.1.2 Inorganic Analysis

The following outline describes the format of the summary data package for inorganic analysis:

Section I **Case Narrative**

1. Case narrative
2. Copies of nonconformance and corrective action forms
3. Chain-of-custody forms
4. Copies of sample receipt notices
5. Internal tracking documents, as applicable

Section II **Sample Results - Form I for the following:**

1. Environmental sample including dilutions and re-analysis

Section III **QA/QC Summaries** - Forms II through XIV for the following:

1. Initial and continuing calibration verifications (Form II)
2. CRDL standard (Form II)
3. Detection limit standard (Form II-Z)
4. Method blanks, continuing calibration blanks, and preparation blanks (Form III)
5. Inductively coupled plasma (ICP) interference-check samples (Form IV)
6. MS and postdigestion spikes (forms V and V-Z)
7. Sample duplicates (Form VI)
8. LCSs (Form VII)
9. Method of standard additions (Form VIII)
10. ICP serial dilution (Form IX)
11. IDL (Form X)
12. ICP inter element correction factors (Form XI)
13. ICP linear working range (Form XII)

A6.2 FULL DATA PACKAGE

Full data packages will contain the information from the summary data package and associated raw data for the samples in one SDG. When a full data package is required, the laboratory will provide TtEMI with as many as two copies of the full data package within 35 days after receiving the last sample in the SDG. Unless otherwise requested, the laboratory will deliver one copy of the full data package. For ease of use, the full data packages should be separated by analysis and should not be bound. The full data package will consist of a case narrative, copies of associated chain-of-custody records, sample results, QA/QC summaries, and associated raw data.

A6.2.1 Organic Analysis

The following outline describes the format of the full data package for organic analysis:

Sections I, II, and III **Summary Package**

Section IV **Sample Raw Data** - indicated form, plus all associated raw data

1. Analytical results, including dilutions and re-analysis (forms I and X)
2. TICs (Form I, VOC and SVOC only)

Section V **QC Raw Data** - indicated form, plus all associated raw data

1. Method blanks (Form I)
2. MS and MSD samples (Form I)
3. Blank spikes or LCSs (Form I)

Section VI **Standard Raw Data** - indicated form, plus all associated raw data

1. Performance check (Form V)
2. Initial calibrations, with retention-time information (Form VI)
3. Continuing calibrations, with retention-time information (Form VII)
4. Quantitation-limit standard (Form VII-Z)
5. GPC calibration (Form IX)

Section VII **Other Raw Data**

1. Percent moisture for soil samples
2. Sample extraction and cleanup logs
3. Instrument analysis log for each instrument used (Form VIII-Z)
4. Standard preparation logs, including initial and final concentrations for each standard used
5. Formula and a sample calculation for the initial calibration
6. Formula and a sample calculation for soil sample results

A6.2.2 Inorganic Analysis

The following outline describes the format of the full data package for inorganic analysis:

Sections I, II, III **Summary Package**

Section IV **Instrument Raw Data** - Sequential measurement readout records for ICP, graphite furnace atomic absorption (GFAA), flame atomic absorption (FAA), cold vapor mercury, cyanide, and other inorganic analyses, which will contain the following information:

1. Environmental samples, including dilutions and re-analysis
2. Initial calibration
3. Initial and continuing calibration verifications
4. Detection limit standards
5. Method blanks, continuing calibration blanks, and preparation blanks
6. ICP interference check samples
7. MS and postdigestion spikes
8. Sample duplicates
9. LCSs
10. Method of standard additions
11. ICP serial dilution

Section V **Other Raw Data**

1. Percent moisture for soil samples
2. Sample digestion, distillation, and preparation logs, as necessary
3. Instrument analysis log for each instrument used
4. Standard preparation logs, including initial and final concentrations for each standard used

5. Formula and a sample calculation for the initial calibration
6. Formula and a sample calculation for soil sample results

Full data packages will contain the information from the summary data package and associated raw data for the samples in one SDG. When a full data package is required, the subcontractor will provide TtEMI with as many as two copies of the full data package within 35 days after receiving the last sample in the SDG. Unless otherwise requested, the subcontractor will deliver one copy of the full data package. For ease of use, the full data packages should be separated by analysis and should not be bound. The full data package will consist of a case narrative, copies of associated chain-of-custody records, sample results, QA/QC summaries, and associated raw data.

A6.3 ELECTRONIC DATA DELIVERABLE FORMAT

EDDs are required for IR04 analytical results. An automated laboratory information management system (LIMS) must be used to produce the EDD. Manual creation of the deliverable (data entry by hand) is unacceptable. The laboratory will verify EDDs internally before they are issued. The EDD will correspond exactly to the hard-copy data. No duplicate data will be submitted. EDDs will be delivered in a format compatible with the Navy Environmental Data Transfer Standards (NEDTS).

- Results that should be included in the EDDs are as follows:
- Target analyte results for each sample and associated analytical methods requested on the chain-of-custody form
- Method and instrument blanks and preparation and calibration blank results reported for the SDG
- Percent recoveries for the spike compounds in the MS samples and blank spikes (that is, LCS)
- Matrix duplicate results reported for the SDG form
- The percent moisture or the percent solids for each solid sample; this determination will be made once for each solid sample listed on the chain-of-custody form. The results for these determinations will be reported in the same manner as for the other target analyte results
- Reanalysis, reextractions or dilutions reported for the SDG, including those associated with samples and the specified laboratory QC samples

Electronic and hard-copy data must be retained for a minimum of 3 and 10 years, respectively, after final data have been submitted. The laboratory will use a magnetic tape storage device or other similar storage

device that is capable of recording data for long-term, off-line storage. Raw data will be retained on magnetic tape.

A6.4 DATA ARCHIVAL AND RETRIEVAL

Field and analytical data collected from this project and other environmental investigations are critical to site characterization efforts, comprehensive conceptual model development, risk assessments, and the selection of remedial actions to protect human health and the environment. An information management system is needed to ensure efficient access to these data so that the goals of real-time decision-making can be achieved. This section describes the strategy to achieve data management goals.

To satisfy data management goals, the data will be loaded into the database system at TtEMI for storage, further manipulation, and retrieval after review and validation of the off-site laboratory and field reports. The database will be used to provide data for chemical and geologic analysis and for preparing reports and graphic representations of the data. Additional data acquired from field activities will be recorded on field forms. These forms are reviewed for completeness and accuracy by the analytical coordinator or geologist. Field forms and related chain-of-custody forms are recorded in the database. Hard copies of forms, data, and chain-of-custody forms are filed in a secure storage area, according to project and document control numbers. Laboratory data packages and reports will be archived at TtEMI or Navy offices. The remaining data will be archived at the off-site laboratory for a minimum of 10 years.

B1 MEASUREMENT AND DATA ACQUISITION

This section describes the requirements for the following:

- Sampling design (Section B2)
- Sampling method requirements (Section B3)
- Collection, handling, and analysis of samples (Section B4, B5)
- QC samples and procedures (Section B6)
- Instrument calibration and maintenance (Section B7)
- Analytical supplies and miscellaneous equipment (B8)

The purpose of this section is to provide sufficient detail to evaluate whether the methods used for this project have been verified and documented.

B2 SAMPLING DESIGN (EXPERIMENTAL DESIGN)

This section contains the following information:

- Types of samples required
- A description of the sampling network design
- Sampling frequencies and matrices
- Measurement parameters of interest
- Design rationale

The DQOs for this sampling are to obtain data of known quality. Sampling and analysis will be conducted in accordance with this document, the approved FSAP, and the HSP. Samples will be collected at locations selected to provide data that can be used to delineate the extent of contamination. The resulting data will support the evaluation of ecological risk levels. Samples will be analyzed by a California-certified and Naval Facilities Engineering Services Center (NFESC)-approved laboratory. The analytical program and analytical methods are presented in Table B-1 and Table B-2, respectively.

TABLE B-1

ANALYTICAL PROGRAM
INVESTIGATION AREA F2
INSTALLATION RESTORATION SITE 04
MARE ISLAND, CALIFORNIA

		Analytical Parameters							
		TPH-e		VOCs		SVOCs		Metals	TOC
Subarea	**Total Borings**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**S**
SBM	• 7 new direct-push borings • 6 direct-push borings collocated with prior borings	30 18	--	30 18	--	30 18	--	--	--
Greensand Disturbance	• 22 hand auger • 10 direct push	--	--	--	--	--	--	22 30	--
Pit 4-M4 (Subarea 3)	4 direct push	3	--	36	20	3	--	--	8
HHRA Concern	3 hand auger	--	--	6	--	--	--	--	--
Pit 4-M4 Monitoring wells	3 wells	--	--	--	--	--	--	--	--
Subtotals	**55**	**51**	**0**	**90**	**20**	**51**	**0**	**52**	**8**
Equipment Rinsate	--	--	5	--	10	--	6	7	--
Source Blank	--	--	1	--	2	--	1	1	--
Field Duplicates	--	--	--	--	2	--	--	--	--
MS/MSD		3	--	5	1	3	--	3	--
Trip Blank	--	--	--	--	10	--	--	--	--
TOTAL	**55**	**54**	**6**	**126**	**50**	**54**	**7**	**63**	**8**

Notes:

HHRA	Human health risk assessment
TPH-e	Total petroleum hydrocarbon extractables per the California leaking underground fuel tank manual (State of California 1989).
TOC	Total organic carbon (see Appendix for method)
VOCs	Contract Laboratory Program (CLP) Method for volatile organic compounds
SVOCs	CLP Method for semivolatile organic compounds
Metals	CLP Method for metals
MS/MSD	Matrix spike and matrix spike duplicate samples
S	Soil
SBM	Sandblast Material
W	Water
--	Not applicable

TABLE B-2

ANALYTICAL METHODS
INVESTIGATION AREA F2
INSTALLATION RESTORATION SITE 04
MARE ISLAND, CALIFORNIA

Parameter		Analytical Method	Reference
Chemical Analysis	TPH-e	CA LUFT/EPA 8015B	LUFT Field Manual (State of California 1989)
Inorganic Analysis	Metals	SW-846 6010B	SW-846 (EPA 1996)
CLP Chemical Analysis	Low-level VOCs	CLP*	CLP SOW for Organic Analysis (EPA 1994b)
	Low-level SVOCs	CLP	CLP SOW for Organic Analysis (EPA 1994b)
	CLP metals and low-level CLP metals	CLP ICPES, ICP-MS, GFAA, CVAA	CLP SOW for Inorganic Analysis (EPA 1995)
Physical Analyses	Percent moisture	CLP Method	CLP SOW for Inorganic Analysis (EPA 1995)
	TOC	See Appendix	See Appendix

Notes:

*VOCs will be analyzed using the CLP method in order to obtain data which is comparable and consistent with data collected during previous sampling events

CA LUFT	California LUFT field manual (State of California 1989)
CLP	Contract Laboratory Program
CVAA	Cold vapor atomic absorption
EPA	U.S. Environmental Protection Agency
GFAA	Graphite furnace atomic absorption
ICPES	Inductively coupled plasma emission spectroscopy
ICP-MS	Inductively coupled plasma mass spectroscopy
LUFT	Leaking underground fuel tank
SOW	Statement of work
SVOC	Semivolatile organic compound
TPH-e	Total petroleum hydrocarbon extractables
TOC	Total organic carbon
VOC	Volatile organic compound

B3 SAMPLING METHOD REQUIREMENTS

The purpose of this discussion is to describe the procedures for collecting samples and includes the following:

- Identification of the sampling methods to be used
- Implementation requirements
- Decontamination procedures
- Materials required

B3.1 SAMPLE COLLECTION, PREPARATION, AND DECONTAMINATION

Sampling methods are discussed in detail in the FSAP (TtEMI and U&A2000). Decontamination procedures are discussed in Section 3.9 of the FSAP.

B3.2 SAMPLING CONTAINERS, PRESERVATION, AND HOLDING TIMES

The type of sample containers to be used for each analysis, sample volumes required, preservation requirements for the samples, and the maximum holding times for sample extraction and analysis are included in Table 3 of the FSAP [TtEMI and U&A 2000].

B4 SAMPLE HANDLING AND CUSTODY PROCEDURES

Documentation and records, including field forms and field logbooks, are discussed in Section A4.4 of this QAPP. The following sections describe sample custody documentation and handling procedures to be followed while in the field, while transporting the sample to the laboratory, and at the laboratory for samples collected at IR04.

B4.1 FIELD FORMS

Field forms are discussed in Section A4.4 of this QAPP.

B4.2 SAMPLE CUSTODY PROCEDURES

Documentation during sampling activities is essential to ensure proper sample identification. Standard sample custody procedures will be used to maintain and document sample integrity during collection, transportation, storage, and analysis. Sample custody documents must be written in indelible black ink.

The documents will be corrected by drawing one line through the incorrect entry, entering the correct information, and initialing and dating the correction. A sample is considered to be in custody if at least one of the following statements applies:

- It is in a person's physical possession or view.
- It is in a secure area with restricted access.
- It is placed in a container and secured with an official seal such that the sample cannot be reached without breaking the seal.

Samples and documentation must be maintained in the custody of authorized personnel or under documented control in a secure area. The field team leaders are responsible for proper sample handling and documentation so that the possession and handling of individual samples can be traced from the time of collection to laboratory receipt. The laboratory QA manager is responsible for establishing a sample control system that will allow sample possession to be traced from laboratory receipt to final sample disposition.

B4.2.1 Sample Labels

A sample label will be affixed to each sample containers sent to the laboratory. This identification label will be completed with the following information written in indelible ink:

- Project name and location
- Sample location
- Sample identification number
- Date and time of sample collection
- Preservative used
- Sampler's name and initials
- Filtering (if applicable)
- Type of sample (grab or composite)
- Analysis required

If a sample is split with another party, sample labels with identical information will be attached to each sample container. After the label is attached, each sample will be refrigerated or placed in a cooler containing ice to maintain the sample at a temperature of 4 (+/- 2) °C.

B4.2.2 Custody Seals

Custody seals will be used on each sample transport container to ensure that no tampering occurs. Custody seals used during the course of the project will consist of security tape with the date and initials of the sampler or field team leader. Samples will be sealed in this manner immediately following collection. The tape will be placed such that the seal must be broken to gain access to the contents.

B4.2.3 Chain-of-Custody Records

Chain-of-custody procedures provide an accurate written record that traces the possession of individual samples from the time of collection in the field to the time of acceptance at the laboratory. The chain-of-custody record will also be used as a document of the samples collected and the analysis requested. The field personnel will record the following information on the chain-of-custody record:

- Project name and number
- Sample location
- Name and signature of sampler
- Destination of samples (laboratory name)
- Sample identification number
- Date and time of collection
- Number and type of containers filled
- Analysis requested
- Preservatives used
- Filtering (if applicable)
- Sample designation (grab or composite)
- Signatures of individuals involved in custody transfer (including date and time of transfer)
- Airbill number (if applicable)

Unused lines on the chain-of-custody record will be crossed out. Chain-of-custody records initiated in the field will be signed by the field personnel. The airbill number (if applicable) will be recorded, and the record will be placed in a plastic bag and taped to the inside of the shipping container used for sample transport. Signed airbills will serve as evidence of custody transfer between field personnel and the courier as well as between the courier and the laboratory. Copies of the chain-of-custody record and the airbill will be retained and filed by field personnel before shipment. Multiple coolers may be sent in one shipment to the laboratory. Each cooler will have a separate chain-of-custody record of the samples contained in it. The outside of the coolers will be marked to indicate the number of coolers in the shipment.

B4.2.4 Shipping Procedures

Samples collected during the field effort must be identified as environmental samples. Environmental samples are defined as samples of sediment, soil, water, or other matrices. U.S. Department of Transportation regulations will be followed during sample packaging and shipment. The following procedures meet these requirements and are explained in EPA guidance on field operations methods (EPA 1987):

- The cooler will be filled with bubble wrap, sample bottles, and packing material. Sufficient packing material will be used to prevent sample containers from making contact during shipment. Enough ice will be added to maintain the sample temperature at 4 °C.

- The chain-of-custody records will be placed inside a plastic bag. The bag will be sealed and taped to the inside of the cooler lid. The air bill, if required, will be filled out before the samples are handed over to the carrier. The laboratory will be notified if the sampler suspects that the sample contains a substance that would require laboratory personnel to take safety precautions.

- The cooler will be closed and taped shut with strapping tape around both ends. If the cooler has a drain, the drain will be taped shut both inside and outside of the cooler.

- Two signed custody seals will be placed on the cooler (one on the front and one on the back). Wide clear tape will be placed over the seals to prevent accidental breakage.

- If the samples are picked up by a laboratory courier, the chain-of-custody record will be transferred to the laboratory courier, who will sign the chain-of-custody record to document the transfer of samples. If the samples are shipped via an overnight carrier, such as Federal Express or United Postal Service, the airbill number will be entered on the chain-of-custody form sealed in the cooler.

Samples may be held on site for more than 3 days only during weekend field activities. Samples collected on the weekend will be stored under refrigeration and shipped on the following Monday. Samples for analytes with extremely short holding times, such as 24 hours, will be shipped out on the day of sampling. Collection of samples with extremely short holding times will not be scheduled for the weekend.

B4.2.5 Cooler Receipt

Upon receiving a cooler, laboratory personnel will review the contents as well as sign and retain the chain-of-custody record and the airbill. The following information will be recorded on the chain-of-custody record or another appropriate document at the time of sample receipt:

- Status of the custody seals
- Temperature of the cooler
- Identification number of any broken sample containers
- Description of discrepancies between the chain-of-custody records, sample labels, and requested analyses
- The pH of water samples upon receipt (pH of VOC water samples will be documented at the time of analysis)
- Storage location of the sample and sample extracts

Laboratory personnel will contact the analytical coordinator regarding discrepancies in paperwork and sample preservation. Nonconformances and corrective actions should be documented in accordance with laboratory SOPs. These procedures will be available on file at the laboratory. After samples have been accepted, checked, and logged in by the laboratory, they must be maintained in a manner consistent with the custody and security requirements specified in the laboratory QA plan.

Samples and sample extracts will be assigned to a specific refrigerator within the laboratory. Each laboratory refrigerator will be assigned a number, and the refrigerator number will be recorded on a document that references the sample and extract locations. Only laboratory personnel will have access to the samples and will be required to sign a log sheet when removing samples and extracts from the refrigerators or replacing them. These log sheets will provide a chain-of-custody record as the sample moves within the laboratory. A chain-of-custody record, similar to the chain-of-custody record used for

sampling procedures, will be completed for samples removed from the laboratory for disposal or other purposes.

B5 ANALYTICAL METHODS REQUIREMENTS

Table B-2 presents analytical methods that will be used to analyze samples collected at IR04. With approval from the SWDIV QA Officer, other EPA- and Navy-approved analytical methods may be selected if existing DQOs are met. A description of any modifications to the analytical methods presented in this section will be specified. The work plan will also be submitted for regulatory agency and SWDIV QA Officer review.

Laboratories will use CLP and other EPA-approved methodologies for which they have been certified by the California Department of Health Services through the Environmental Laboratory Accreditation Program and approved by the Navy. These methods include the methods presented in the EPA *Test Methods for Evaluating Solid Waste* (EPA 1996). The analytical, data reporting, and validation procedures will be carried out in accordance with the protocols documented in this QAPP.

Off-site laboratories will retain a staff that possesses analytical expertise in (1) organic and inorganic analyses, (2) QA/QC procedures, (3) production of CLP and CLP-type data packages, and (4) operation and maintenance of the LIMS. The off-site laboratory will have sufficient qualified personnel and appropriate analytical instrumentation available to technically and contractually carry out work required for IR04.

B5.1 OFF-SITE LABORATORY ANALYSIS

The off-site analytical program will include analyses of soil, groundwater, and QC-related water samples for the analytical methods summarized in Table B-2. Table 3 of the FSAP summarizes the holding times, containers, and preservation requirements [TtEMI and U&A 2000]. Samples will be subjected to analysis for one or more of the following groups of analytes, as specified in the FSAP:

- Modified CLP SVOC (low-level) (EPA 1994b)
- Modified CLP VOC (low-level) (EPA 1994b)
- Modified CLP metals (low-level) (EPA 1995)
- SW-846 Method 6010B metals (EPA 1996)
- Methods 9040A and 9045C pH (EPA 1996)

- California leaking underground fuel tank field manual (CA LUFT) (State of California 1989) and Method 8015B (EPA 1996) for TPH-e
- TOC (see appendix)
- Percent moisture as referenced in the CLP inorganic SOW (EPA 1995)

The following sections discuss the analyses to be performed.

B5.1.1 Statement of Work for Volatile Organic Compounds

CLP VOC is a purge-and-trap gas chromatography and mass spectrometry (GC/MS) method applicable to the determination of purgeable organic compounds in solid or aqueous samples (EPA 1994b). An inert gas is bubbled through a specially designed purging chamber at 40 °C for soil samples and at ambient temperatures for water samples. The GC instrument is temperature-programmed to separate the purgeables, which are then detected by the mass spectrometer. Target compound list (TCL) components are identified by mass spectra and retention time. The TCL components will be quantified in each sample matrix. In addition to the TCL components, library searches will be performed to identify the 30 highest concentration nontarget compounds in each sample. Table A-5 presents the TCL and CRQLs for this method.

Method modifications to routine CLP VOC analysis may be made to achieve lower quantitation limits or analyze for additional target compounds included in EPA Method 8260A TCL (EPA 1994b).

B5.1.2 Statement of Work for Semivolatile Organic Compounds

CLP SVOC analysis (OLM03.1) is a GC/MS method applicable to the determination of organic compounds that can be partitioned into an organic solvent and are amenable to GC analysis (EPA 1994b). A measured amount of sample is solvent-extracted using an appropriate extraction technique (EPA Method 3520B or 3550A). The extract is then dried and concentrated. Extract cleanup by GPC is performed, if required. The extract is then analyzed by GC/MS. The GC instrument is temperature-programmed to separate the extractables, which are then detected with a mass spectrometer. The mass spectra and retention times of components are used to identify the target analytes. In addition, library searches will be performed to identify the 30 highest concentration TICs. Table A-6 presents the TCL and CRQLs for this method.

B5.1.3 Modified Contract Laboratory Program for Semivolatile Organic Analysis

In order to meet comparison criteria, the following compounds are to be analyzed for using quantitation limits that are lower than the CLP CRQL: 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, and bis(2–ethylhexyl) phthalate.

For IR04, a modified CLP SVOC low-level analysis is used to measure the presence of SVOCs in solid samples (EPA 1994b). To meet comparison criteria, the extract volumes are to be modified to achieve a 10 times lower quantitation limit than the CLP CRQL.

B5.1.4 U.S. Environmental Protection Agency Method 8015B (modified) Total Petroleum Hydrocarbon Extractables

TPH-e analysis is applicable to the determination of semivolatile and nonvolatile petroleum products and fuels in soil, groundwater, and other matrices. The analysis is performed in accordance with the procedures specified in Appendix D of the CA LUFT field manual (State of California 1989) and by EPA in Method SW-846 8015B (EPA 1996). Method 8015B is a gas chromatograph and flame ionization detector (FID) method that is used to measure the presence of TPH-e fuels (i.e., diesel and motor oil range hydrocarbons) in solid and aqueous samples (EPA 1996). A measured amount of sample is solvent-extracted using the appropriate extraction technique (EPA Method 3510B, 3520B, or 3550A). The extract is dried, concentrated, and injected into a GC instrument that is temperature-programmed to separate the extractables and uses a FID to detect the analytes. Hydrocarbons detected at retention times between those of decane (containing 10 carbon atoms) and n-tricosane, as well as a pattern comparison to a diesel standard will be used to identify diesel-range hydrocarbons. Motor oil (consisting of hydrocarbons eluting at retention times after n-tricosane) and other unknown hydrocarbons may also be identified. The CRQLs for TPH-e are presented in Table A-7.

Because a fuel is a complex mixture of hydrocarbons, it produces a distinctive pattern that can be used to classify it as a specific fuel. If a fuel pattern from a sample matches a reference standard, the fuel is identified as a target fuel analyte. Chromatograms that appear to be fuels or motor oils but do not match any of the reference chromatograms for diesel or motor oil will be flagged with a "Y" qualifier and reported as "diesel range organic compounds" or "motor oil range organic compounds," depending on the reference pattern that most closely matches the chromatogram. For chromatograms that appear to be dominated by one or more single peaks that do not correspond to a fuel pattern or a petroleum compound, the unidentified peak results will be flagged with a "Z" qualifier and reported in the diesel or motor oil

range. Because such sample results are not considered to represent petroleum hydrocarbons, "Z" qualified data will not be reported in detected or statistical data tables; however, they will be reported in full data tables.

B5.1.5 Contract Laboratory Program Metal Analysis

Soil samples will be analyzed for metals (EPA 1995). Analyses will be performed in accordance with CLP procedures, and metal analytes on the target analyte list will be measured in the samples. Table A-4 presents the CRDL for metals. CLP metal analysis (ILM04.0) uses a variety of inorganic detection instrumentation to evaluate the presence of selected metals in solid samples (EPA 1995).

Specific metals are analyzed for as follows:

- CLP mercury analysis
  - Cold vapor atomic absorption (CVAA) technique is based on the absorption, by mercury vapor, of radiation at 258 nanometers. The mercury is reduced to the elemental state and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an atomic absorption spectrophotometer. Absorbance is measured as a function of mercury concentration.
- CLP arsenic, copper, lead, selenium, and thallium analysis
  - GFAA, in which absorbance is measured at a specific wavelength on an atomic absorption spectrophotometer as a function of metal concentration. GFAA allows the individual analysis of arsenic, lead, selenium, and thallium to provide lower detection limits. In the furnace, the sample is evaporated to dryness, charred, and atomized. A light beam from a hollow cathode lamp or an electrodeless discharge lamp is directed through the tube into a monochromator and onto a detector that measures the amount of light. Because the wavelength of a light beam is characteristic of a single metal, the light energy absorbed is a measure of that metal's concentration.
- CLP analysis for other metals
  - Inductively coupled plasma emission spectroscopy (ICPES), in which intensity is measured at a specific line-emission spectrum as a function of the concentration of the metal for which analysis is being performed. ICPES analysis allows the simultaneous, multielemental determination of metals. Element-specific atomic-line emission spectra are dispersed by a grating spectrometer, and the intensities of the lines are monitored by photomultiplier tubes. Depending on the ability to meet required reporting limits, ICPES may also used to analyze arsenic, copper, lead, selenium, and thallium.

Method modifications to the routine CLP metals analysis may be made to achieve lower quantitation limits or analyze individual metals. In addition, ICPES trace analysis and ICP-MS (mass spectroscopy)

may be used for the analysis of ICPES and GFAA target elements. The laboratory is to achieve the modified reporting limits discussed in the following text.

B5.1.6 Modified Contract Laboratory Program Metal Analysis

For IR04, a modified CLP metal low-level analysis is used to evaluate the presence of metals in solid samples (EPA 1995). To meet comparison criteria, the following compounds are to be analyzed using detection limits that are lower than the CLP contract required detection limit: aluminum, antimony, beryllium, cadmium, copper, lead, mercury, nickel, silver, and thallium.

B5.1.7 SW-846 Method 6010B Metal Analysis

To meet comparison criteria that cannot be met with CLP analysis, some metals may be analyzed by SW-846 method 6010B (EPA 1996). This method uses inductively coupled plasma-atomic emission spectrometry (ICP-AES) to determine trace metals.

The laboratory is to achieve the lowest reporting limits. If problems occur in achieving the required reporting limits, the TtEMI project chemist will be contacted immediately, and other alternatives will be pursued (such as analyzing an undiluted aliquot and allowing nontarget compound peaks to go off-scale) to achieve acceptable detection limits. In addition, results below the reporting limit but above the instrument detection limit will be reported with appropriate flags to indicate the greater uncertainty associated with such values. Method blanks must not contain target analytes at concentrations greater than one-fifth of the reporting limit.

B5.2 MISCELANEOUS METHODS

Soil from IR04 will also be analyzed for TOC. This parameter is not considered a contaminant but is included in the monitoring event to characterize the physical properties of the soil for the purpose of future anticipated fate and transport modeling.

B5.2.1 Total Organic Carbon Analysis

TOC shall be analyzed for in accordance with the SOP included in the appendix to this QAPP. This test measures TOC by using hydrochloric acid to remove carbonate and then combusting the sample to produce carbon dioxide. The carbon dioxide is measured with either (1) a tarred ascarite tube that is used

to trap the carbon dioxide or (2) an elemental analyzer that measures carbon dioxide using a thermal conductivity detector.

B5.2.2 Contract Laboratory Program Percent Moisture Analysis

CLP percent moisture (ILM04.0) is a gravimetric method used to evaluate the level of moisture in solid samples (EPA 1995). The solid sample is weighed while wet, dried, and weighed again. The resulting percent moisture is calculated based on the difference in the weights. The percent moisture shall be used to calculate soil results on a dry weight basis. Sample duplicate analysis shall be performed; no other laboratory QC samples shall be required. This analysis is intended only for soil analysis.

B6 QUALITY CONTROL REQUIREMENTS

The main functions of any sampling and analysis program are to obtain accurate, representative environmental samples and to provide valid analytical data. A program to evaluate field and laboratory data was developed to achieve these goals. Quality of the field data will be assessed through the collection and analysis of field QC samples on a regularly scheduled basis. Laboratory QC samples will also be analyzed in accordance with referenced analytical method protocols to ensure that laboratory procedures and analyses are conducted properly.

The following subsections discuss the types of QC samples collected and analyzed for this project and their role in the assurance of acceptable project data. QC procedures are not limited to those discussed in this section. Additional procedures are implemented by field and laboratory personnel in accordance with specific method protocols. The following subsections discuss field QC samples, field measurement QC procedures, laboratory QC samples, and laboratory QC procedures.

B6.1 FIELD QUALITY CONTROL SAMPLES

QC samples are collected in the field and used to evaluate the validity of the field sampling effort. Field QC samples are collected for laboratory analysis to check sampling and analytical precision, accuracy, and representativeness. The following section discusses the types and purposes of field QC samples that will be collected for this project. Table B-3 provides a summary of the types and frequency of collection of field QC samples.

TABLE B-3

FIELD QUALITY CONTROL SAMPLES
INVESTIGATION AREA F2
INSTALLATION RESTORATION SITE 04
MARE ISLAND, CALIFORNIA

Sample Type	Frequency of Analysis
Matrix duplicate	5 percent*
Field duplicates	10 percent of samples
Source water blank	1 per source per event for each analyte[b]
Equipment rinsate	1 per day per sampling equipment used

Notes:

a MS/MSD for soil samples will be selected by the laboratory.

b A sampling event is defined as the period of time during which sampling activities occur.

* water only

B6.1.1 Field Duplicate Samples

Field duplicate samples are replicate samples collected in the field and analyzed to provide a measure of the total variability introduced by sample matrix heterogeneity, field sampling techniques, and laboratory analytical methods. Field duplicate precision for water samples is evaluated by calculating the RPD only for target analytes detected in both field duplicate samples. Field duplicate samples will not be collected for soil samples.

B6.1.2 Field Blanks

Contamination can be introduced from many external sources during the collection of field samples. Two types of field blanks will be collected and analyzed in an attempt to discern these potential sources of contamination. Source water blanks and equipment rinsate blanks will be collected. The applicability of each of these blanks and the effect on the analytical data will be discussed in the following sections.

Results for field-blank samples should remain below the CRDL and CRQL for each analyte of interest. If a contaminant is present in the blank samples, associated field samples containing the same contaminant must be qualified as not detected if the concentration of the field sample is less than 5 times the concentration detected in the blank.

B6.1.2.1 Source-Water Blank

Source-water blanks consist of the water used as the final rinse water during the decontamination procedure. At a minimum, one source-water blank from each sampling event will be collected and analyzed for the same parameters as the samples collected during the event. A sampling event is defined as a period of time during which sampling activities occur.

B6.1.2.2 Equipment Rinsates

The equipment rinsate demonstrates whether the decontamination procedure is effective in removing the contaminants from field equipment used to collect samples. An equipment rinsate is a sample collected after a sampling device is subjected to standard decontamination procedures. Appropriate water for the intended analysis will be poured over or through the sampling equipment, reserved in a sample container, and sent to the laboratory for analysis. Analytically certified, organic-free, water will be used for organic parameters. Deionized or distilled water will be obtained from the laboratory for inorganic parameters.

The presence of contamination in the equipment rinsate indicates that the cleaning procedure for the field equipment is not effective, allowing for the possibility of cross-contamination. One equipment rinsate per sampling device will be collected on a daily basis and analyzed for the same parameters as the field samples collected on that day, not to exceed 5% of total number of project samples. The equipment rinsates will be sent to the laboratory on a blind basis. During the data validation process, the results of the equipment rinsate analyses will be used to qualify data or evaluate the levels of analytes in the field samples collected on the same day.

B.6.1.2.3 Trip Blanks

Trip blanks are used to identify possible sample contamination originating from sample transport, shipping, or site conditions. Trip blanks will be prepared in the off-site laboratory using organic-free water. They will then be shipped with the sample containers to the field, stored with the field samples, and returned to the off-site subcontract laboratory with the samples requiring VOC analysis. One trip blank will accompany each cooler containing water samples for VOC analysis and will only be analyzed for VOCs since they have the greatest potential for cross-contamination

B6.2 LABORATORY QUALITY CONTROL SAMPLES

Laboratory QC samples are analyzed to evaluate the quality of the preparation and analysis of field samples. Laboratory QC samples are also prepared and analyzed at the laboratory to assess analytical PARCC. The types of laboratory QC samples that will be used are discussed in the following sections and summarized in Table B-4.

B6.2.1 Method Blanks

Method blanks are prepared to evaluate whether contamination is originating from the reagents used in the analysis, handling, preparation, or analysis of the sample. They are critical in distinguishing between low-level field contamination and laboratory contamination. A method blank consists of laboratory organic-free water and each of the reagents used in the analytical procedure. It is prepared for each analysis in the same manner as a field sample and is processed through each of the analytical steps. Method blanks are prepared at the frequency prescribed in the individual method.

B6.2.2 Laboratory Duplicates

Laboratory duplicates consist of two separate aliquots taken from a single field sample and analyzed in an identical manner. They are used to evaluate analytical precision by calculating RPDs.

B6.2.3 Surrogates

Surrogates will be spiked into samples for organic analyses to evaluate whether significant matrix effects exist within the samples and to measure the efficiency of recovery of analytes in the sample preparation and analysis. The calculated percent recovery of the spike is used as a measure of the accuracy of the total analytical method. A surrogate spike sample is prepared by adding to each sample a known amount of pure compound similar to those that will be assayed in the sample. Surrogate compounds will be added to each sample before it is extracted or analyzed, as appropriate.

B6.2.4 Internal Standards

Internal standards are compounds that are added to every VOC and SVOC standard, method blank, LCS, MS/MSD, and sample or sample extract at a known concentration prior to instrument analysis. They are used as the basis for quantification of the target compounds. Internal standards ensure that GCMS sensitivity and response are stable during every analytical run. An internal standard is used to evaluate the efficiency of the sample introduction process and monitors the efficiency of the analytical procedure for each sample matrix encountered. Internal standards may also be used in the analysis of organic compounds by GC to monitor retention-time shifts. Validation of internal standards data will be based on EPA protocol presented in guidelines for evaluating organic analyses (EPA 1999b).

B6.2.5 Laboratory Control Samples or Blank Spikes

An LCS (or blank spike) originates in the laboratory as deionized or distilled water that has been spiked with standard reference materials of a known concentration. An LCS (or blank spike) is analyzed to verify the accuracy of the analytical system. LCSs and blank spikes are processed through the same analytical procedure as field samples. The LCS or blank spike is analyzed at the frequency prescribed in the individual method. If LCS or blank spike percent recovery results used to evaluate accuracy or RPD results used to evaluate precision are outside of the established acceptance limits, appropriate CLP and laboratory-specific protocols will be followed to evaluate the usability of the data.

TABLE B-4

INTERNAL QUALITY CONTROL PROCEDURES

Parameter	Analytical Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
TPH-e	CA LUFT / EPA Method 8015 mod.	Surrogates	With each sample	85 - 115% recovery	1. Evaluate system 2. Recalibrate as necessary 3. Reanalyze affected samples
		Multipoint calibration (minimum of 5 points)	Initially and as required	%RSD ≤ 20% or r ≤ 0.995	1. Evaluate system 2. Recalibrate as necessary
		Method blanks	After initial calibration	No target analytes present above half the PQL.	1. Reanalyze blank 2. Clean system 3. Reanalyze affected samples
		Continuing calibration check standard	Every 10 injections and at beginning and end of sequence	85 - 115% recovery	1. Evaluate system 2. Reanalyze standard 3. Recalibrate if necessary 4. Reanalyze affected samples
Non-CLP Type Physical Analysis (TOC)	See Appendix	Sample triplicate	Once per batch (maximum of 20 samples)	RPD ≤ 10 %	1. Evaluate system 2. Flag data if matrix effects are indicated.
		Method blanks	Once per batch (maximum of 20 samples)	No target analytes present above half the PQL.	1. Reanalyze blank 2. Clean system 3. Reanalyze affected samples
		Multipoint calibration (minimum of 2 points)	Daily for carbon analyzer	Method specific control limits.	1. Evaluate system 2. Recalibrate as necessary
Metals by ICPES, ICP-AES, ICP-MS and CVAA	CLP Method, SW-846	Multipoint calibration (minimum 3 points)	Daily, prior to analyses	r ≥ 0.995	1. Evaluate system 2. Recalibrate as necessary
		Calibration blank	After calibration, every 10 samples, and at end of run	No metals present above half of the PQL	1. Reanalyze blank 2. Clean system 3. Reanalyze affected samples
		LCS	Once per batch (maximum of 20 samples)	75 – 125 % recovery	1. If LCS sample is not within control limit, then evaluate system and recalibrate as necessary

TABLE B-4 (Continued)

INTERNAL QUALITY CONTROL PROCEDURES

Parameter	Analytical Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
Metals by ICPES, ICP-AES, ICP-MS and CVAA (Continued)	CLP Method, SW-846	MS	Once per batch (maximum of 20 samples)	75-125% recovery (ICP)	1. If MS sample is not within control limit, then evaluate system and recalibrate as necessary. IF LCS is in control, no action is necessary. 2. Flag the data if they appear to indicate significant matrix effects
VOCs	CLP	Surrogates	With each sample	See Table B-5 for % recovery values.	1. Evaluate system 2. Reanalyze standard 3. Recalibrate if necessary 4. Reanalyze affected samples
		Check of instrument tuning using BFB	Every 12 hours	Refer to method	1. Retune instrument 2. Reanalyze BFB
		Multipoint calibration (minimum of 5 points)	Initially and as required by results	%RSD ≤ 20.5% for CCC RF ≥ 0.01 for SPCC	1. Evaluate system 2. Recalibrate as necessary
		Method blanks	After initial calibration	No target analytes present above half of the PQL	1. Reanalyze blank 2. Clean system 3. Reanalyze affected samples
		MS/MSDs	Once per batch (maximum of 20 samples)	See Table B-5 for % recovery values and %RPD values	1. If MS/MSD sample is not within control limit, then evaluate system and recalibrate as necessary 2. Flag the data if they appear to indicate significant matrix effects
SVOCs	CLP	Surrogates	With each sample	See Table B-5 for % recovery values.	1. Evaluate system 2. Reanalyze standard 3. Recalibrate if necessary 4. Reanalyze affected samples
		Check of instrument tuning using DFTPP	Every 12 hours	Refer to method	1. Retune instrument 2. Reanalyze DFTPP
		Multipoint calibration (minimum of 5 points)	Initially and as required by results	%RSD ≤ 20.5% for CCC RF ≥ 0.01 for SPCC.	1. Evaluate system 2. Recalibrate as necessary

TABLE B-4 (Continued)

INTERNAL QUALITY CONTROL PROCEDURES

Parameter	Analytical Method	QC Check	Frequency	Acceptance Criteria	Corrective Action
SVOCs (Continued)	CLP	Method blanks and equipment blanks	After initial calibration	No target analytes present above half of the PQL	1. Reanalyze blank 2. Clean system 3. Reanalyze affected samples
		MS/MSDs	Once per batch (maximum of 20 samples)	See Table B-5 for % recovery values and %RPD values	1. If MS/MSD sample is not within control limit, evaluate system and recalibrate as necessary 2. Flag the data if they appear to indicate significant matrix effects

Notes:

BFB	4-Bromofluorobenzene
CA LUFT	California leaking underground fuel tank field manual
CCC	Continuing calibration check
CLP	Contract Laboratory Program
CVAA	Cold vapor atomic absorption
DFTPP	Decafluorotriphenylphosphine
EPA	U.S. Environmental Protection Agency
GFAA	Graphite furnace atomic absorption
ICP	Inductively coupled plasma
ICPES	Inductively coupled plasma emission spectroscopy
ICP-AES	Inductively coupled plasma atomic emission spectrocscopy
ICP-MS	Inductively coupled plasma mass spectroscopy
LCS	Laboratory Control Spike (Blank Spike)
MS	Matrix spike
MSD	Matrix spike duplicate
PQL	Practical quantitation limit
QC	Quality control
R	Correlation coefficient
RF	Response factor
RSD	Relative standard deviation of response factors
SPCC	System performance check compounds
SVOC	Semivolatile organic compounds
TOC	Total organic carbon
TPH	Total petroleum hydrocarbon
VOC	Volatile organic compound

B6.2.6 Matrix Spikes and Matrix Spike Duplicates

MSs measure the efficiency of each of the steps of the analytical method in recovering target analytes from an environmental sample matrix. MS/MSDs will be used to evaluate the accuracy and precision of the analytical results. Triplicate aliquots of the same sample are prepared in the laboratory, and each aliquot is treated exactly the same throughout the analytical method. For the MS/MSDs, spike compounds are added to two of the aliquots at known concentrations, and accuracy will be measured as the percent recovery of the analyte from the sample matrix.

MS results outside acceptance criteria are either caused by a matrix effect in the sample chosen for the spike or a batch recovery that is out of control. To help assess whether the observed excursion is caused by a matrix effect, method blanks will be analyzed (Section B6.2.1). The results will help indicate if matrix effect or out-of-control conditions apply. The proper corrective actions will be taken depending on these results.

Precision is assessed with duplicate analyses on spiked or unspiked samples, as specified in the methods. A MSD sample is prepared in the same manner as the MS sample. The RPD between the values of the spiked duplicates is taken as a measure of the precision of the analytical method. MS samples are collected at a frequency of 5 percent. If the MS percent recovery used to assess accuracy is outside of the established acceptance limits, appropriate CLP and laboratory protocols specific to the method will be followed to evaluate the usability of the data during data validation. Blank spikes, if available, will be examined to evaluate the effect of the out-of-control event on the reported results. Table B-5 provides control limits for the evaluation of MS and matrix duplicate sample accuracy and precision.

B6.3 LABORATORY QUALITY CONTROL PROCEDURES

The following sections discuss the laboratory performance requirements.

B6.3.1 Method Detection Limit Studies

The MDL is the minimum concentration of a compound that can be measured and reported. The MDL is a specified limit at which there is 99 percent confidence that the analyte concentration is greater than zero. The MDL takes into account sample matrix and preparation. The subcontract laboratory will demonstrate the MDLs for all analyses except inorganic analyses and physical properties test methods. MDL studies will be conducted annually or more frequently if method or instrumentation changes occur. Each MDL study will consist of seven replicates spiked with the target analytes of interest at

concentrations no greater than required quantitation limits. The replicates will be extracted and analyzed in the same manner as routine samples. If multiple instruments are used, each will be included in the MDL study. The reported MDLs will be representative of the least sensitive instrument. MDLs must meet the required quantitation limits. If MDLs do not meet the required quantitation limits, the situation is considered out-of—control, and corrective action will be taken.

B6.3.2 Instrument Detection Limit Studies

The IDL is the minimum concentration of a compound that can be distinguished from background noise by an analytical instrument. The IDL is a measurement of instrument sensitivity and does not take into account sample matrix and preparation. The subcontract laboratory will demonstrate the IDLs for the required analyses.

B6.3.3 Sample Quantitation Limits

Sample quantitation limits (SQL), also referred to as practical quantitation limits, are CRQLs adjusted for individual sample characteristics. The CRQL is a chemical-specific level that a laboratory should be able to routinely detect and quantitate in a given sample matrix. The CRQL is usually defined in the analytical method or in project-specific documentation. The SQL takes into account changes in the preparation and analytical methodology that may alter the ability to detect an analyte, including changes such as use of a smaller sample aliquot or dilution of the sample extract. Physical characteristics such as sample matrix and percent moisture that may alter the ability to detect the analyte are also considered. The laboratory will calculate and report SQLs for the environmental samples.

B6.3.4 Control Charts

Control charts document data quality in graphic form for specific method parameters such as surrogates and blank spike recoveries. A collection of data points for each parameter is used to statistically calculate means and control limits for a given analytical method. This information is useful in determining whether chemical measurement systems are in control. In addition, control charts provide information about trends over time in specific analytical and preparation methodologies. Although not required, it is recommended that subcontract laboratories maintain control charts for organic and inorganic analyses. At a minimum, method-blank surrogate recoveries and blank spike recoveries should be charted for each organic method. Blank spike recoveries should be charted for inorganic methodologies. Control charts should be updated monthly.

TABLE B-5

QUALITY ASSURANCE OBJECTIVES FOR ANALYTICAL PARAMETERS
INVESTIGATION AREA F2
INSTALLATION RESTORATION SITE 04
MARE ISLAND, CALIFORNIA

Compound	QC Type	Analytical Method	Precision (RPD)(a)		Accuracy (% Rec)(b)	
			Water	Soil	Water	Soil
TPH-extractable	MS/MSD	CA LUFT Manual	50	50	50-150	50-150
BFB	Surrogate		NA	NA	60-140	60- 140
Total Organic Carbon (TOC)	Lab triplicate	See Appendix	NA	10	NA	NA
Metals (ICP)	MS/MSD	CLP, SW-846	20	35	75-125	75-125
Metals (ICP) (with the exception of Ag and Sb)	LCS	CLP, SW-846	20	20	80-120	80-120 (or EPA control limits)
Metals (GFAA)	Spike	CLP	20	20	85-115	85-115
VOCs		CLP				
1,1-Dichloroethene	MS/MSD		14	22	61-145	59-172
Trichloroethene	MS/MSD		14	24	71-120	62-137
Benzene	MS/MSD		11	21	76-127	66-142
Toluene	MS/MSD		13	21	76-125	59-139
Chlorobenenze	MS/MSD		13	21	75-130	60-133
Toluene-d8	Surrogate		NA	NA	88-110	84-138
Bromofluorobenzene	Surrogate		NA	NA	86-115	59-113
1,2-Dichloroethane-d4	Surrogate		NA	NA	76-114	70-121
SVOCs		CLP				
Acenaphthene	MS/MSD		31	19	46-118	31-137
2,4-Dinitrotoluene	MS/MSD		38	47	24-96	28-89
Pyrene	MS/MSD		31	36	26-127	35-142
N-Nitroso-di-n-propylamine	MS/MSD		38	38	41-116	41-126
Pentachlorophenol	MS/MSD		50	47	9-103	17-109
Phenol	MS/MSD		42	35	12-110	26-90
2-Chlorophenol	MS/MSD		40	50	27-123	25-102
4-Chloro-3-methylphenol	MS/MSD		42	33	23-97	26-103
4-Nitrophenol	MS/MSD		50	50	10-80	11-114
Nitrobenzene-d5	Surrogate		NA	NA	35-114	23-120
2-Fluorobiphenyl	Surrogate		NA	NA	43-116	30-115
p-Terphenyl-d14	Surrogate		NA	NA	33-141	18-137
Phenol-d5	Surrogate		NA	NA	10-110	24-113
2-Fluorophenol	Surrogate		NA	NA	21-110	25-121
2,4,6-Tribromophenol	Surrogate		NA	NA	10-123	19-122

Notes:

a	Precision as relative percent difference (RPD)
b	Accuracy as percent recovery (% Rec)
Ag	Silver
BHC	Benzene hexachloride
CA LUFT	California leaking underground fuel tank Manual method (State of California 1989)
CLP	Contract Laboratory Program
DDD	Dichlorodiphenyldichloroethane
DDT	Dichlorodiphenyltrichloroethane
EPA	U.S. Environmental Protection Agency
GFAA	Graphite furnace atomic absorption
ICP	Inductively coupled plasma
LCS	Laboratory control spike (blank spike)
MS	Matrix spike
MS/MSD	Matrix spike and matrix spike duplicate
NA	Not applicable
QC	Quality Control
Rec	Recorded
RPD	Relative percent difference
Sb	Tin
SM	*Standard Methods for the Analysis of Water and Wastewater* (APHA 1992)
SVOC	Semivolatile organic compounds
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
VOC	Volatile organic compounds

B7 INSTRUMENT AND EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

The following sections discuss regularly scheduled preventive maintenance and calibration procedures used to keep laboratory equipment in good working condition.

B.7.1 MAINTENANCE OF FIELD EQUIPMENT

Detailed information regarding maintenance and servicing of field equipment is available in the instruction manual of the specific instrument to be used. Field personnel will record equipment maintenance information in field logbooks. Instrument problems encountered during field work will be recorded and remedied in the field, if possible. Specific preventive maintenance procedures will follow manufacturer recommendations.

B.7.2 CALIBRATION OF FIELD ANALYTICAL EQUIPMENT

Equipment used during field activities will be calibrated at the beginning of each day of sampling or as directed by the manufacturer or vendor. The frequency of calibration may depend on the type and stability of equipment, the analytical methods employed, and the intended use of the equipment. At a minimum, the calibration will be checked daily and calibration data recorded on calibration forms. More detailed calibration procedures for equipment are available from the specific manufacturer instruction manuals. A label specifying the scheduled date of the next calibration will be attached to the field equipment. If this identification is not feasible, calibration records for the equipment will be readily available for reference.

Should any of the field equipment become inoperable, it will be removed from service and tagged to indicate that repair, recalibration, or replacement is needed. The field team leaders will be notified so that prompt service can be completed or substitute equipment can be obtained. Action of this type will be reported in the daily field QC report.

B7.3 MAINTENANCE OF LABORATORY EQUIPMENT

The off-site subcontract laboratories will prepare and follow a maintenance schedule for each instrument used to analyze samples collected from IR04. Instruments will be serviced at scheduled intervals necessary to optimize factory specifications. Routine preventive maintenance and major repairs will be documented in a maintenance logbook.

An inventory of items to be kept ready for use in case of instrument failure will be maintained and restocked as needed. The list of spare parts will include equipment replacement parts subject to frequent failure, parts that have a limited lifetime of optimum performance, and parts that cannot be obtained in a timely manner.

As required by Navy QA guidelines (NFESC 1996), a description of specific preventive maintenance procedures for laboratory equipment is available in the laboratory's QA plan and in the written SOPs maintained by the laboratory. These documents identify the personnel responsible for major, preventive, and daily maintenance procedures, the frequency and type of maintenance performed, and maintenance documentation procedures.

B7.4 CALIBRATION OF LABORATORY ANALYTICAL EQUIPMENT

Laboratory instrument calibration procedures and frequencies will be conducted in accordance with analytical method requirements, including CLP. Laboratory calibration procedures and frequencies are listed in the subcontract laboratory's QA plan, the written SOPs maintained by the laboratory, and the analytical methods referenced in Section B5 of this QAPP. Qualified analysts will conduct the instrument calibration procedure and will document the procedure in an instrument logbook.

B7.4.1 Calibration Standards

Calibration standards will be obtained by the laboratory from the EPA repository or commercial vendors for both inorganic and organic compounds and analytes. Stock solutions for surrogate parameters and other inorganic mixes will be made from reagent-grade chemicals or as specified in the method SOP. Stock standards will also be used to make intermediate standards from which calibration standards are made. Special attention will be given to expiration dating, proper labeling, proper refrigeration, and freedom from contamination. Documentation relating to the receipt, mixing, and use of standards will be recorded in the appropriate laboratory logbook. Logbooks must be bound. Specific handling and documentation requirements for the use of standards will be provided in the selected laboratory's QA manual.

B7.4.2 Corrective Action Procedures

Instrument malfunctions will require immediate corrective action. Actions should be documented in field or laboratory logbooks. No other formal documentation is required unless data quality is adversely

affected or further corrective action is necessary. On-the-spot corrective actions will be taken as necessary in accordance with the procedures described in the laboratory QA plan and SOPs.

B8 INSPECTION AND ACCEPTANCE REQUIREMENTS FOR SUPPLIES

Analytical laboratories are required to provide certified clean containers for analyses. The subcontract laboratories will maintain an inventory of the analytical supplies required for the analytical procedures, as described in Section B5. The materials will be inspected before they are used, and defective material will be replaced before the sampling event begins or before the samples are analyzed.

Solvents and reagents used by the laboratories in analytical procedures will be documented in a laboratory logbook. At a minimum, information regarding the manufacturer, lot number, date received, and date opened should be included. Solvents and reagents will be tested for contamination before use. The results of this procedure and any other quality inspections will be documented in a laboratory notebook.

Off-site laboratories will maintain and follow a written SOP for the decontamination of glassware used in analytical procedures. Off-site laboratories will check the calibration of analytical balances and automatic pipettes on a daily basis and document the results in a laboratory logbook. Analytical balances will be recalibrated as necessary, in accordance with the laboratory's written SOPs.

Subcontractor laboratories will check the temperature daily of refrigerators used to store IR04 samples, standards, extracts, and other consumables, and will document measured temperatures in a laboratory logbook.

B9 DATA ACQUISITION REQUIREMENTS

Data acquired through the analysis of samples will be reported following formats established by the method and TtEMI within the required deliverable schedule. Data from analytical laboratories will be presented in a CLP hard-copy or equivalent data package and in the EDD format specified by TtEMI.

The EDD is an ASCII file of the analytical results and the sample identification information downloaded into a specific file structure from the LIMS. After the data files have been checked for completeness and proper structuring, the EDD will be imported into the IR04 database.

Field-direct reading results will be recorded on the appropriate field forms for data entry into the Mare Island database. Data entered into the database, either from EDD or field forms, will be reviewed for accuracy and completeness.

B10 DATA MANAGEMENT

After the review and validation of the field and laboratory data reports, the data will be entered into the database system in place at TtEMI. The database will provide data for (1) contamination and geologic observations, (2) preparing reports and graphics, (3) use with the geographic information system, and (4) transmittal of electronic data in a format compatible with the NEDTS. The following sections describe the data-tracking process that is implemented to ensure the quality of the database.

B10.1 DATA-TRACKING PROCEDURES

Data that are generated in support of the IR04 project are tracked through the use of a TtEMI-created database. Information related to the receipt and delivery of samples, project order fulfillment, and invoicing for laboratory and validation tasks is stored in the TtEMI program, SAMTRAK. Data are filed according to the document control number.

B10.2 DATA PATHWAYS

Data are generated in a variety of formats throughout the IR04 project; these data must be entered into the IR04 database. To evaluate whether the data have been accurately loaded into the database in a timely manner, data pathways must be established and well documented. The following three sections describe the pathways for data that are received from the field, laboratory, and data validation process.

B10.2.1 Field Data Pathway

When data are generated during field activities, data records are kept using field data forms. These forms are reviewed for completeness and accuracy by the analytical coordinator or geologist. The chain-of-custody form is entered into SAMTRAK, and the other forms (borelogs, well development sheets, and sampling data sheets) are filed in a secured storage area according to the document control number. These forms will be used to write the report for that specific investigation.

B10.2.2 Laboratory Data Pathway

The laboratory will generate a hard copy of the results and EDDs after the samples have been analyzed. The laboratory will send the data to the TtEMI analytical coordinator or analytical coordinator. The analytical coordinator will review the data deliverable for completeness and format. Once the format has been approved, the electronic data are manipulated and downloaded into the IR04 database. The hard-copy data are also reviewed for accuracy. If anything appears to be incomplete or incorrect, the laboratory is required to resubmit the entire data package and EDD. If everything appears to be in order, the TtEMI analytical coordinator will send the full data package to a third party validation subcontractor for validation.

After the data are received from the laboratory, the data entry staff will update SAMTRAK with the total number of samples received and number of days required to receive the data. The date the data were sent to the validation subcontractor is also recorded in the SAMTRAK program. Document control numbers are assigned to the data, and data that are not sent to the data validation subcontractor are filed in a secured storage area.

B10.2.3 Validated Data Pathway

After the data have been validated, the validated data will be sent to the TtEMI analytical coordinator by the data validation subcontractor. After the TtEMI analytical coordinator has reviewed the validated data for accuracy, TtEMI will update the IR04 database with the appropriate qualifiers. SAMTRAK will then be updated, recording associated costs from the laboratory and the data validation subcontractor. After entry into the database, the validated data are bound and filed in a secured storage area according to the document control number.

C1 ASSESSMENTS AND RESPONSE ACTIONS

Oversight of QA activities will be completed through the use of three types of audits, described in the following section. Problems encountered during the field investigation will require appropriate corrective action procedures to ensure that problems do not go unresolved. This section describes the types of audits that may be completed, appropriate corrective action procedures to be taken in the event of problems in the field or laboratory, and QA reports to management.

C1.1 PERFORMANCE, SYSTEM, AND FIELD AUDITS

An audit evaluates the capability and performance of a measurement system or its component and identifies problems warranting correction. Three types of audits may be conducted during the field work for this project: performance, system, and field. Audits will be completed at scheduled intervals by the QA program manager, project QAOs, or senior technical staff. Auditors will be independent of the activities audited and will be selected by the project QA manager. Technical expertise and experience in auditing will be considered during the selection of an auditor or audit team.

The auditor or audit team will develop an individual audit plan to provide a basis for each audit. Audits may include reviews of project plan adherence, training status, health and safety procedures, activity performance and records, budget status, QC data, calibrations, and conformance to SOPs. Audits may also review compliance with laws, regulations, policies, and procedures. Following completion of an audit, the auditor or audit team will submit an audit report to the Navy RPM. This report will also be included in the project summary report. The QA program manager will coordinate a management review of any deficiencies that are noted.

The auditor or audit team can issue a corrective-action request form to identify and schedule specific corrective actions to be undertaken and completed by the project managers. Completion of corrective action is verified by the auditor or audit team. After acceptance and verification of corrective actions, the corrective-action request form will be used to close the audit.

C1.1.1 Performance Audits

A performance audit is a review of the existing project and QC data to evaluate the accuracy of a total measurement system or a component of the system. Laboratories selected for use in this project will have had performance audits conducted by the Navy, before samples are submitted to the laboratory for analysis. Internal audit routines for the laboratory are described in the laboratory QA plan.

C1.1.2 System Audits

A system audit is used to verify adherence to QA policies and SOPs. This type of audit may consist of on-site review of measurement systems. In addition, procedures for measurement, QC, and documentation may be evaluated. The first system audit is conducted shortly after a system becomes operational and on a regularly scheduled basis thereafter.

C1.1.3 Field Audits

A field audit involves an on-site visit by the auditor or audit team. Items to be examined include the availability and implementation of approved field procedures, calibration and operation of equipment, chain-of-custody procedures, packaging, storage, and shipping of samples, health and safety procedures, documentation of procedures and instructions, and nonconformance documentation.

C1.2 CORRECTIVE ACTION PROCEDURES

An effective QA program requires prompt and thorough correction of nonconformance conditions that affect quality. Rapid and effective corrective action minimizes the possibility of questionable data or documentation. Two types of corrective actions exist: immediate and long term. Immediate corrective actions include correction of documentation deficiencies or errors, repair of inaccurate instrumentation, or correction of inadequate procedures. The source of the problem is generally obvious and can be corrected at the time of the observation. Long-term corrective actions are designed to eliminate the sources of problems. Examples of long-term corrective actions are correction of systematic errors in sampling or analysis and correction of procedures producing questionable results. Corrections can be made through additional personnel training, instrument replacement, or procedural improvements. One or more corrections may be necessary.

QA problems and corrective actions will be documented to provide a complete record of QA activities and to help to identify needed long-term corrective actions. Defined responsibilities are required for scheduling, performing, documenting, and ensuring the effectiveness of the corrective action. This section describes the corrective action procedures to be followed in the field and laboratory.

C1.2.1 Field Procedures

Field nonconformance conditions are defined as occurrences or measurements that are either unexpected or that do not meet established acceptance criteria and will affect data quality if corrective action is not implemented. Examples of nonconformances are as follows:

- Incorrect use of field equipment
- Improper sample collection, preservation, and shipment procedures
- Incomplete field documentation, including chain-of-custody records
- Incorrect decontamination procedures
- Incorrect collection of QC samples

Corrective action procedures will depend on the severity of the nonconformance. In cases where immediate and complete corrective action is implemented by field personnel, the corrective action will be recorded in the field logbook and summarized in the daily field progress report.

Nonconformances that have a substantial impact on data quality require the completion of a corrective-action request form. This form may be filled out by an auditor or any individual who suspects that any aspect of data integrity is being affected by a field nonconformance. Each form is limited to a single nonconformance. If additional problems are identified, multiple forms will be used for documentation.

Copies of the corrective-action request form will be distributed to the project managers, the field team leaders, the project QA manager, and the project file. The project QA manager will forward completed corrective-action forms to the Navy QAO program manager and the QA program manager. The project manager, field team leader, and the project QA manager will meet to discuss the appropriate steps to resolve the problem and will use the following list:

- Determine when and how the problem developed
- Assign responsibility for problem investigation and documentation
- Determine the corrective action to eliminate the problem
- Design a schedule for completing the corrective action

- Assign responsibility for implementing the corrective action
- Document and verify that the corrective action has eliminated the problem
- Notify the Navy of the problem and the corrective action taken

A corrective action status report is used by the project QA manager to monitor the status of corrective actions. The report will list a brief description of the problem, the individual who identified it, and the personnel responsible for determining and implementing the corrective action. The report will also list completion dates for each phase of the corrective-action procedure and the due date for the QA program manager to review and check the effectiveness of the solution. Follow-up data will be listed to check that the problem has not reappeared. The follow-up review is conducted to ensure that the solution has adequately and permanently corrected the problem.

The QA program manager can require data acquisition to be limited or discontinued until the corrective action is complete and the nonconformance is eliminated. The QA program manager can also request the reanalysis of any or all data acquired since the system was last in control.

C1.2.2 Laboratory Procedures

Internal laboratory procedures for corrective action and a description of out-of-control situations requiring corrective action are contained in the laboratory QA plan. At a minimum, corrective action will be implemented when any of the following three conditions occurs: control limits are exceeded, method QC requirements are not met, or sample holding times are exceeded. Out-of-control situations will be reported to the TtEMI analytical coordinator within 2 working days of identification. In addition, a corrective action report signed by the laboratory director or project manager and the laboratory QC coordinator will be provided to the TtEMI analytical coordinator.

C1.3 REPORTS TO MANAGEMENT

Several reports will be prepared during the course of the field work at IR04 addressing QA. Each of these reports is summarized in this section.

C1.3.1 Daily Quality Control Reports

The daily QC report will summarize daily field activities throughout the field program. This report will include the work completed, including any QA/QC activities, health and safety activities, problems encountered, and corrective actions taken. The daily QC report is prepared by the field team leader and

submitted to the TtEMI project manager. The content of the reports will be summarized and included in the final report submitted for the field investigation.

C1.3.2 Project Monthly Progress Report

A summary report will be prepared by the TtEMI project manager and TtEMI project QA manager on a monthly basis and submitted to the program managers and QA program manager. This report will include the following:

- Status of the project
- Instrument, equipment, or procedural problems affecting QA and recommended solutions
- Objectives from the previous report that were achieved
- Objectives from the previous report that were not achieved
- Work planned for the next month

The aforementioned information will also be required from subcontractors and will be included in the monthly progress report.

C1.3.3 Quality Control Summary Report

A QC summary report (QCSR) will be prepared by TtEMI and submitted to the Navy RPM with the final report for the activity. The QCSR will include a summary and evaluation of the QC completed during the task and will indicate the duration and location of storage for the complete data packages. Particular emphasis will be placed on determining whether project DQOs were met and whether data are of sufficient quality to support required decisions.

D1 DATA VALIDATION AND USABILITY

This section discusses the requirements and methods for data review, verification, and validation as well as the process for reconciling the data generated with the DQOs for the task.

D1.1 DATA REVIEW, VERIFICATION, AND VALIDATION REQUIREMENTS

Data for IR04 will be reviewed and verified before they are input into the database. At a minimum, 10 percent of the analytical data will be randomly selected and fully validated. Ninety percent of the analytical data will undergo cursory validation. Validation will be preformed by an independent party.

D1.2 VALIDATION AND VERIFICATION METHODS

Validation and verification of the data generated during field activities are essential to obtaining data of defensible and acceptable quality. Data values that are significantly different from the population are called "outliers." A systematic effort will be made to identify outliers or errors before field and laboratory personnel report the data. Outliers can result from improper sampling or analytical methodology, matrix interference, data transcription errors, and calculation errors, or they may represent inherent variability in the sample. Outliers resulting from errors found during data verification will be identified and corrected. Outliers that cannot be attributed to analytical, calculation, or transcription errors will be reported in the case narrative section of the analytical report.

D1.2.1 Verification of Field Data

Project team personnel will validate field data through reviews of data sets to identify inconsistencies or anomalous values. If possible, any inconsistencies discovered will be resolved immediately by seeking clarification from the field personnel responsible for data collection. Field personnel will be responsible for following the sampling and documentation procedures described in the accompanying FSAP (TtEMI and U&A 2000) and this QAPP so that defensible and justifiable data are obtained.

D1.2.2 Verification of Laboratory Data

Laboratory personnel will verify analytical data at the time of analysis and reporting through reviews of the raw data for any nonconformances of the analytical method requirements. Detailed procedures for laboratory verification and corrective action will be provided in the laboratory's QA plan.

D1.2.3 Validation of Analytical Data

The following four sections describe the validation requirements for analytical data.

D1.2.3.1 Technical Requirements

Analytical data will be validated by an independent third party contractor in accordance with EPA National Functional Guidelines for data validation of organic (EPA 1999b) and inorganic analyses (EPA 1994a). Ninety percent of the data will be subject to cursory validation and 10 percent of the data will be subject to full validation. The requirements for cursory and full validation are described in Section D1.2.3.4.

D1.2.3.2 Cursory Data Validation

Cursory data validation will be completed on the data summary packages for analyses of samples by CLP and non-CLP methods. Ninety percent of analytical data will be validated using cursory data validation. The data reviewer is required to notify TtEMI and request missing information needed from the laboratory. Elimination of data from the review process is not allowed.

D1.2.3.3 Full Data Validation

Full data validation will be completed on 10 percent of data packages for analyses of samples by CLP and non-CLP methods. The data reviewer is required to notify TtEMI if any required information is missing and request missing information needed from the laboratory. Elimination of data from the review process is not allowed. Data packages consist of sample results, QA/QC summaries (equivalent to CLP forms I through X for organic analyses and forms I through XIV for inorganic analyses), and raw data associated with the sample results and QA/QC summaries.

D1.2.3.4 Criteria for Data Validation

The QC criteria to be reviewed for both cursory and full validations are identified as follows:

<u>Cursory Data Validation</u>

1. CLP Organic Analyses
   - Holding times
   - Calibration
   - Blanks
   - Surrogate recovery

- MS and MSD
- Blank spike or LCS recovery
- Internal standard performance
- Overall assessment of data for an SDG
- Field duplicate sample analysis

2. CLP Inorganic Analyses
   - Holding times
   - Calibration
   - Blanks
   - LCS
   - MS recovery
   - Matrix duplicate sample analysis
   - Field duplicate sample analysis
   - ICP serial dilution
   - Overall assessment of data for an SDG
3. Non-CLP Organic Analyses
   - Method compliance
   - Holding times
   - Calibration
   - Blanks
   - Surrogate recovery
   - MS and MSD recovery
   - LCS or blank spike
   - Internal standard performance
   - Other laboratory QC specified by the method
   - Overall assessment of data for an SDG
   - Field duplicate sample analysis
4. Non-CLP Inorganic Analyses
   - Holding times
   - Calibration
   - Blanks
   - MS and MSD recovery
   - Internal standard performance
   - LCS
   - Field duplicate sample analysis
   - Other laboratory QC specified by the method
   - Overall assessment of data for an SDG

<u>Full Data Validation</u>

1. CLP Organic Analyses
   - Holding times

- GC/MS tuning
- Calibration
- Blanks
- Surrogate recovery
- MS and MSD recovery
- Internal standard performance
- Target compound list identification
- Compound quantitation and reported detection limits
- TICs
- Field duplicate sample analysis
- Blank spike or LCS analysis
- System performance
- Overall assessment of data for an SDG

2. CLP Inorganic Analyses
   - Holding times
   - Calibration
   - Blanks
   - ICP interference check sample
   - LCS
   - MS recovery
   - Field duplicate sample analysis
   - Matrix duplicate sample analysis
   - GFAA QC
   - Sample result verification
   - ICP serial dilution
   - Overall assessment of data for an SDG
3. Non-CLP Organic Analyses
   - Method compliance
   - Holding times
   - Calibration
   - Blanks
   - Surrogate recovery
   - MS and MSD recovery
   - LCS or blank spike
   - Internal standard performance
   - Field duplicate sample analysis
   - Other laboratory QC specified by the method
   - Detection limits
   - Compound identification
   - Compound quantitation
   - Sample results verification

- Overall assessment of data for an SDG

4. Non-CLP Inorganic Analyses
   - Holding times
   - Calibration
   - Blanks
   - MS and MSD recovery
   - Internal standard performance
   - LCS
   - Field duplicate sample analysis
   - Other laboratory QC specified by the method
   - Detection limits
   - Analyte identification
   - Analyte quantitation
   - Sample results verification
   - Overall assessment of data for an SDG

D2 RECONCILIATION WITH DATA QUALITY OBJECTIVES

In both this QAPP and the FSAP (TtEMI and U&A 2000), DQOs were developed to ensure that the quantity (number, types, and location of samples) and quality (analytical method and detection limit) of the data collected would be sufficient to support (1) the horizontal and vertical delineation of contamination and (2) the calculation of potential human health and ecological risk at IR04. The sampling and laboratory methods and procedures detailed throughout the QAPP should provide data of sufficient quantity and quality to meet the project objectives.

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APPENDIX

STANDARD OPERATING PROCEDURE FOR THE DETERMINATION OF TOTAL ORGANIC CARBON

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1.0 INTRODUCTION

Total organic carbon (TOC) is a measure of the total amount of nonvolatile, volatile, partially volatile, and particulate organic compounds in a sample. TOC is independent of the oxidation state of the organic compounds and is not a measure of the organically bound and inorganic elements that contribute to the biochemical and chemical oxygen demand tests. Inorganic carbon should be removed because it interferes with TOC determinations.

2.0 FIELD PROCEDURES

Field procedures for determining sediment TOC are described in the following sections.

2.1 COLLECTION

Samples can be collected in glass or plastic containers. A minimum sample size of 100 to 150 grams (g) is recommended. If unrepresentative material is to be removed from the sample, it should be removed in the field under the supervision of the chief scientist and noted on the field log sheet.

2.2 PROCESSING

Samples should be stored frozen and can be held for up to 6 months under before analysis. Excessive temperatures should not be used to thaw samples.

3.0 LABORATORY PROCEDURES

Laboratory procedures for determining sediment TOC are described in the following sections.

3.1 ANALYTICAL PROCEDURES

Analytical procedures for determining sediment TOC are discussed in the following sections.

3.1.1 Equipment

The following equipment should be used to determine sediment TOC:

- Induction furnace (for example, Leco WR-12, Dohrmann DC-50, Coleman CH analyzer, Perkin Elmer 240 elemental analyzer, Carlo-Erba 1106)

- Analytical balance (0.1 milligram [mg] accuracy)
- Desiccator
- Combustion boats
- 10 percent hydrochloric acid
- Cupric oxide fines
- Benzoic acid

3.1.2 Equipment Preparation

Equipment should be prepared as follows:

- Clean combustion boats by placing them in the induction furnace at 950 °C. After being cleaned, combustion boats should not be touched with bare hands.
- Cool boats to room temperature in a desiccator.
- Weigh each boat to the nearest 0.1 mg.

3.1.3 Sample Preparation

- Allow frozen samples to warm to room temperature.
- Homogenize each sample mechanically.
- Transfer a representative aliquot (5 to 10 g) to a clean container.

3.1.4 Analytical Procedures

- Dry samples to constant weight at 70 plus or minus 2°C. The drying temperature is relatively low to minimize loss of volatile organic compounds.
- Cool dried samples to room temperature in a desiccator.

- Grind sample using a mortar and pestle to break up aggregates.
- Transfer a representative aliquot (0.2 to 0.5 g) to a clean, preweighed combustion boat.
- Determine sample weight to the nearest 0.1 mg.
- Add several drops of hydrochloric acid to the dried sample to remove carbonates. Wait until the effervescing is complete and add more acid. Continue this process until the incremental addition of acid causes no further effervescence. Do not add too much acid at one time as this may cause loss of sample because of frothing. Exposure of small samples (that is, 1 to 10 mg) containing less than 50 percent carbonate to an hydrochloric acid atmosphere for 24 to 48 hours has been shown to be an effective means of removing carbonates (Hedges and Stern 1984). If this method is used for sample sizes greater than 10 mg, its effectiveness should be demonstrated by the user.
- Dry the sample treated with hydrochloric acid to constant weight at 70 plus or minus 2 °C.
- Cool to room temperature in a desiccator.
- Add previously ashed cupric oxide fines or equivalent material (for example, alumina oxide) to the sample in the combustion boat.
- Combust the sample in an induction furnace at a minimum temperature of 950 plus or minus 10 °C.

3.1.5 Calculations

If an ascarite-filled tube is used to capture carbon dioxide, the carbon content of the sample can be calculated as follows:

$$\text{Percent carbon} = \frac{A(0.2729)(100)}{B}$$

where:

A = the weight (g) of carbon dioxide determined by weighing the ascarite tube before and after combustion

B	=	dry weight (g) of the unacidified sample in the combustion boat
0.2729	=	the ratio of the molecular weight of carbon to the molecular weight of carbon dioxide

A silica gel trap should be placed before the ascarite tube to catch any moisture driven off during sample combustion. Additional silica gel should be placed at the exit end of the ascarite tube to trap any water that might be formed by reaction of the trapped carbon dioxide with the sodium hydroxide in the ascarite.

If an elemental analyzer is used, the amount of carbon dioxide will be measured by a thermal conductivity detector. The instrument should be calibrated daily using an empty boat blank as the zero point and at least two standards. Standards should bracket the expected range of carbon concentrations in the samples.

3.2 QUALITY ASSURANCE AND QUALITY CONTROL PROCEDURES

It is critical that each sample be homogenized thoroughly in the laboratory before a subsample is collected for analysis. Laboratory homogenization should be conducted even if samples were homogenized in the field.

Dried samples should be cooled in a desiccator and held there until they are weighed. If a desiccator is not used, the sediment will accumulate ambient moisture, and the sample weight will be overestimated. A color-indicating desiccant is recommended so that spent desiccant can be detected easily. Also, the seal on the desiccator should be checked periodically and, if necessary, the ground glass rims should be greased, or the "O" rings should be replaced.

It is recommended that triplicate analyses be conducted on one of every 20 samples or on one sample per batch if less than 20 samples are analyzed. A method blank should be analyzed at the same frequency as the triplicate analyses. The analytical balance should be inspected daily and calibrated at least once per week. The carbon analyzer should be calibrated daily with freshly prepared standards. A standard reference material should be analyzed at least once for each major survey.

4.0 DATA REPORTING REQUIREMENTS

TOC should be reported as a percentage of the dry weight of the unacidified sample to the nearest 0.1 unit. The laboratory should report the results of all samples (including quality assurance replicates,

method blanks, and standard reference measurements) and should note any problems that may have influenced sample quality. The laboratory should also provide a summary of the calibration procedure and results (for example, range covered, regression equation, coefficient of determinations)

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