WORK PLAN
SOIL CHARACTERIZATION
AMCO Chemical Superfund Site
1414 3rd Street
Oakland, California

Contract Number: EP-S9-08-03
Task Order No: 0018
Document Control Number: 07163.0019.0066

Prepared For:

United States Environmental Protection Agency, Region 9
75 Hawthorne Street
San Francisco, California 94105

Prepared By:

Innovative Technical Solutions, Inc.
2730 Shadelands Drive, Suite 100
Walnut Creek, CA 94598

In Association with:
CDM Federal Programs Corporation
100 Pringle Avenue, Suite 300
Walnut Creek, CA 94596

November 2011

WORK PLAN
SOIL CHARACTERIZATION
AMCO Chemical Superfund Site
1414 3rd Street
Oakland, California

November 2011

Contract No: EP-S9-08-03
Task Order No: 0018

Prepared by: _____ Date: _____
Kent Baugh, PhD, CA C28941
ITSI Project Manager

Approved by: _____ Date: _____
Peter Lange, P.G.
ITSI Program Manager

TABLE OF CONTENTS

List of Tables ii
List of Figures ii
List of Appendices ii
Acronyms and Abbreviations iii
1.0 Introduction 1
1.1 Purpose, Scope, and Objectives 1
1.2 Site Location, History, and Description 3
1.3 Geology and Hydrogeology 4
1.4 Soil Contamination Reported in the Remedial Investigation Report 4
2.0 Sampling Design and Rationale 5
2.1 Former AMCO Facility 6
2.2 Large Vacant Lot 6
2.3 Small Vacant Lot 7
2.4 Parking Lot 7
3.0 Field Activities 7
3.1 Planning Activities 7
3.1.1 Health and Safety 7
3.1.2 Permitting, Notifications, and Utility Clearance 8
3.2 Drilling and Sampling Methodologies 10
3.2.1 Sonic Drilling 10
3.2.2 Soil Sampling and logging Procedures 11
3.2.3 Borehole Abandonment 11
3.2.4 Drilling Equipment Decontamination 12
3.3 Analytical Methods 12
3.4 Surveying of Sampling Borehole Locations 12
3.5 Management of Investigation-Derived Wastes 13
4.0 Sample Management and Documentation Requirements 14
5.0 Reporting of Soil Characterization Results 14
6.0 Schedule 15
7.0 References 15

LIST OF TABLES

Table No.	Title
1	Summary of Screening Levels for Key Contaminants
2	Sampling Areas and Rationale
3	Planned Sample Table

LIST OF FIGURES

Figure No.	Title
1	Site Location Map
2	Site Plan and Proposed Soil Characterization Areas
3	Soil Concentrations Above Screening Criteria, Remedial Investigation 2004
4	Proposed Sampling Grid and Borehole Locations at AMCO Facility Yard and Warehouse Building
5	Proposed Sampling Grid and Borehole Locations at Large Vacant Lot, Small Vacant Lot, and Parking Lot
6	Project Schedule

LIST OF APPENDICES

A	Addendum to Sampling and Analysis Plan
B	Air Monitoring Plan

ACRONYMS AND ABBREVIATIONS

AMCO	AMCO Chemical Corporation
AST	above-ground storage tank
bgs	below ground surface
CAM	California Administrative Manual
CCR	California Code of Regulations
CDM	CDM Federal Programs Corporation
COC	chemical of concern
DTSC	California Department of Toxic Substances Control
ESL	Environmental Screening Level
EPA	United States Environmental Protection Agency
GPS	global positioning system
HASP	Health and Safety Plan
Hz	cycles per second
IDW	investigation-derived waste
ITSI	Innovative Technical Solutions, Inc.
ml	milliliter(s)
NAD 83	North American Datum of 1983
NAPL	non-aqueous phase liquid
PCBs	polychlorinated biphenyls
PID	photo-ionization detector
PPE	personal protective equipment
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation
SAP	Sampling and Analysis Plan
Site	AMCO Chemical Superfund site, 1414 3rd Street, Oakland, California
SL	Screening Level
SVOC	semi-volatile organic compound
TO	Task Order
UN	United Nations
USA	Underground Service Alert
USCS	Unified Soil Classification System
UST	underground storage tank
VOA	volatile organic analyses
VOC	volatile organic compound
Work Plan	Soil Characterization Work Plan

1.0 INTRODUCTION

This Soil Characterization Work Plan (Work Plan) provides details of the additional soil investigation activities for defining the lateral and vertical extent of soil contamination at the AMCO Chemical Superfund site (Site). As used herein, Site refers to the former AMCO Chemical facility property located at 1414 3rd Street, Oakland, California and Off-Facility properties on Center Street and 3rd Street that are located adjacent to the former AMCO property. This work is being conducted under Contract No: EP-S9-08-03, Task Order No: 0018, for the United States Environmental Protection Agency (EPA).

The soil characterization plan described herein consists of supplemental activities to characterize soil contamination relative to the results reported in the Remedial Investigation (RI) Report (CH2M-Hill, 2011). The RI Report also presents a conceptual site model and discusses past operations that resulted in chemical releases, and the nature and extent of contamination in soil and groundwater. As recommended by EPA's Remedy Review Board, additional soil characterization is needed to better define the extent of soil contamination at the source area and other portions of the Site. The results from the soil characterization will be used to define requirements for soil and source area remediation. The following portions of Section 1 describe the following:

- The purpose and objectives of this Work Plan,
- Site background and information details,
- Geology and hydrogeology at the Site, and
- Soil contamination results previously reported (CH2M-Hill, 2011).

1.1 PURPOSE, SCOPE, AND OBJECTIVES

The soil characterization activities will be performed as a supplement to remedial investigation (RI) activities performed and documented in the Remedial Investigation Report (CH2MHill, 2011). The primary objectives of the soil characterization effort as described in this Work Plan are listed below:

- Further define the nature and extent (lateral and vertical) of soil contamination in the source area of the Site.

- Further characterize the lateral and vertical distribution of contamination at the Site, which includes the former AMCO Facility property and adjacent Off-Facility properties on 3rd Street and Center Street.
- Evaluate the extent that contaminants have migrated vertically downward and the potential for contaminants to be present in the Lower Aquifer.

An important area of focus for these supplemental soil characterization efforts is the source area, because the analytical data collected to date have not defined the extent of contamination at the source area. Specifically, the intent is to achieve a detailed characterization of the constituents-of-concern (COCs) and the lateral and vertical limits of contamination in the source area. These data are considered critical for supporting the planned evaluations of remedial action alternatives for the Site.

Sonic drilling will be used as the drilling method for the soil characterization field work. Given the subsurface geological conditions at the Site, use of sonic drilling will facilitate successful completion of soil borings with soil sampling at specific target depths and will minimize the mass and volume of investigation-derived waste (IDW). Although groundwater is shallow at the Site, soil sampling is planned for this investigation because the geological conditions at the Site have made grab groundwater sampling difficult at depths beyond 30 feet. All soil concentrations will be reported on a dry weight basis.

Field investigation activities and data quantification will be conducted in accordance with this Work Plan and the Sampling and Analysis Plan (SAP) (CH2M-Hill, 2004a), the 2010 Addendum to the Remedial Investigation Sampling and Analysis Plan (ITSI, 2010), and the October 2011 Addendum to the Remedial Investigation Sampling and Analysis Plan (ITSI, 2011b). As referenced herein, the SAP encompasses the original plan and subsequent addendums. The SAP is an integrated document for this activity. The SAP consists of field sampling and analytical procedures, including decontamination procedures and a Quality Assurance Project Plan (QAPP). The field investigations will also be performed in accordance with the site-specific Health and Safety Plan (HASP) (ITSI, 2011a). The SAP amendment addressing specific tasks under the scope of work for the soil characterization is included as Appendix A.

1.2 SITE LOCATION, HISTORY, AND DESCRIPTION

The former AMCO Chemical Corporation facility at 1414 3rd Street in Oakland, California is located adjacent to the intersection of 3rd Street and Mandela Parkway (see Figure 1). The Site is on the southeastern boundary of the South Prescott neighborhood, in the portion of the city referred to as "West Oakland". Current land uses at properties adjacent to the former AMCO facility include residential and commercial/light industrial. No commercial/light industrial activity is currently occurring at the Site.

AMCO Chemical Corporation (AMCO) owned and operated the property as a chemical distribution facility from the 1960s to 1989. The former AMCO facility operations included off-loading of bulk chemicals from rail spur lines and from other bulk delivery methods. At the former AMCO facility, chemicals were stored in drums and storage tanks before being transferred to smaller containers for resale. Bulk chemical storage facilities included up to 12 above-ground storage tanks (ASTs) and two 10,000-gallon underground storage tanks (USTs), as well as numerous drums. Inspections conducted by the California Department of Toxic Substances Control (DTSC) in 1988 identified corroded, bulging, or leaking drums and noted chemical spillage to soil.

In 1989, the Site was acquired by the owners of DC Metals under the name of Cypress Street Investments. From 1989 to 1998, DC Metals used the property, along with the large vacant lot on Center Street and a parking lot on Third Street, as a scrap-metals yard. DC Metals operations at the Site closed down in November 1998 and scrap metal was removed. The former AMCO facility property was leased to Cable Moore, which used the property for cable storage until December 2009. Existing structures at the former AMCO facility consist of an office building, a warehouse, and two small storage buildings. Other properties adjacent to the former AMCO facility property and also owned by Cypress Street Investments include a shop and parking lot at 1448 3rd Street, a small vacant lot (324 Center Street), and a large vacant lot (332-346 Center Street). Figure 2 shows the locations of the on-site AMCO facility yard structures and the adjacent Off-Facility properties (parking lot, small vacant lot, and large vacant lot) included as part of the AMCO Superfund site (Site).

1.3 GEOLOGY AND HYDROGEOLOGY

The geology and hydrogeology beneath the Site have been studied as part of a Remedial Investigation (RI) conducted to define the nature and extent of contamination, and help evaluate the fate and transport of contaminants present in soil, soil vapor, and groundwater at the Site as a result of the former AMCO operations (CH2M-Hill, 2011). The sedimentary deposits at the Site are overlain by several feet of fill. The Site is underlain by two aquifers, identified as the Upper Aquifer and Lower Aquifer (Merritt Sands and Alameda Formation, respectively), which are separated by a regional aquitard referred to as the Older Bay Mud. The Upper Aquifer (Merritt Sands) is composed of fill near the ground surface that overlies native loose sand and silty sand deposits, with lenses of silt and clay. Merritt Sand deposits at the Site vary between approximately 45 and 55 feet thick (CH2M-Hill, 2011). The shallow water table fluctuates between 2.5 and 6.5 feet below ground surface (bgs). The Older Bay Mud underlies the Merritt Sands unit and is reportedly 50 to 90 feet thick in the vicinity of the Site (CH2M-Hill, 2011). The Older Bay Mud typically consists of a firm, dark greenish-gray, low- to moderate-plasticity clay with varying amounts of sand and fine gravel. The Alameda Formation, which generally consists of interbedded clay, silt, sand, and gravel, underlies the Older Bay Mud. The Alameda Formation has a reported thickness of greater than 250 feet in the vicinity of the Site. Bedrock is composed of Jurassic-aged Franciscan Formation sandstone and shale's, which lie more than 400 feet below the Site (CH2M-Hill, 2011).

1.4 SOIL CONTAMINATION REPORTED IN THE REMEDIAL INVESTIGATION REPORT

In performing the RI, samples of non-aqueous phase liquid (NAPL), groundwater, soil, soil gas, indoor and outdoor air, and locally grown produce were collected and analyzed. The samples were analyzed for some or all of the following: volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, pesticides, polychlorinated biphenyls (PCBs), dioxins/furans, cyanide, cations and anions, general chemistry, and physical parameters (CH2M-Hill, 2011). Over 200 individual contaminants were detected in groundwater, soil, soil gas, or indoor/outdoor air during the RI, with 98 of those identified as contaminants of concern (COCs). The COCs include VOCs (chlorinated and petroleum hydrocarbons), SVOCs, organochlorine pesticides, PCBs, metals, and dioxins/furans (CH2M-Hill, 2011). VOCs are present as NAPL as well as sorbed and dissolved phase in the saturated zone, with previous detections in the vadose

zone likely attributable to volatilization from the water table. The highest level of subsurface contamination was present in the portion of the former AMCO facility property to the west of the warehouse and associated with bulk chemical transfers during AMCO's operations. This area with the highest level of contamination is referred to as the "source area" in this Work Plan. While non-aqueous phase liquid (NAPL) and high groundwater concentrations have been detected in wells located in the area of the "source area", the lateral and vertical extent of the source area has not been defined by previous investigations.

To evaluate chemical concentrations from this supplemental soil characterization and establish the lateral and vertical extent of COCs, Screening Levels (SL) have been adopted that are primarily based on EPA's Residential Regional Screening Levels (RSLs), with the California Regional Water Quality Control Board's (San Francisco Bay region) Environmental Screening Levels (ESLs) as default values for compounds that do not have RSLs. The SLs are listed in Table 1 along with the source of the SLs. Chemical concentrations will be compared to the SLs to establish COCs and the nature and extent of soil contamination (EPA, 2002). The SLs are only a screening tool, and not remediation criteria. Soil analytical data from the RI Report (CH2M-Hill, 2011) for COC detections above the Screening Levels are displayed on Figure 3. Soil contamination as reported in the RI Report is limited to a depth of 5 feet, and therefore does not account for many COCs present in shallow groundwater, such as VOCs.

2.0 SAMPLING DESIGN AND RATIONALE

The rationale for the soil sampling is as follows:

(1) For areas with known or suspected subsurface contamination, use an appropriate sampling grid so that remediation requirements can be defined.

(2) For areas not suspected of having subsurface contamination, complete sufficient borings and sampling to determine if contamination is present or not.

(3) Collect soil samples throughout the vertical profile of the vadose zone and Upper Aquifer, and also assess if contamination has moved vertically and could possibly impact the Lower Aquifer.

Details of the sampling grid for each investigation area are presented in Sections 2.1 through 2.4.

Soil sample collection will occur at target depths of 1, 3, 5, 8, 13, 20, 30, 40, 50, 60, 65, and 70 feet below ground surface (bgs). The sampling depth of 60 or 65 feet bgs is the estimated depth

of the Upper Aquifer. The final sampling depth (70 feet bgs assumed) will extend 5 feet into the Older Bay Mud aquitard. These sampling depths are relative to ground surface. Where concrete pavement is present, the ground surface is considered to be located at the base of the concrete pavement. The sampling depths to the base of the Upper Aquifer and to a depth of 5 feet into the Older Bay Mud aquitard may be adjusted in the field by the Project Geologist based on visual observation of the soil profile. Sampling grids and proposed drilling locations are depicted on Figures 4 and 5 for the former AMCO facility and the adjacent Off-Facility Properties, respectively. The sampling rationale for the characterization of soil contamination at each area is summarized in Table 2.

Based on the results from the planned boring locations and sampling depths, additional borings (step-out borings) may be completed to better define the extent (lateral and/or vertical) of contamination. An example would be additional borings and sampling to further define the extent of the source area and/or variation of COC concentrations with depth at the source area or other areas of the Site. Any recommendations for step-out borings and associated sampling will be established based on the soil characterization results. Before performing step-out borings and subsurface sampling, written approval will be obtained from the EPA Remedial Project Manager.

2.1 FORMER AMCO FACILITY

The sampling grid within the former AMCO facility will consist of 20 feet by 20 feet spacing throughout the outside yard. A reduced sampling grid of 10 feet by 10 feet spacing will be established within the current estimated extent of the source area (between monitoring wells MW-14 and MW-12). There will be approximately 74 soil boring locations based on the proposed grid spacing within the yard. The sampling grid within the warehouse area will consist of nine equally spaced soil boring locations placed along the north-south axis of the warehouse (see Figure 4).

2.2 LARGE VACANT LOT

The sampling grid within the large vacant lot will consist of borings spaced approximately 20 feet by 20 feet throughout the lot. A total of 36 soil boring locations will be advanced within this lot (see Figure 5).

2.3 SMALL VACANT LOT

A total of three soil boring locations will be placed in the small vacant lot. One boring will be placed near the eastern edge of the lot and the other two boring locations will be equally spaced along the center line of the small vacant lot (see Figure 5).

2.4 PARKING LOT

A total of three boring locations will also be established within the parking lot. One boring location will be to the east of a former boring location (RSB-33) completed as part of the RI (CH2M-Hill, 2011), and the other two equally spaced south to north across the lot (see Figure 5).

3.0 FIELD ACTIVITIES

Due to the level of noise expected to be generated during drilling operations and the existing agreement with the nearby residences regarding noise abatement and working hours, field work will occur only during weekdays between 7:30 AM and 5:30 PM. Actual drilling activities will be limited to the period between 8:00 AM and 5:00 PM.

3.1 PLANNING ACTIVITIES

3.1.1 Health and Safety

A Site-Specific Health and Safety Plan (HASP) has been prepared by ITSI (2011a) for this project and is incorporated into this Work Plan by reference. A hard copy of the HASP will be maintained at the Site during all field activities. A kick-off meeting will be held on-site prior to beginning field activities to address the potential for encountering physical and chemical hazards associated with the soil characterization activities, and to instruct and notify on-site workers of the emergency routes and contacts.

The field work associated with the soil characterization is anticipated to be performed in modified Level D personal protective equipment (PPE), with the potential to upgrade to Level C, if needed. Borehole and personal breathing space air monitoring will be conducted using a calibrated, portable photoionization detector (PID) (10.6 eV) to detect the presence of organic vapors. The following actions will be taken if vapor levels equal or exceed the allowable levels specified in the HASP as identified below.

If the PID consistently detects organic vapor levels above background, up to 5 ppmv, in the breathing zone for 5 minutes, air monitoring will be increased in order to identify the source of the vapors and increase vapor controls. If PID levels are consistently at or above 5 ppmv for 5 minutes or more, the work activities will be immediately modified (Level C PPE) or suspended in order to reduce worker vapor exposure levels, and air monitoring will be continued. If PID levels are consistently above 10 ppmv for 5 minutes or more, work will be suspended and personnel removed from the drilling area. If the appropriate control measures cannot be implemented to reliably reduce the airborne vapor levels, work will stop until the SSHO contacts ITSI's Health and Safety Manager for further direction as to the protection of site personnel.

Additional area air monitoring as described in Appendix B will also be performed. Air monitoring during drilling activities is designed to enable the field investigations to be completed while protecting the health and safety of the field personnel and nearby residents.

3.1.2 Permitting, Notifications, and Utility Clearance

Even though the AMCO project is under the Superfund Program and therefore exempt from county and state permit fees, the drilling and grouting of the boreholes will follow the Alameda County Environmental Health guidelines.

Field work will be coordinated with the property owner, including access to the warehouse interior. Locations for the field trailer, portable toilets, and the temporary on-site staging of investigation-derived waste (IDW), such as roll-off bins for storing drill cuttings and drums to contain decontamination fluids, will be coordinated with the property owner. Section 3.5 describes management of IDW generated during field activities.

Proposed boring locations will be marked on the ground to identify the locations for underground utility clearance. Boring locations will be marked consistent with the locations and spacing shown on Figures 4 and 5. For planned borings on the outer rows of the sampling grid and closest to fencing or other structures, drilling locations will be marked at a sufficient distance (10 feet assumed as a minimum distance) so that a drill rig can be properly aligned and operated to perform the drilling and sampling. Sampling locations for the small vacant lot, parking lot, and

warehouse areas will be as shown on Figures 4 or 5, and not based on grid spacing. Boring locations will be moved a short distance from the locations shown on Figures 4 and 5, as necessary, due to access limitations, surface or subsurface obstructions, overhead utility lines, and/or other conditions that limit access or could impact the safe performance of the field activities.

Before any soil boring is drilled, ITSI will check the boring locations for potential utilities by notifying Underground Service Alert (USA) and conducting utility clearance surveys. USA will be notified a minimum of two working days prior to drilling so that utility companies can mark underground conduits and pipelines around the marked locations. Each boring location will also be cleared by an independent utility locating subcontractor using surface geophysical methods to identify possible subsurface obstructions within a 10-foot radius of each proposed location. Geophysical methods may include electromagnetic induction, geomagnetics, ground penetrating radar, or a combination of methods. Suspected underground utilities will be marked on the ground with color-coded marking paint in accordance with American Public Works Association standards (e.g., red = electrical line, blue = water line, green = sanitary/storm sewer line, orange = telecommunications, yellow = gas line).

The proposed borings will be located at least 24 inches away from active underground utilities. If necessary or if the present of subsurface utilities is in doubt, hand auguring may be performed to confirm that no underground utilities and/or buried drums are located at the proposed boring locations.

Based on past drilling experiences at the Site, concrete paving thickness various from 0.5 to 6 feet. The average thickness of concrete is approximately 1-foot across most of the Off-Facility Properties. Concrete thickness varies at the former AMCO facility yard and generally is between 1 and 2 feet thick. In the northeast area of the former AMCO yard, concrete thickness is between 5 and 6 feet. The warehouse has a reinforced, concrete slab that is 4 feet thick. Concrete pavement will be cored to provide drill rig access to for drilling at the proposed borehole locations.

3.2 DRILLING AND SAMPLING METHODOLOGIES

3.2.1 Sonic Drilling

The sonic drilling method uses a hydraulic drill head that transmits high frequency, sinusoidal pressure waves through a steel drill pipe to create a cutting action at the bit face. The pressure waves are created by counter-rotating, offset balance roller weights located in the sonic drill head. The drill head is designed to operate at frequencies close to the natural frequency of the steel drill column causing the column to vibrate elastically along its longitudinal axis. In the resonant condition, the drill pipe acts like a flywheel, storing energy for intermittent release at many times the input level. Operating frequencies exceeding 150 Hertz (Hz) and forces ranging up to 250,000 pounds per cycle are generated during the operation.

By coupling the sonic drill head to the drill pipe, the cutting action developed at the bit face yields a continuous core of formation material moving into the core barrel. One drill stem affixes to the core barrel and the other drill rod encapsulates the core barrel. Both drill rods are independent, one rod ahead of the other rod. Sonic drilling proceeds in five, ten, or twenty foot core runs as dictated by sampling requirements. Once the desired amount of core is in the core barrel, the inner drill rod and core barrel are removed in sections from the borehole and the core is retrieved. The outer drill pipe remains in place to support the borehole while the core is removed. Because of the high forces developed by the resonant drill head and the external flush nature of the drill pipe, formation material displaced by the cutting face of the bit is forced either into the borehole wall or into the core barrel resulting in minimal cuttings generated in the drilling process. To enhance core quality, little, if any, rotation of the drill rods is used in this method.

The Sonic drilling continuous core sample recovery provides a representative lithological core for review and description. Core samples can be hydraulically extracted from the sample barrel. Alternatively, the Aqua-lock® sampling method can also be employed to retrieve soil samples for analytical purposes. This method consists of placing an Aqua-lock® piston in a barrel and attaching a water line to a valve head to push the piston down the barrel by the hydraulic pressure of the water. Sampling commences once the piston is at the bottom of the barrel and the water line valve is opened to advance the sampler to the desired sample depth. The sampler is slowly advanced with the soil pushing the piston up the barrel.

Sonic coring in dense, dry, consolidated or cemented formations may be subjected to drilling induced heat generated from the impact of the bit on the formation, and the friction created when the core barrel is forced into the formation. Generation of heat is not expected to occur at the Site because the Upper Aquifer formation is predominantly composed of unconsolidated silty sand and sands, materials that are ideal and usually requiring minimal energy for sonic drilling to advance. The shallow groundwater level across the Site also helps to eliminate or minimize heating effects. Even though the presence of cemented formations has not been described or observed at the Site based on past drilling logs, precautionary measures to address potential for heat generation during the drilling are planned. These measures include shortening sampling runs, changing vibration level and rotation speed, using cooling water, collecting larger diameter samples to reduce effect on the interior of the sample, and using fluid coring methods or by using alternate sampling methods (such as switching the sampling of soils and using a split barrel with autohammer).

3.2.2 Soil Sampling and logging Procedures

The proposed number of soil boring locations, depths of soil sampling, and specific analytes are identified in Table 3. Soil samples will be collected at discrete depths once the soil cores are retrieved in a liner from the sample barrel. Initially, soil samples for Volatile Organic Compound (VOC) analysis will be collected in accordance with EPA Method 5035 (Terra Core), with the soil sample transferred from the Terra Core sampler to a 40 milliliter (ml) VOA vial with preservative and then the sample vial will be capped, labeled, and sealed in a sample pouch. Sufficient soil from the liner will then be transferred to two 8-ounce glass jars (minimum of 70 grams per jar). The remaining soil core in the open liner will be inspected for soil properties and measured to determine the soil sampling depth.

Logging of soil cores will be performed in accordance with the Unified Soil Classification System (USCS) by the drilling geologist. In addition to lithologic description, observations of unusual odor, staining, color, and organic vapor readings will be noted on the boring log.

3.2.3 Borehole Abandonment

Once drilling and sampling is completed at each borehole location, the borehole will be tremie grouted with bentonite grout slurry (water, cement, and a minimum of 3 percent bentonite by weight). A rod with a disposable tip will be advanced to the total depth of the borehole and the

bentonite grout slurry will be injected as the pipe is slowly removed. To complete the borehole abandonment, the boreholes will be finished smooth at the elevation of the concrete pavement.

3.2.4 Drilling Equipment Decontamination

Portable decontamination trailers will be established for cleaning reusable sampling and drilling rods. Any down hole equipment used during the soil characterization activities will be decontaminated prior to its initial use and between boreholes thereafter. Tools will be disassembled as required so that components can be thoroughly cleaned. Down hole rods, drill pipes, and any other non-dedicated drilling equipment that come in contact with soil or groundwater will be steam-cleaned for decontamination. All decontamination water will be contained and collected for characterization and disposal.

3.3 ANALYTICAL METHODS

Soil samples will be analyzed by a commercial laboratory. Each sample submitted for laboratory analysis will be analyzed for:

- Volatile Organic Compounds (VOCs) by EPA Method 8260B
- Semi-Volatile Organic Compounds by EPA Method 8270C
- Polychlorinated biphenyls (PCBs) by EPA Method 8082
- Pesticides by EPA Method 8081A
- Metals by EPA Method 6010B/7471A
- Percent Moisture by ASTM D2216 (or equivalent). [Note: Chemical concentrations in soil will be reported on a dry weight basis.]

3.4 SURVEYING OF SAMPLING BOREHOLE LOCATIONS

Surveying to establish the east and north coordinates of the completed borehole locations at the Site will be performed using a handheld Global Positioning System (GPS) Trimble Geo XH. The Trimble Geo XH is capable of achieving sub-foot accuracy through calculation of differential correction during a post-processing phase following the collection of the raw data in the field. The collected position data will be post-processed and loaded into the AMCO Geographic Information System database as actual soil boring positions for each of the soil characterization boreholes. The horizontal coordinates (easting and northing) of the surveyed locations will be based on U.S. survey feet in California State Plane Coordinates. The horizontal datum used will be the North American Datum of 1983 (NAD 83).

3.5 MANAGEMENT OF INVESTIGATION-DERIVED WASTES

Investigation-derived waste (IDW) anticipated to be generated during field activities includes:

- Soil cuttings,
- Used personal protective equipment (PPE),
- Disposable sampling equipment, and
- Decontamination fluids.

IDW will be temporarily stored onsite for 90 days or less pending waste characterization, profiling, and final off-site transport and disposal. The required documentation for waste transport and disposal will be submitted to EPA for signature. The following standard practices for management and disposal of IDW will be followed:

- Non-soil solid IDW (such as disposable PPE and other miscellaneous waste [e.g., paper towels]) will be placed in garbage bags, sealed, and disposed of as solid waste.
- Solid IDW consisting of soil cuttings will be placed into United Nations (UN)-approved 55-gallon drums or roll-off bins.
- Liquid IDW consisting of decontamination fluids will be placed into UN-approved 55-gallon drums.
- Drums and bins containing soil or liquid IDW will be temporarily labeled as potentially hazardous waste pending analysis, and stored on-site in a locked and fenced yard pending waste characterization, profiling, and final off-site disposal.
- The generation, management, characterization, and disposal of IDW will be documented.

Profiling of the containerized IDW will be necessary for waste acceptance by an EPA-approved disposal facility. A representative sample of the IDW will be collected using a small clean trowel for soil and a clean disposable bailer for liquid IDW. Soil samples from roll-off bins containing soil cuttings will be composited and submitted to an off-site laboratory for waste characterization and profiling for disposal. For liquid IDW, a grab sample of the liquid wastes will be collected from the drums. Following collection, the IDW samples will be transferred into clean sample containers. The sample containers will be labeled, placed on ice in a cooler, and transported under chain-of-custody procedures to a California-certified analytical laboratory.

Analytical criteria will depend on the requirements of the receiving disposal facility, and are expected to include the following analyses:

- Total extractable petroleum hydrocarbons;

- VOCs;
- Polychlorinated biphenyls;
- California Administrative Manual (CAM) 17 metals (refers to a list of 17 heavy metals also known as Title 22 metals from the California Code of Regulations [CCR] Title XXII).

Additional tests, including any tests specifically required by the sampling program established for the disposal facility, may be performed based on the results of the above tests and discussions with the disposal facility.

Based on the results of the IDW sample analyses, the IDW will be properly profiled for disposal at an appropriate licensed and EPA-approved disposal facility. All waste will be transported and disposed by a licensed waste-handling subcontractor. Wastes characterized as hazardous will be disposed within 90 days of waste generation.

4.0 SAMPLE MANAGEMENT AND DOCUMENTATION REQUIREMENTS

Samples (soil and IDW) will be collected in accordance with the SAP and subsequent addendums. The procedures for sample collection, management, and analysis are detailed in the SAP Addendum (ITSI, 2011b), included as Appendix A to this Work Plan.

5.0 REPORTING OF SOIL CHARACTERIZATION RESULTS

Following completion of the final sampling activities, disposal of IDW, and evaluation of the field and analytical data, ITSI/CDM will prepare a Technical Memorandum that fully documents the fieldwork completed, presents field and laboratory analytical data, and provides an interpretation of the data and findings.

The Technical Memorandum will include the following content:

- A brief site description to clarify the site location, physiographic conditions, and geologic and hydrogeologic setting.
- An explanation of any deviations from the field procedures prescribed in the Work Plan or SAP.
- A listing of the COCs at the Site; a discussion of the field investigation and sampling methods used; a tabulation of the analytical results; and a presentation and interpretation of the field investigation and analytical results .

- A record of IDW management and disposal.
- A list of references.

Tables and Figures planned for the Technical Memorandum will include the following:

- A site map showing the soil borehole and sampling locations.
- Site maps showing the estimated extent of COCs, with a separate site map for each major COC.
- One or more cross-sections across the Site showing geologic units and displaying the distribution of COCs.
- A listing of the analytical methods used.
- A tabular summary with complete analytical results for all samples, including detected and non-detected results with qualifiers.

The Technical Memorandum will also contain appendices for:

- Analytical results, including certificates of analyses, chain-of-custody documentation, and data validation reports;
- Field notes, borehole logs; photographic log and
- Documentation of IDW final management.

6.0 SCHEDULE

The proposed schedule for implementing this work is provided as Figure 6. ITSI estimates that the field tasks outlined in this Work Plan will take approximately 6 months to complete. The table below shows the approximate or tentative project schedule. The actual project starting date will depend on EPA's approval of this Work Plan.

WORK ACTIVITY	DATE	DURATION
Soil Characterization Work Plan	November 2011	Completed
Implement Work Plan	November 2011 – April 2012	6 Months
Soil Characterization Technical Memorandum	February 2012 - June 2012	4 Months

7.0 REFERENCES

CH2M-Hill, 2004a. *Remedial Investigation Sampling and Analysis Plan, AMCO Chemical Superfund Site*. August.

CH2M-Hill, 2004b. *Addendum 1 to the Remedial Investigation Sampling and Analysis Plan: Additional Sample Control Procedures, AMCO Chemical Superfund Site*. December 21.

CH2M-Hill, 2011. *Final Report - Remedial Investigation, AMCO Chemical Superfund Site*. January.

Innovative Technical Solutions, Inc. (ITSI), 2010. *2010 Addendum to the Remedial Investigation Sampling and Analysis Plan, AMCO Chemical Superfund Site*. July 6.

ITSI, 2011a. *Site-Specific Health and Safety Plan*. Remedial Investigations and Pre-Design Investigations, AMCO Chemical Superfund Site. Revision 26. August.

ITSI, 2011b. *2011 Addendum to the Remedial Investigation Sampling and Analysis Plan, AMCO Chemical Superfund Site*. October.

U.S. Environmental Protection Agency (EPA), 2002. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*. OSWER 9355.4-24. December

TABLES

TABLE 1

Summary of Screening Levels for Key Contaminants

AMCO Chemical Superfund Site, Oakland, CA

	Contaminants	Soil Screening Level (micrograms per kilogram)	Source
Metals	Antimony	31,000	RSL
	Arsenic	14,000*	RSL
	Barium	15,000,000	RSL
	Beryllium	1,400,000	RSL
	Cadmium	70,000	RSL
	Chromium	120,000,000	RSL
	Cobalt	370,000	RSL
	Copper	3,100,000	RSL
	Lead	400,000	RSL
	Nickel	13,000,000	RSL
	Silver	390,000	RSL
	Vanadium	390,000	RSL
	Zinc	23,000,000	RSL
Pesticides	4'4-DDT	1,700	RSL
	DDD	2,000	RSL
	DDE	1,400	RSL
	Aldrin	29	RSL
	alpha-Chlordane	1,600	RSL
	Dieldrin	30	RSL
PCBs	Aroclor-1260	220	RSL
SVOCs	2-Methylnaphthalene	310,000	RSL
	2,4-Dimethylphenol	1,200,000	RSL
	2-Methylphenol (o-Cresol)	3,100,000	RSL
	4-Methylphenol (p-Cresol)	310,000	RSL
	Acenaphthene	3,400,000	RSL
	Anthracene	17,000,000	RSL
	Benzo(a)anthracene	150	RSL
	Benzo(a)Pyrene	15	RSL
	Benzo(b)fluoranthene	150	RSL
	Benzo(g,h,i)perylene	27,000	ESL
	Benzo(k)fluoranthene	1,500	RSL
	Biphenyl (Diphenyl)	80,000	RSL
	bis(2-Ethylhexyl) Phthalate	35,000	RSL
	Caprolactam	31,000,000	RSL
	Chrysene	15,000	RSL
	Di-n-Butyl Phthalate	6,100,000	RSL
	Dibenzofuran	78,000	RSL
	Diethyl Phthalate	49,000,000	RSL
	Fluoranthene	2,300,000	RSL
	Fluorene	2,300,000	RSL
	Indeno(1,2,3-c,d)pyrene	150	RSL
	Isophorone	510,000	RSL
	Naphthalene	3,600	RSL
	Phenanthrene	11,000	ESL
	Phenol	18,000,000	RSL
	Pyrene	1,700,000	RSL
	Petroleum Hydrocarbons (as Diesel)	100,000	ESL
	Petroleum Hydrocarbons (as Motor Oil)	370,000	ESL

TABLE 1

Summary of Screening Levels for Key Contaminants

AMCO Chemical Superfund Site, Oakland, CA

	Contaminants	Soil Screening Level (micrograms per kilogram)	Source
VOCs	1,1-Dichloroethane	3,300	RSL
	1,1,1-Trichloroethane	8,700,000	RSL
	1,1,2-Trichloroethane	1,100	RSL
	1,1-Dichloroethene	240,000	RSL
	1,2,4-Trichlorobenzene	22,000	RSL
	1,2,4-Trimethylbenzene	62,000	RSL
	1,2-Dichlorobenzene	1,900,000	RSL
	1,3,5-Trimethylbenzene	780,000	RSL
	1,3-Dichlorobenzene	7,400	ESL
	1,4-Dichlorobenzene	2,400	RSL
	1,4-Dioxane (p-Dioxane)	4,900	RSL
	2-Butanone (MEK)	28,000,000	RSL
	4-Methyl-2-pentanone (MIBK)	5,300,000	RSL
	Acetone	61,000,000	RSL
	Benzene	1,100	RSL
	Bromomethane	7,300	RSL
	Carbon Disulfide	820,000	RSL
	Chlorobenzene	290,000	RSL
	Chloroethane	850	ESL
	Chloromethane	120,000	RSL
	Cyclohexane	13,000,000	RSL
	cis-1,2-dichloroethene	160,000	RSL
	trans-1,2-Dichloroethene	150,000	RSL
	Ethylbenzene	5,400	RSL
	Isopropylbenzene (Cumene)	2,100,000	RSL
	m,p-Xylene	590,000	RSL
	Methylene Chloride	11,000	RSL
	o-Xylene	690,000	RSL
	tert-Butyl Methyl Ether (MTBE)	43,000	RSL
	Tetrachloroethene (PCE)	550	RSL
	Trichloroethene	2,800	RSL
	Toluene	5,000,000	RSL
	tert-Butyl Alcohol	100,000	ESL
	Vinyl Chloride	60	RSL

Notes:

* Background for Arsenic in Bay Area soils is 14 mg/kg as reported in the Remedial Investigation Report (CH2MHill, 2011). RSL for arsenic in residential soil is 390 µg/kg.

(1) Residential Regional Screening Levels (RSLs):

Source: USEPA 2011 (June), obtained online at: http://www.epa.gov/region9/superfund/prg/ at location listed below.
Soil - http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/ressoil_sl_table_run_JUN2011.pdf

(2) Environmental Screening Levels (ESLs)

Source: San Francisco Regional Water Quality Control Board (RWQCB) (May 2008) using Table A-1 (Shallow Soil, Residential Land Use, groundwater potential drinking water) obtained online at:
http://www.swrcb.ca.gov/sanfranciscobay/water_issues/available_documents/ESL_May_2008.pdf

Table 2
Investigation Areas and Sampling Rationale
AMCO Superfund Site, Oakland, California

Investigation Area	Number of Borings	Sampling Depth* (feet bgs)	Rationale
AMCO Facility Yard	74	1, 3, 5, 8, 13, 20, 30, 40, 50, 60, 65, 70	Assess the extent of soil impacted by VOCs, SVOCs, metals, PCBs, and pesticides across the yard and further define the boundary of VOCs and other COCs, particularly within the source area (chemical delivery by rail)
AMCO Warehouse Building	9	1, 3, 5, 8, 13, 20, 30, 40, 50, 60, 65, 70	Assess the extent of soil impacted by VOCs, SVOCs, metals, PCBs, and pesticides under the warehouse
Large Vacant Lot	36	1, 3, 5, 8, 13, 20, 30, 40, 50, 60, 65, 70	Assess the extent of soil impacted by VOCs, SVOCs, metals, PCBs, and pesticides
Small Vacant Lot	3	1, 3, 5, 8, 13, 20, 30, 40, 50, 60, 65, 70	Assess the extent of soil impacted by VOCs, SVOCs, metals, PCBs, and pesticides from a possible secondary source (e.g., surface run-off)
Parking Lot	3	1, 3, 5, 8, 13, 20, 30, 40, 50, 60, 65, 70	Assess the extent of soil impacted by VOCs, SVOCs, metals, PCBs, and pesticides from a possible secondary source (e.g., previous site usage by DC Metals and others)

Explanation:
bgs = below ground surface
* Anticipated depth of sampling from the top of soil surface (bottom of concrete or asphalt pavement) to define the vertical extent of contamination.

Table 3
Planned Sampling for the Soil Characterization
AMCO Superfund Site, Oakland, California

Soil Boring Location	Targeted Sampling Depth from Top of Soil Surface (feet) *	Medium	VOCs	SVOCs	Metals	PCBs	Pesticides	Notes
Warehouse Building								
SC-001	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-001	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-001	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-002	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-002	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-002	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-003	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-003	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-003	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-004	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-004	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-004	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-005	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-005	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-005	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-006	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-006	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-006	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-007	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-007	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-007	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)
SC-008	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-008	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-008	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-009	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-009	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-009	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)
Former AMCO Yard								
SC-010	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-010	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-010	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-011	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-011	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-011	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-012	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-012	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-012	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation

Table 3
Planned Sampling for the Soil Characterization
AMCO Superfund Site, Oakland, California

Soil Boring Location	Targeted Sampling Depth from Top of Soil Surface (feet) *	Medium	VOCs	SVOCs	Metals	PCBs	Pesticides	Notes
SC-013	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-013	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-013	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-014	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-014	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-014	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-015	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-015	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-015	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)
SC-016	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-016	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-016	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-017	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-017	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-017	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-018	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-018	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-018	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-019	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-019	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-019	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-020	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-020	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-020	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)
SC-021	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-021	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-021	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-022	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-022	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-022	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-023	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-023	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-023	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-024	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-024	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-024	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)
SC-025	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-025	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-025	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation

Table 3
Planned Sampling for the Soil Characterization
AMCO Superfund Site, Oakland, California

Soil Boring Location	Targeted Sampling Depth from Top of Soil Surface (feet) *	Medium	VOCs	SVOCs	Metals	PCBs	Pesticides	Notes
SC-026	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-026	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-026	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-027	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-027	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-027	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-028	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-028	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-028	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-029	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-029	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-029	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-030	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-030	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-030	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-031	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-031	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-031	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-032	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-032	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-032	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-033	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-033	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-033	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-034	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-034	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-034	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-035	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-035	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-035	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)
SC-036	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-036	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-036	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-037	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-037	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-037	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-038	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-038	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-038	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation

Table 3
Planned Sampling for the Soil Characterization
AMCO Superfund Site, Oakland, California

Soil Boring Location	Targeted Sampling Depth from Top of Soil Surface (feet) *	Medium	VOCs	SVOCs	Metals	PCBs	Pesticides	Notes
SC-039	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-039	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-039	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-040	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-040	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-040	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)
SC-041	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-041	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-041	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-042	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-042	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-042	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-043	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-043	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-043	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)
SC-044	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-044	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-044	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-045	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-045	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-045	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-046	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-046	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-046	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-047	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-047	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-047	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-048	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-048	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-048	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)
SC-049	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-049	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-049	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-050	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-050	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation.
SC-050	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-051	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-051	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-051	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)

Table 3
Planned Sampling for the Soil Characterization
AMCO Superfund Site, Oakland, California

Soil Boring Location	Targeted Sampling Depth from Top of Soil Surface (feet) *	Medium	VOCs	SVOCs	Metals	PCBs	Pesticides	Notes
SC-052	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-052	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-052	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-053	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-053	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-053	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-054	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-054	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-054	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)
SC-055	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-055	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-055	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-056	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-056	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-056	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-057	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-057	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-057	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-058	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-058	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-058	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-059	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-059	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-059	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-060	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-060	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-060	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)
SC-061	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-061	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-061	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-062	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-062	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-062	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-063	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-063	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-063	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-064	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-064	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-064	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation

Table 3
Planned Sampling for the Soil Characterization
AMCO Superfund Site, Oakland, California

Soil Boring Location	Targeted Sampling Depth from Top of Soil Surface (feet) *	Medium	VOCs	SVOCs	Metals	PCBs	Pesticides	Notes
SC-065	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-065	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-65	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-066	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-066	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-066	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-067	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-067	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-067	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-068	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-068	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-068	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-069	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-069	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-069	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-070	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-070	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-070	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-071	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-071	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-071	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-072	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-072	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-072	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)
SC-073	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-073	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-073	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-074	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-074	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-074	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-075	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-075	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-075	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-076	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-076	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-076	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-077	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-077	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-077	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation

Table 3
Planned Sampling for the Soil Characterization
AMCO Superfund Site, Oakland, California

Soil Boring Location	Targeted Sampling Depth from Top of Soil Surface (feet) *	Medium	VOCs	SVOCs	Metals	PCBs	Pesticides	Notes
SC-078	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-078	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-078	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-079	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-079	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-079	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-080	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-080	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-080	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-081	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-081	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-081	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-082	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-082	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-082	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-083	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-083	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-083	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
Large Vacant Lot								
SC-084	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-084	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-084	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-085	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-085	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-085	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-086	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-086	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-086	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-087	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-087	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-087	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-088	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-088	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-088	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)
SC-089	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-089	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-089	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation

Table 3
Planned Sampling for the Soil Characterization
AMCO Superfund Site, Oakland, California

Soil Boring Location	Targeted Sampling Depth from Top of Soil Surface (feet) *	Medium	VOCs	SVOCs	Metals	PCBs	Pesticides	Notes
SC-090	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-090	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-090	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-091	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-091	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-091	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-092	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-092	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-092	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-093	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-093	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-093	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-094	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-094	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-094	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-095	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-095	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-095	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-096	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-096	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-096	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)
SC-097	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-097	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-097	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)
SC-098	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-098	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-098	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-099	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-099	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-099	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-100	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-100	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-100	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-101	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-101	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-101	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-102	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-102	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-102	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)

Table 3
Planned Sampling for the Soil Characterization
AMCO Superfund Site, Oakland, California

Soil Boring Location	Targeted Sampling Depth from Top of Soil Surface (feet) *	Medium	VOCs	SVOCs	Metals	PCBs	Pesticides	Notes
SC-103	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-103	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-103	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-104	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-104	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-104	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-105	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-105	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-105	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-106	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-106	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-106	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-107	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-107	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-107	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-108	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-108	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-108	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-109	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-109	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-109	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-110	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-110	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-110	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-111	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-111	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-111	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-112	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-112	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-112	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)
SC-113	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-113	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-113	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-114	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-114	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-114	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-115	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-115	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-115	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation

Table 3
Planned Sampling for the Soil Characterization
AMCO Superfund Site, Oakland, California

Soil Boring Location	Targeted Sampling Depth from Top of Soil Surface (feet) *	Medium	VOCs	SVOCs	Metals	PCBs	Pesticides	Notes
SC-116	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-116	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-116	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-117	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-117	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-117	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-118	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-118	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-118	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-119	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-119	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-119	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
Small Vacant Lot								
SC-120	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-120	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-120	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-121	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-121	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-121	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-122	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-122	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation (collect one ms/msd sample)
SC-122	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
Parking Lot								
SC-123	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation (collect one ms/msd sample)
SC-123	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-123	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-124	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-124	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-124	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation
SC-125	1, 3, 5, 8, 13, 20, 30, 40, 50, 60	Soil	X	X	X	X	X	Merritt Sands Formation
SC-125	65 (see Note 1)	Soil	X	X	X	X	X	Base of Merritt Sands Formation
SC-125	70 (see Note 2)	Soil	X	X	X	X	X	Older Bay Mud Formation (collect one ms/msd sample)

Table 3
Planned Sampling for the Soil Characterization
AMCO Superfund Site, Oakland, California

Soil Boring Location	Targeted Sampling Depth from Top of Soil Surface (feet) *	Medium	VOCs	SVOCs	Metals	PCBs	Pesticides	Notes

Notes:

Analytes (All soil concentrations determined based on dry weight)
VOCs = Volatile organic compounds (analyzed by EPA Method 8260 B)
SVOCs = Semivolatile organic compounds (analyzed by EPA Method 8270C)
PCBs = Polychlorinated biphenyls (analyzed by EPA Method 8082)
Metals (analyzed by EPA Method 6010B/7471A)
Pesticides (analyzed by EPA Method 8081A)

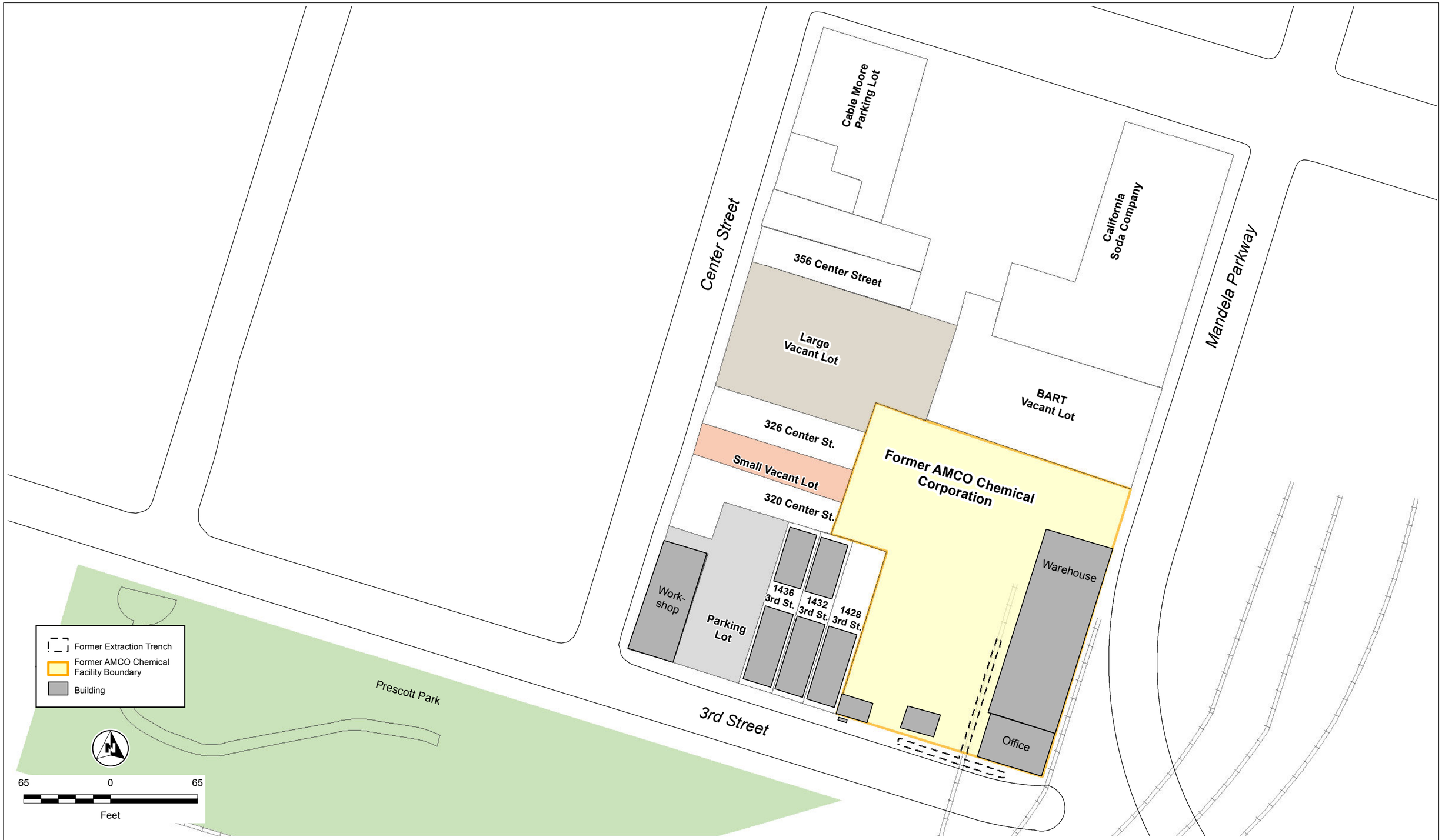
* Sampling depths may vary being adjusted based on visual field observation of soil cores.
1. Estimated depth to the base of the Upper Aquifer (Merritt Sands). Actual depth may vary.
2. Estimated depth from the ground surface to 5 feet below the top of the Older Bay Mud. Actual depth may vary.

FIGURES

USEPA, Region 9
AMCO Chemical Superfund Site
Oakland, California

FIGURE 1
Site Location Map

G:\ArcGIS\EPA\AMCO_Chemical\PROJECTS\Indoor_Air\Figure_1.mxd 8/31/2010 ITSI-WC Eloise Anderson

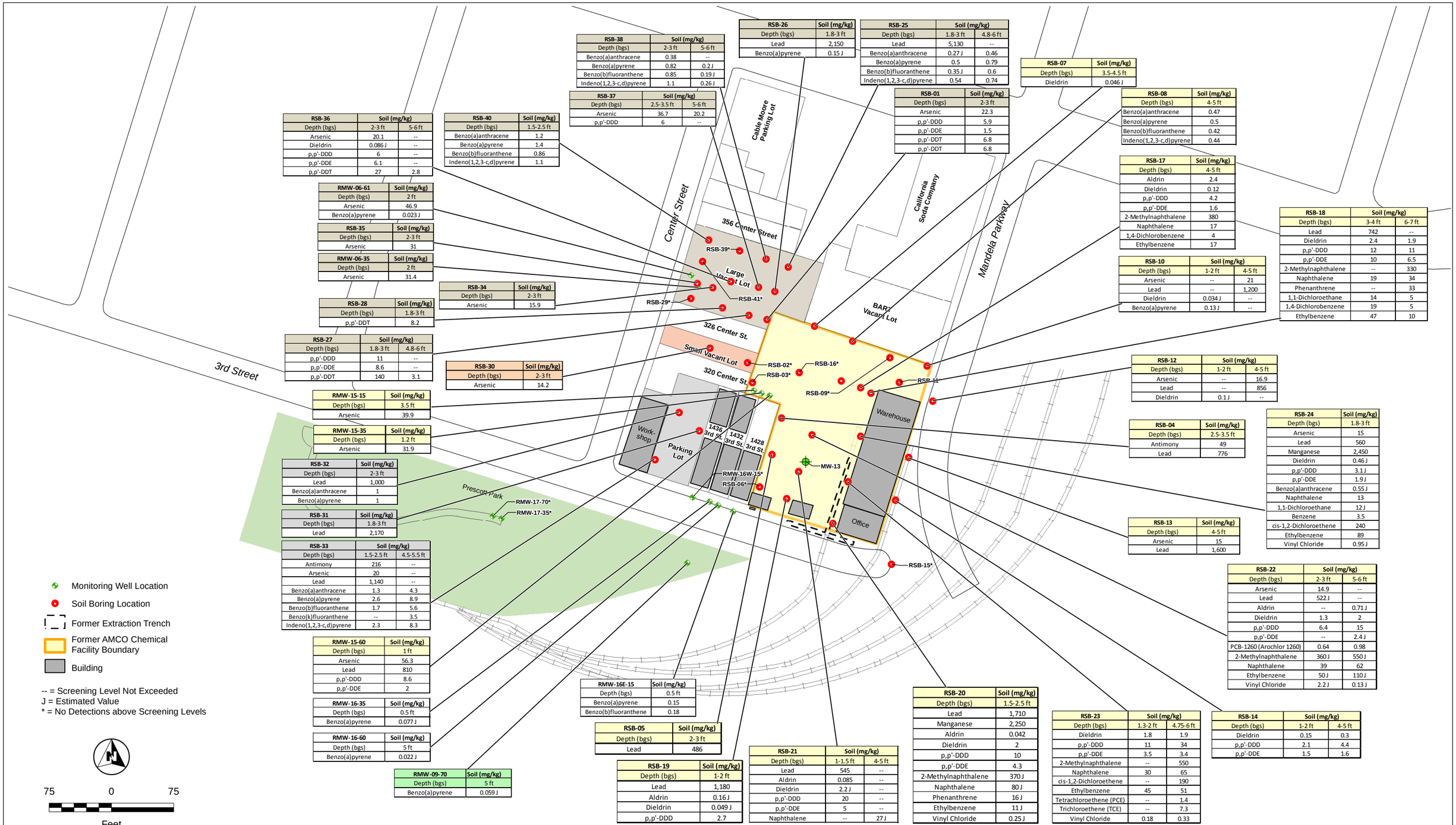


Innovative Technical Solutions, Inc.
A Gilbane Company

AMCO Chemical Superfund Site
Oakland, California

FIGURE 2
Site Plan

G:\ArcGIS\EPA\AMCO_Chemical\PROJECTS\WP\RI_Soil_Exceedances_NoTables_1117.mxd 10/7/2011 [14:36 PM] EANDERSON, ITSI



RSB-38	Soil (mg/kg)	
Depth (bgs)	2-3 ft	5-6 ft
Benzo(a)anthracene	0.38	--
Benzo(a)pyrene	0.82	0.2 J
Benzo(b)fluoranthene	0.85	0.19 J
Indeno(1,2,3-c,d)pyrene	1.1	0.26 J

RSB-26	Soil (mg/kg)
Depth (bgs)	1.8-3 ft
Lead	2,150
Benzo(a)pyrene	0.15 J

RSB-25	Soil (mg/kg)	
Depth (bgs)	1.8-3 ft	4.8-6 ft
Lead	5,130	--
Benzo(a)anthracene	0.27 J	0.46
Benzo(a)pyrene	0.5	0.79
Benzo(b)fluoranthene	0.35 J	0.6
Indeno(1,2,3-c,d)pyrene	0.54	0.74

RSB-07	Soil (mg/kg)
Depth (bgs)	3.5-4.5 ft
Dieldrin	0.046 J

RSB-37	Soil (mg/kg)	
Depth (bgs)	2.5-3.5 ft	5-6 ft
Arsenic	36.7	20.2
p,p'-DDD	6	--

RSB-01	Soil (mg/kg)
Depth (bgs)	2-3 ft
Arsenic	22.3
p,p'-DDD	5.9
p,p'-DDE	1.5
p,p'-DDT	6.8
p,p'-DDT	6.8

RSB-08	Soil (mg/kg)
Depth (bgs)	4-5 ft
Benzo(a)anthracene	0.47
Benzo(a)pyrene	0.5
Benzo(b)fluoranthene	0.42
Indeno(1,2,3-c,d)pyrene	0.44

RSB-36	Soil (mg/kg)	
Depth (bgs)	2-3 ft	5-6 ft
Arsenic	20.1	--
Dieldrin	0.086 J	--
p,p'-DDD	6	--
p,p'-DDE	6.1	--
p,p'-DDT	27	2.8

RSB-40	Soil (mg/kg)
Depth (bgs)	1.5-2.5 ft
Benzo(a)anthracene	1.2
Benzo(a)pyrene	1.4
Benzo(b)fluoranthene	0.86
Indeno(1,2,3-c,d)pyrene	1.1

RSB-17	Soil (mg/kg)
Depth (bgs)	4-5 ft
Aldrin	2.4
Dieldrin	0.12
p,p'-DDD	4.2
p,p'-DDE	1.6
2-Methylnaphthalene	380
Naphthalene	17
1,4-Dichlorobenzene	4
Ethylbenzene	17

RMW-06-61	Soil (mg/kg)
Depth (bgs)	2 ft
Arsenic	46.9
Benzo(a)pyrene	0.023 J

RSB-35	Soil (mg/kg)
Depth (bgs)	2-3 ft
Arsenic	31

RMW-06-35	Soil (mg/kg)
Depth (bgs)	2 ft
Arsenic	31.4

RSB-34	Soil (mg/kg)
Depth (bgs)	2-3 ft
Arsenic	15.9

RSB-18	Soil (mg/kg)	
Depth (bgs)	3-4 ft	6-7 ft
Lead	742	--
Dieldrin	2.4	1.9
p,p'-DDD	12	11
p,p'-DDE	10	6.5
2-Methylnaphthalene	--	330
Naphthalene	19	34
Phenanthrene	--	33
1,1-Dichloroethane	14	5
1,4-Dichlorobenzene	19	5
Ethylbenzene	47	10

RSB-10	Soil (mg/kg)	
Depth (bgs)	1-2 ft	4-5 ft
Arsenic	--	21
Lead	--	1,200
Dieldrin	0.034 J	--
Benzo(a)pyrene	0.13 J	--

RSB-28	Soil (mg/kg)
Depth (bgs)	1.8-3 ft
p,p'-DDT	8.2

RSB-27	Soil (mg/kg)	
Depth (bgs)	1.8-3 ft	4.8-6 ft
p,p'-DDD	11	--
p,p'-DDE	8.6	--
p,p'-DDT	140	3.1

RSB-30	Soil (mg/kg)
Depth (bgs)	2-3 ft
Arsenic	14.2

RSB-12	Soil (mg/kg)	
Depth (bgs)	1-2 ft	4-5 ft
Arsenic	--	16.9
Lead	--	856
Dieldrin	0.1 J	--

RMW-15-15	Soil (mg/kg)
Depth (bgs)	3.5 ft
Arsenic	39.9

RSB-04	Soil (mg/kg)
Depth (bgs)	2.5-3.5 ft
Antimony	49
Lead	776

RSB-24	Soil (mg/kg)
Depth (bgs)	1.8-3 ft
Arsenic	15
Lead	560
Manganese	2,450
Dieldrin	0.46 J
p,p'-DDD	3.1 J
p,p'-DDE	1.9 J
Benzo(a)anthracene	0.55 J
Naphthalene	13
1,1-Dichloroethane	12 J
Benzene	3.5
cis-1,2-Dichloroethene	240
Ethylbenzene	89
Vinyl Chloride	0.95 J

RMW-15-35	Soil (mg/kg)
Depth (bgs)	1.2 ft
Arsenic	31.9

RSB-32	Soil (mg/kg)
Depth (bgs)	2-3 ft
Lead	1,000
Benzo(a)anthracene	1
Benzo(a)pyrene	1

RSB-31	Soil (mg/kg)
Depth (bgs)	1.8-3 ft
Lead	2,170

RSB-13	Soil (mg/kg)
Depth (bgs)	4-5 ft
Arsenic	15
Lead	1,600

RSB-33	Soil (mg/kg)	
Depth (bgs)	1.5-2.5 ft	4.5-5.5 ft
Antimony	216	--
Arsenic	20	--
Lead	1,140	--
Benzo(a)anthracene	1.3	4.3
Benzo(a)pyrene	2.6	8.9
Benzo(b)fluoranthene	1.7	5.6
Benzo(k)fluoranthene	--	3.5
Indeno(1,2,3-c,d)pyrene	2.3	8.3

RSB-22	Soil (mg/kg)	
Depth (bgs)	2-3 ft	5-6 ft
Arsenic	14.9	--
Lead	522 J	--
Aldrin	--	0.71 J
Dieldrin	1.3	2
p,p'-DDD	6.4	15
p,p'-DDE	--	2.4 J
PCB-1260 (Arochlor 1260)	0.64	0.98
2-Methylnaphthalene	360 J	550 J
Naphthalene	39	62
Ethylbenzene	50 J	110 J
Vinyl Chloride	2.2 J	0.13 J

RMW-15-60	Soil (mg/kg)
Depth (bgs)	1 ft
Arsenic	56.3
Lead	810
p,p'-DDD	8.6
p,p'-DDE	2

RMW-16E-15	Soil (mg/kg)
Depth (bgs)	0.5 ft
Benzo(a)pyrene	0.15
Benzo(b)fluoranthene	0.18

RSB-20	Soil (mg/kg)
Depth (bgs)	1.5-2.5 ft
Lead	1,710
Manganese	2,250
Aldrin	0.042
Dieldrin	2
p,p'-DDD	10
p,p'-DDE	4.3
2-Methylnaphthalene	370 J
Naphthalene	80 J
Phenanthrene	16 J
Ethylbenzene	11 J
Vinyl Chloride	0.25 J

RSB-23	Soil (mg/kg)	
Depth (bgs)	1.3-2 ft	4.75-6 ft
Dieldrin	1.8	1.9
p,p'-DDD	11	34
p,p'-DDE	3.5	3.4
2-Methylnaphthalene	--	550
Naphthalene	30	65
cis-1,2-Dichloroethene	--	190
Ethylbenzene	45	51
Tetrachloroethene (PCE)	--	1.4
Trichloroethene (TCE)	--	7.3
Vinyl Chloride	0.18	0.33

RSB-14	Soil (mg/kg)	
Depth (bgs)	1-2 ft	4-5 ft
Dieldrin	0.15	0.3
p,p'-DDD	2.1	4.4
p,p'-DDE	1.5	1.6

RMW-16-35	Soil (mg/kg)
Depth (bgs)	0.5 ft
Benzo(a)pyrene	0.077 J

RSB-05	Soil (mg/kg)
Depth (bgs)	2-3 ft
Lead	486

RMW-16-60	Soil (mg/kg)
Depth (bgs)	5 ft
Benzo(a)pyrene	0.022 J

RSB-21	Soil (mg/kg)	
Depth (bgs)	1-1.5 ft	4-5 ft
Lead	545	--
Aldrin	0.085	--
Dieldrin	2.2 J	--
p,p'-DDD	20	--
p,p'-DDE	5	--
Naphthalene	--	27 J

RSB-19	Soil (mg/kg)
Depth (bgs)	1-2 ft
Lead	1,180
Aldrin	0.16 J
Dieldrin	0.049 J
p,p'-DDD	2.7

RMW-09-70	Soil (mg/kg)
Depth (bgs)	5 ft
Benzo(a)pyrene	0.059 J

Monitoring Well Location

Soil Boring Location

Former Extraction Trench

Former AMCO Chemical Facility Boundary

Building

-- = Screening Level Not Exceeded
J = Estimated Value
* = No Detections above Screening Levels

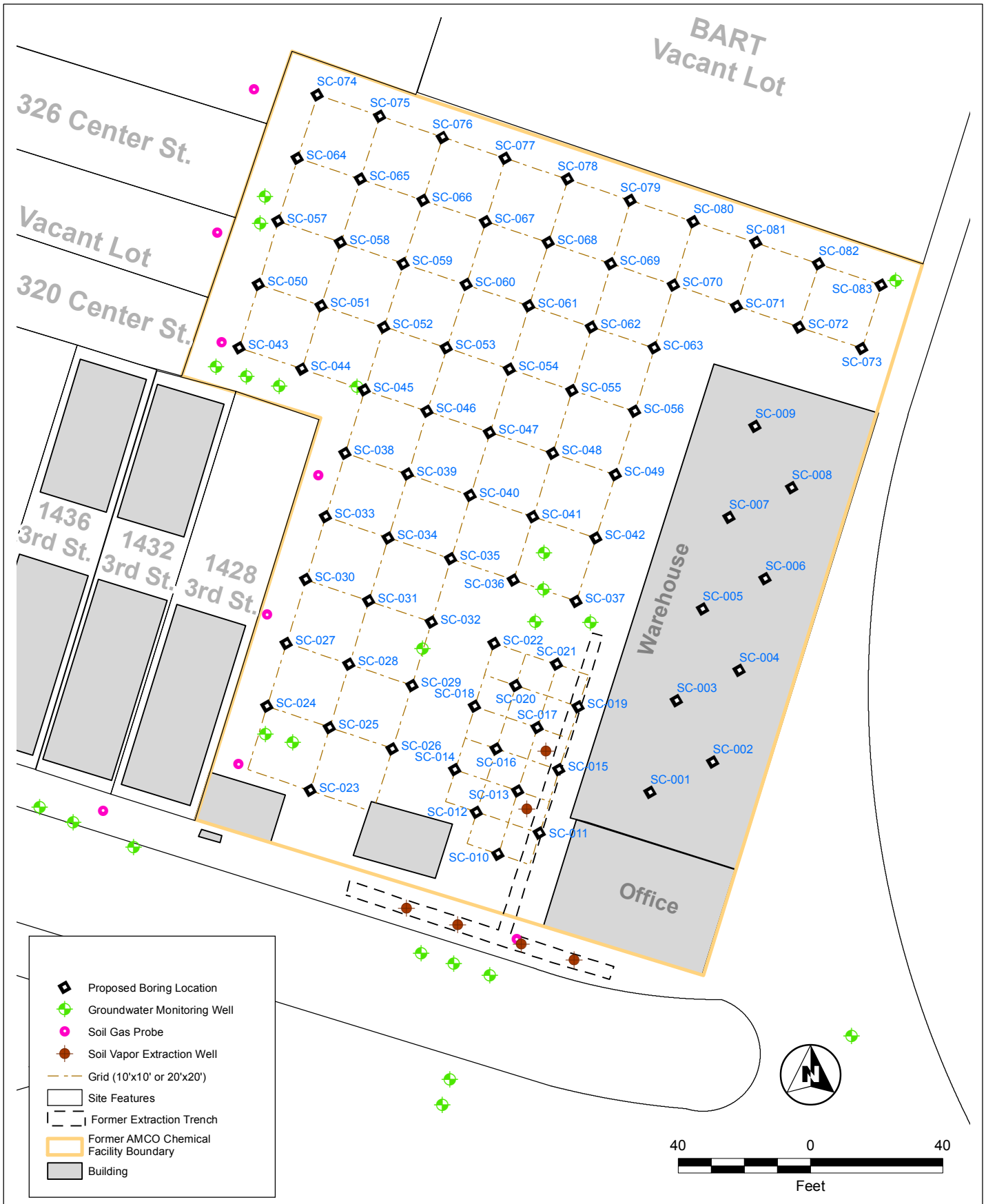
75 0 75
Feet

ITSI Innovative Technical Solutions, Inc.
A Gilbane Company

AMCO Chemical Superfund Site
Oakland, California

FIGURE 3
Soil Concentrations Above Screening Levels
Remedial Investigation

G:\ArcGIS\EPA\AMCO_Chemical\PROJECTS\WP\RI_Soil_Exceedances_RSG_1117.mxd 10/7/2011 [14:32 PM] EANDERSON, ITSI

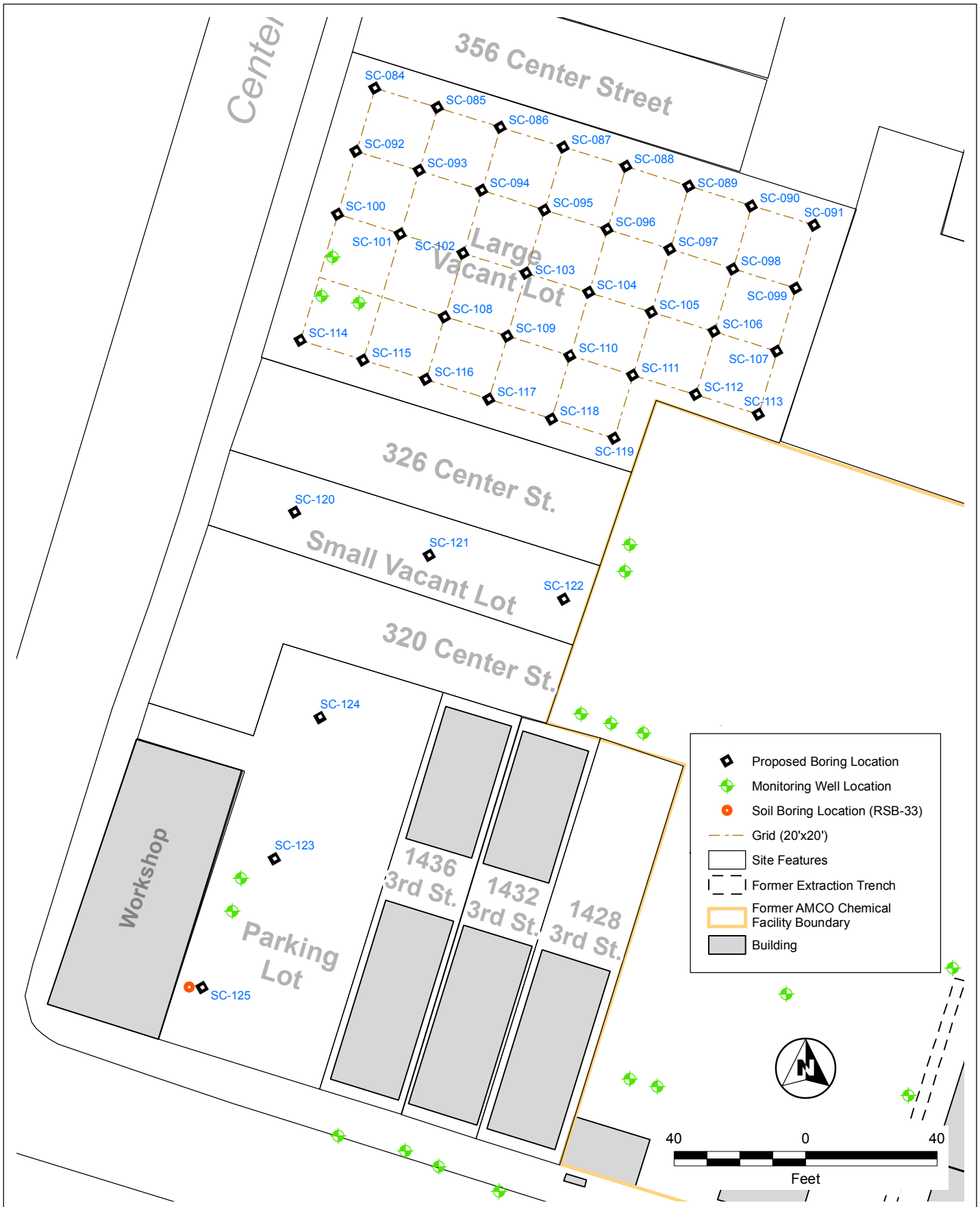


Innovative Technical Solutions, Inc.
A Gilbane Company

AMCO Chemical Superfund Site
Oakland, California

FIGURE 4
Proposed Sampling Grid and Boring Locations at Former AMCO Facility Yard and Warehouse Building

G:\ArcGIS\EPA\AMCO_Chemical\PROJECTS\Soil_Characrtzn\Grid_Right_Former_AMCO_Bndry.mxd 10/6/2011 [09:17 AM] AZHUK, ITSI



Innovative Technical Solutions, Inc.
A Gilbane Company

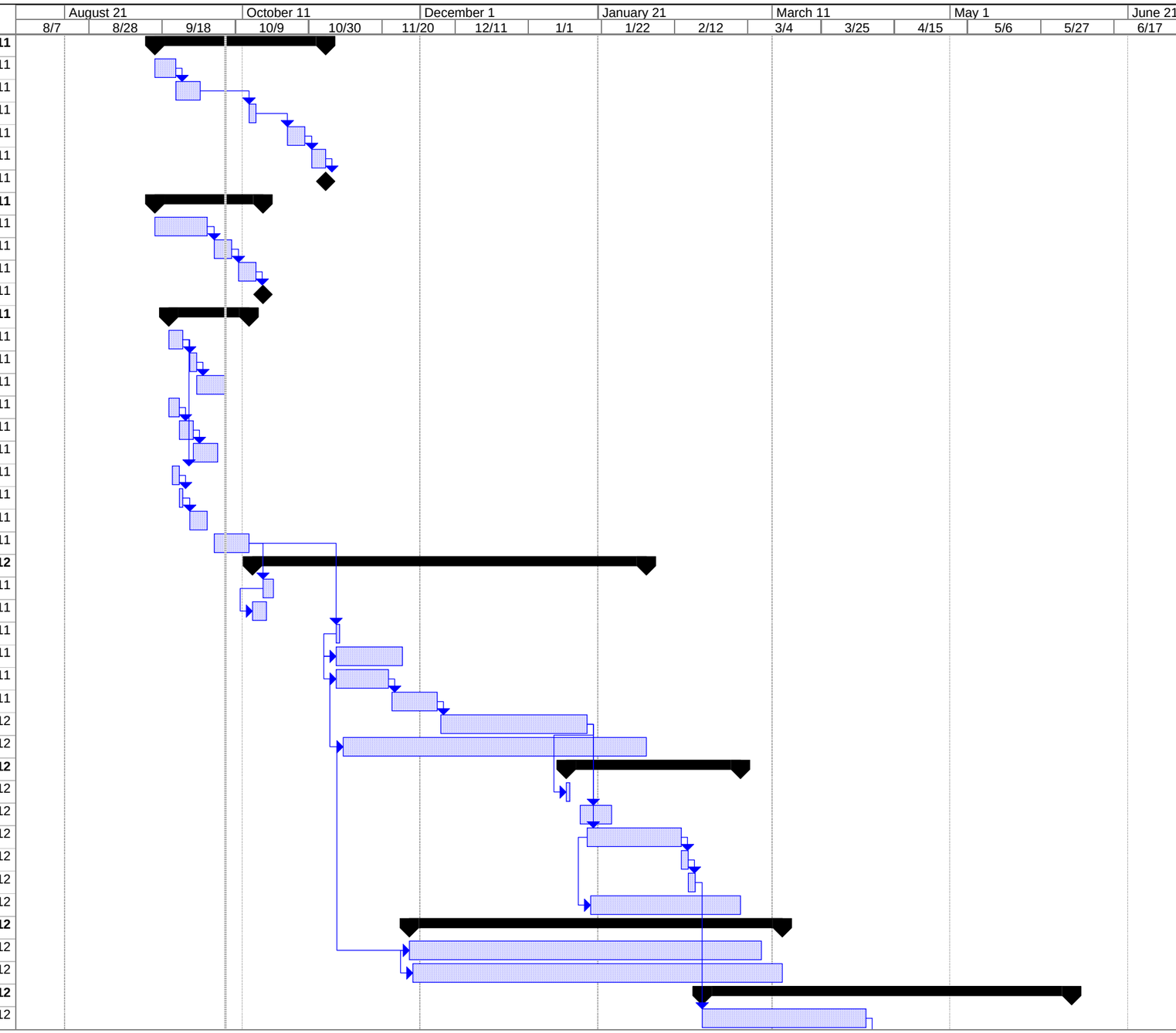
AMCO Chemical Superfund Site
Oakland, California

FIGURE 5
Proposed Sampling Grid and Boring Locations at the Large Vacant Lot, Small Vacant Lot, and Parking Lot

G:\ArcGIS\EPA\AMCO_Chemical\PROJECTS\Soil_Characrtzn\Grid_Left_Lots.mxd 10/6/2011 [09:27 AM] AZHUK, ITSI

Figure 6 - AMCO Soil Characterization Schedule

ID	Task Name	Duration	Start	Finish
1	**Geophysical Investigaton**	**35 days**	**Fri 9/16/11**	**Thu 11/3/11**
2	Prepare SOW for Geophy. Inv	4 days	Fri 9/16/11	Wed 9/21/11
3	Procure Geophysicist	5 days	Thu 9/22/11	Wed 9/28/11
4	Perform Geophysical Investigation	2 days	Thu 10/13/11	Fri 10/14/11
5	Prepare Geophysical Investigation Memo	5 days	Mon 10/24/11	Fri 10/28/11
6	Review Geophysical Inv Memo	4 days	Mon 10/31/11	Thu 11/3/11
7	Submit Geophysical Investigation memo	0 days	Thu 11/3/11	Thu 11/3/11
8	**Plan Soil Characterization**	**21 days**	**Fri 9/16/11**	**Mon 10/17/11**
9	Prepared Work Plan (draft)	11 days	Fri 9/16/11	Fri 9/30/11
10	Review Work Plan (draft)	5 days	Mon 10/3/11	Fri 10/7/11
11	Finalize Work Plan	5 days	Mon 10/10/11	Fri 10/14/11
12	Submit Work Plan to EPA RPM	0 days	Mon 10/17/11	Mon 10/17/11
13	**Procure Subcontractors**	**17 days?**	**Tue 9/20/11**	**Wed 10/12/11**
14	Prepare SOW for Driller	4 days	Tue 9/20/11	Fri 9/23/11
15	Review and Approve Drilling SOW	2 days	Mon 9/26/11	Tue 9/27/11
16	Bid Preparation by Drillers	6 days	Wed 9/28/11	Wed 10/5/11
17	Prepare SOW for Analytical	3 days	Tue 9/20/11	Thu 9/22/11
18	Review and Approve Analytical SOW	2 days	Fri 9/23/11	Mon 9/26/11
19	Bid Preparation by Anal. Labs	5 days	Tue 9/27/11	Mon 10/3/11
20	Prepare SOW for Waste Hauler	2 days	Wed 9/21/11	Thu 9/22/11
21	Review and Approve Waste Hauler SOW	1 day	Fri 9/23/11	Fri 9/23/11
22	Bid Preparation by Waste Haulers	5 days	Mon 9/26/11	Fri 9/30/11
23	Procure Subcontrated Services	8 days?	Mon 10/3/11	Wed 10/12/11
24	**Field Investigation - AMCO**	**81 days**	**Fri 10/14/11**	**Fri 2/3/12**
25	USA Notification	3 days	Mon 10/17/11	Wed 10/19/11
26	Mark all boring locations	2 days	Fri 10/14/11	Mon 10/17/11
27	Mobilization-Equipment and Subs	1 day	Mon 11/7/11	Mon 11/7/11
28	Perform Concrete Coring (AMCO only)	15 days	Mon 11/7/11	Fri 11/25/11
29	Perform Source Area Borings (20)	11 days	Mon 11/7/11	Mon 11/21/11
30	Perform Warehouse Borings (9)	9 days	Wed 11/23/11	Mon 12/5/11
31	Perform Other AMCO Yard Borings (54)	30 days	Wed 12/7/11	Tue 1/17/12
32	Analyze Soil Samples	63 days	Wed 11/9/11	Fri 2/3/12
33	**Field Investigation - Lots**	**36 days**	**Thu 1/12/12**	**Thu 3/1/12**
34	USA Notification	1 day	Thu 1/12/12	Thu 1/12/12
35	Perform Concrete Coring (Lots)	7 days	Mon 1/16/12	Tue 1/24/12
36	Perform Large Lot Borings	19 days	Wed 1/18/12	Mon 2/13/12
37	Perform Small Lot Borings	2 days	Tue 2/14/12	Wed 2/15/12
38	Perform Parking Lot Borings	2 days	Thu 2/16/12	Fri 2/17/12
39	Analyze Soil Samples	31 days	Thu 1/19/12	Thu 3/1/12
40	**Data Evaluation and Validation**	**77 days**	**Mon 11/28/11**	**Tue 3/13/12**
41	Review and upload analytical data	73 days	Mon 11/28/11	Wed 3/7/12
42	Perform data validation	76 days	Tue 11/29/11	Tue 3/13/12
43	**Report Preparation**	**76 days**	**Mon 2/20/12**	**Mon 6/4/12**
44	Prepare Draft Report	35 days	Mon 2/20/12	Fri 4/6/12

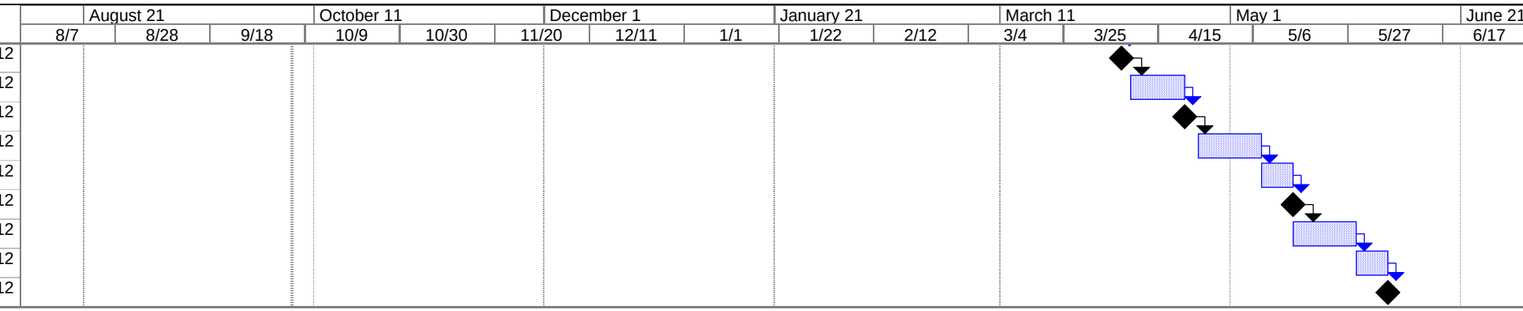


Project: Fig 6 - Schedule
Date: Thu 10/6/11

Task | Milestone | Rolled Up Task | Rolled Up Progress | External Tasks | Group By Summary
Progress | Summary | Rolled Up Milestone | Split | Project Summary | Deadline

Figure 6 - AMCO Soil Characterization Schedule

ID		Task Name	Duration	Start	Finish
45		Submit Draft Report for Peer Review	0 days	Fri 4/6/12	Fri 4/6/12
46		Peer Review and Revision of Draft Plan	10 days	Mon 4/9/12	Fri 4/20/12
47		Submit Draft Report to EPA	0 days	Fri 4/20/12	Fri 4/20/12
48		EPA Review of Draft Report	10 days	Tue 4/24/12	Mon 5/7/12
49		Address EPA Review Comments	5 days	Tue 5/8/12	Mon 5/14/12
50		Submit Repsonses to EPA Review Comments	0 days	Mon 5/14/12	Mon 5/14/12
51		Finalize Revisions to Address Comments	10 days	Tue 5/15/12	Mon 5/28/12
52		Prepare and Review Final Report	5 days	Tue 5/29/12	Mon 6/4/12
53		Submit Final Report	0 days	Mon 6/4/12	Mon 6/4/12



Project: Fig 6 - Schedule
Date: Thu 10/6/11

Task | Milestone | Rolled Up Task | Rolled Up Progress | External Tasks | Group By Summary
Progress | Summary | Rolled Up Milestone | Split | Project Summary | Deadline

APPENDIX A

ADDENDUM TO SAMPLING AND ANALYSIS PLAN

Technical Memorandum

To:	Ms. Rose Marie Caraway, US EPA RPM		
From:	Mr. Kent Baugh, ITSI/Walnut Creek		
Date:	October 6, 2011		
Subject:	**October 2011 Addendum to the Remedial Investigation Sampling and Analysis Plan, AMCO Chemical Superfund Site**		
Contract/TO:	EP-S9-08-03, TO 0018	**ITSI DCN:**	07163.0019.0065

1.0 INTRODUCTION

This Technical Memorandum (TM) represents the October 2011 Addendum to the previously approved Remedial Investigation Sampling and Analysis Plan (RI SAP) titled *Remedial Investigation Sampling and Analysis Plan, AMCO Chemical Superfund Site* (CH2M HILL, 2004a) and *Addendum 1 to the Remedial Investigation Sampling and Analysis Plan: Additional Sample Control Procedures* (CH2M HILL, 2004b). (The *June 2010 Addendum to the Remedial Investigation Sampling and Analysis Plan, AMCO Chemical Superfund Site* [ITSI, 2010a] was prepared to address additional groundwater monitoring activities.) The U.S. Environmental Protection Agency (EPA) plans to perform additional field activities at the AMCO Chemical Superfund Site (Site) for the following purposes:

- To further delineate the vertical and lateral extent of soil contamination at the former AMCO site, adjacent properties, and downgradient of the Site. These further contaminant delineation activities are part of various additional remedial investigations being performed at the Site.
- To assess treatability results relative to key contaminants that are site-specific drivers for soil and groundwater remediation at the Site.

The additional proposed activities will include:

- Soil sampling and analysis.

ITSI is conducting these activities for the EPA under Remedial Action Contract (RAC) number EP-S9-08-03, Task Order 0018.

The soil sampling and analysis is described in the *Upper Aquifer Investigation/Well Installation* (CH2M-Hill, 2009), *Work Plan, CPT-MIP Investigation* (ITSI, 2010b), and *Work Plan, Soil Characterization* (ITSI, 2011). A forthcoming plan being drafted by ITSI teaming partner CDM will present the procedures for the treatability study. These documents are incorporated by reference, and remain applicable to the work to be performed by ITSI. In addition, all features of the RI SAP are incorporated by reference, and remain applicable to the work to be performed by ITSI, except as noted in the following sections.

2.0 CHANGES TO THE RI SAP

All activities described in the RI SAP will remain as previously stated, with the following noted changes and additions.

Part I – Site Specific Work Plan

2.1 *Project Organization*

The project organization chart has been updated for these activities and is presented as Figure 1 of this TM.

2.2 *Field Activities and Sampling and Analysis Program*

The field activities and sampling and analysis program sections of the 2004 work plan (Part I of CH2M-Hill, 2004a) for soil sampling are superseded by the *Upper Aquifer Investigation/Well Installation* (CH2M-Hill, 2009), *Work Plan, CPT-MIP Investigation* (ITSI, 2010b), *Work Plan, Soil Characterization* (ITSI, 2011) and the *Treatability Study Work Plan* (CDM, in preparation).

Part II – Quality Assurance Project Plan and Field Sampling Plan

2.3 *Measurement Performance Criteria*

Table 14b of the RI SAP (screening levels and reporting limits for soils) has been revised to update the applicable regulatory limits, to include organochlorine pesticides and Aroclors, and to provide laboratory target detection limits for each compound. Revised Table 14b is included in this 2011 SAP Addendum as Table A1. Table 14a of the RI SAP (screening levels and reporting limits for groundwater) has been revised to update the applicable regulatory limits, to include organochlorine pesticides and Aroclors, and to provide laboratory target detection limits for each compound. Revised Table 14a is included in this 2011 SAP Addendum as Table A4.

2.4 *Sampling and Analysis Program*

2.4.1 Field Activities Schedule

The field activities covered by this TM began in November 2010 and are scheduled to be completed by May 2012. This schedule is subject to change based on field conditions and availability of funding.

2.4.2 Request for Analyses

This section presents the request for analyses for the soil characterization investigation and for the investigation-derived waste (IDW) samples resulting from the field activities described in the various work plans referenced herein. Tables 16a through 16i of the 2004 SAP (CH2M-Hill, 2004a) will be replaced by tables detailing the planned soil sampling and included in each Work Plan.

2.4.3 Analytical Methods Requirements

Commercial laboratories will be used for all analytical parameters for the soil characterization investigation and treatability study. Commercial laboratories will be California state-certified with either the California Department of Public Health Environmental Laboratory Accreditation Program (ELAP) certification or National Environmental Laboratory Accreditation Program (NELAP) certification. Table A1 of this Addendum presents analytes and screening levels for commercial analytical laboratories for the soil characterization and treatability study. Table 15 of the RI SAP (CH2M-Hill, 2004a), which presents project analytes, methods, and performance criteria, has been revised for investigations utilizing commercial laboratories and is presented as Table A2 of this Addendum.

RI SAP Table 15 (CH2M-Hill, 2004a) applies as presented for investigations using the EPA Contract Laboratory Program (CLP). For analyses through the CLP, RI SAP Table 14b (CH2M-Hill, 2004a) has been revised to include organochlorine pesticides and Aroclors, to update the regulatory limits, and to include reporting limits. Revised RI SAP Table 14b is included in this 2011 SAP Addendum as Table A3.

2.5 *Quality Assurance and Quality Control Requirements*

2.5.1 Data Management

Section 6.5 of the RI SAP is superseded by the ITSI Data Management Standard Operating Procedure (SOP) PR-TC-02.12.02.00 v1.1, provided in Attachment 1 of this Addendum.

2.6 *Field Methods and Procedures*

2.6.1 Soil Sampling

Soil samples will be collected using direct push, hollow-stem auger, or sonic drilling methods following the procedures outlined in ITSI SOP Subsurface Soils: Direct Push or Drill Rig (PR-TC-02.02.01.03), provided herein in Attachment 1. The cross-referenced ITSI SOP for Soil: Volatile Organic Compound (VOC) Sampling PR-TC-02-02-01-05 v1.1, also is provided in Attachment 1.

In addition, due to the heaving sands encountered at the Site, as described in the Technical Memorandum *Comparison of Hollow Stem Auger and Mud Rotary Drilling Methods for the Installation of 6-inch Groundwater Extraction Wells at the AMCO Chemical Superfund Site* (ITSI, June 2011; included herein as Attachment 2), mud rotary drilling also may be used. Guidance for the use of mud rotary drilling methods can be found in the aforementioned technical memorandum. Field documentation will be completed in accordance with ITSI Field Documentation SOP PR-TC-01.04.01.00, provided in Attachment 1.

Field forms for documenting the field activities associated with soil sampling that are not included as part of the SOPs in Attachment 1 are provided in Attachment 3 and include:

- Boring Log
- Sample Collection Log.

2.7 *Sample Management Procedures and Documentation Procedures*

2.7.1 Sample Identification and Labeling

Samples will be identified and labeled in accordance with the procedures described in the ITSI SOP Creating a Sample Identification System PR-TC-01.04.04.00, included herein in Attachment 1.

2.7.2 Sample Handling

Samples will be handled in accordance with the procedures set forth in ITSI Sample Handling, Packaging and Shipping SOP PR-TC-02.04.01.01 v1.2, presented herein in Attachment 1.

2.7.3 Chain of Custody

Chain of custody will be established and maintained following the procedures outlined in ITSI SOP Chain-of-Custody Procedures for Environmental Samples PR-TC-01.04.05.00, presented herein in Attachment 1.

2.8 *Data Validation and Usability*

Data for definitive parameters will undergo two levels of review and validation: (1) at the laboratory and (2) outside the laboratory. One hundred percent of the data will undergo EPA Stage 2a validation electronic (VE; EPA, 2009) automated data validation upon upload to ITSI's environmental data management system (eDMS). A third-party independent validator will review the resulting reports and augment the validation with calibration information for a resulting EPA Stage 2b validation electronic manual (VEM) for 90% of the data. The remaining randomly selected 10% of the data will undergo full validation (EPA Stage 3VEM; EPA, 2009).

Validation will be done in accordance with the ITSI Data Review, Verification, and Validation SOP PR-TC-04.01.00.00, included herein in Attachment 1.

3.0 References

CH2M-Hill, 2004a. *Remedial Investigation Sampling and Analysis Plan, AMCO Chemical Superfund Site.* August.

CH2M-Hill, 2004b. Addendum 1 to the Remedial Investigation Sampling and Analysis Plan: Additional Sample Control Procedures. December 21.

CH2M-Hill, 2009. Upper Aquifer Investigation/Well Installation, AMCO Chemical Superfund Site, Oakland, California. September 30.

CH2M-Hill, 2011. Remedial Investigation, AMCO Chemical Superfund Site, 1414 3rd Street, Oakland, California. January.

Innovative Technical Solutions, Inc. (ITSI), 2010a. June 2010 Addendum to the Remedial Investigation Sampling and Analysis Plan, AMCO Chemical Superfund Site. July 6.

ITSI, 2010b. Work Plan, CPT-MIP Investigation, AMCO Chemical Superfund Site, 1414 3rd Street, Oakland, California. September.

ITSI, 2011. Work Plan, Soil Characterization, AMCO Chemical Superfund Site, 1414 3rd Street, Oakland, California. October.

ITSI/CDM, 2011. Treatability Study Work Plan, AMCO Chemical Superfund Site (forthcoming).

U.S. Environmental Protection Agency (EPA), 2009. Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use. EPA 540-R-08-005. January.

EPA, 2010. Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzon-p-dioxin and Dioxin-Like Compounds. EPA/100/R 10/005. December.

LIST OF TABLES

Table A1 Screening Levels and Reporting Limits for Soils – Commercial Laboratories

Table A2 Lab Performance Criteria – Commercial Laboratories

Table A3 Screening Levels and Reporting Limits for Soils – CLP

Table A4 Screening Levels and Reporting Limits for Groundwater – Commercial Laboratories

LIST OF FIGURES

Figure 1 Organizational Chart

LIST OF ATTACHMENTS

Attachment 1 Standard Operating Procedures

- PR-TC-01.01.01.00 Field Documentation
- PR-TC-01.04.04.00 Sample Identification
- PR-TC-01.04.05.00 Chain-of-Custody Procedures for Environmental Samples
- PR-TC-02.02.01.03 Subsurface Soils: Direct-Pus or Drill Rig
- PR-TC-02.02.01.05 v1.1 Soil: Volatile Organic compound (VOC) Sampling
- PR-TC-02.04.01.01 v1.2 Sample Handling, Packaging and Shipping
- PR-TC-02.12.02.00 v.1.1 Sample Tracking and Electronic Data Management
- PR-TC-04.01.00.00 Data Validation

Attachment 2 Technical Memorandum: Comparison of Hollow Stem Auger and Mud Rotary Drilling Methods for the Installation of 6-inch Groundwater Extraction Wells at the AMCO Chemical Superfund Site

Attachment 3 Field Forms

- Boring Log
- Sample Collection Log

LIST OF ABBREVIATIONS

CLP	Contract Laboratory Program
DCN	document control number
eDMS	environmental data management system
ELAP	Environmental Laboratory Accreditation Program
EPA	US Environmental Protection Agency
IDW	investigation-derived waste
ITSI	Innovative Technical Solutions, Inc.
NELAP	National Environmental Laboratory Accreditation Program
RAC	Remedial Action Contract
RI	Remedial Investigation
RPM	Remedial Project Manager
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
TEF	Toxicity Equivalence Factors
TM	Technical Memorandum
TO	Task Order
VE	validation electronic
VEM	validation electronic manual
VOC	volatile organic compound

TABLES

Table A1
Screening Levels and Reporting Limits for Soils
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Commercial Laboratories

Parameter to be Analyzed	Screening Level – Residential Scenario (mg/kg)	Source	Reporting Limit/Target Detection Limit (mg/kg)
TCL VOCs			
Acetone	61,000	EPA Region 9 RSL [(A)]	0.020
Benzene	1.1	EPA Region 9 RSL [(A)]	0.005
Bromodichloromethane	0.27	EPA Region 9 RSL [(A)]	0.005
Bromoform	62	EPA Region 9 RSL [(A)]	0.005
Bromomethane	7.3	EPA Region 9 RSL [(A)]	0.010
Carbon disulfide	820	EPA Region 9 RSL [(A)]	0.005
Carbon tetrachloride	0.61	EPA Region 9 RSL [(A)]	0.005
Chlorobenzene	290	EPA Region 9 RSL [(A)]	0.005
Chloroethane (Ethyl Chloride)	15,000	EPA Region 9 RSL [(A)]	0.010
Chloroform	0.29	EPA Region 9 RSL [(A)]	0.005
Chloromethane	120	EPA Region 9 RSL [(A)]	0.010
Cyclohexane	7,000	EPA Region 9 RSL [(A)]	0.005
Dibromochloromethane	0.68	EPA Region 9 RSL [(A)]	0.005
Dibromochloropropane (DBCP)	0.0054	EPA Region 9 RSL [(A)]	0.005
1,2-Dibromoethane	0.034	EPA Region 9 RSL [(A)]	0.005
1,2-Dichlorobenzene	1,900	EPA Region 9 RSL [(A)]	0.005
1,3-Dichlorobenzene	7.4	RWQCB SF Bay Region ESL [(B)]	0.005
1,4-Dichlorobenzene	2.4	EPA Region 9 RSL [(A)]	0.005
Dichlorodifluoromethane	94	EPA Region 9 RSL [(A)]	0.005
1,1-Dichloroethane	3.3	EPA Region 9 RSL [(A)]	0.005
1,2-Dichloroethane	0.43	EPA Region 9 RSL [(A)]	0.005
1,1-Dichloroethene	240	EPA Region 9 RSL [(A)]	0.005
cis-1,2-Dichloroethene	160	EPA Region 9 RSL [(A)]	0.005
trans-1,2-Dichloroethene	150	EPA Region 9 RSL [(A)]	0.005
Dichloromethane (Methylene chloride)	11	EPA Region 9 RSL [(A)]	0.020
1,2-Dichloropropane	0.94	EPA Region 9 RSL [(A)]	0.005
cis-1,3-Dichloropropene	1.7	EPA Region 9 RSL [(A)]	0.005
trans-1,3-Dichloropropene	1.7	EPA Region 9 RSL [(A)]	0.005
Ethylbenzene	5.4	EPA Region 9 RSL [(A)]	0.005
2-Hexanone	210	EPA Region 9 RSL [(A)]	0.010
Isopropylbenzene (Cumene)	2,100	EPA Region 9 RSL [(A)]	0.005
Methyl acetate	78,000	EPA Region 9 RSL [(A)]	0.005
Methyl ethyl ketone (MEK)	28,000	EPA Region 9 RSL [(A)]	0.010

Table A1
Screening Levels and Reporting Limits for Soils
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Commercial Laboratories

Parameter to be Analyzed	Screening Level – Residential Scenario (mg/kg)	Source	Reporting Limit/Target Detection Limit (mg/kg)
Methyl isobutyl ketone (MIBK)	5,300	EPA Region 9 RSL [(A)]	0.010
Methylcyclohexane	N/A	No applicable action level	0.005
Styrene	6,300	EPA Region 9 RSL [(A)]	0.005
1,1,2,2-Tetrachloroethane	0.56	EPA Region 9 RSL [(A)]	0.005
Tetrachloroethene (PCE)	0.55	EPA Region 9 RSL [(A)]	0.005
Toluene	5,000	EPA Region 9 RSL [(A)]	0.005
1,2,4-Trichlorobenzene	22	EPA Region 9 RSL [(A)]	0.005
1,1,1-Trichloroethane	8,700	EPA Region 9 RSL [(A)]	0.005
1,1,2-Trichloroethane	1.1	EPA Region 9 RSL [(A)]	0.005
Trichloroethene (TCE)	2.8	EPA Region 9 RSL [(A)]	0.005
Trichlorofluoromethane	790	EPA Region 9 RSL [(A)]	0.005
1,1,2-Trichloro-1,2,2-Trifluoroethane	43,000	EPA Region 9 RSL [(A)]	0.005
Vinyl chloride	0.06	EPA Region 9 RSL [(A)]	0.005
Xylene(s)	630	EPA Region 9 RSL [(A)]	0.010
MTBE and Fuel Oxygenates			
Methyl tert-butyl ether (MTBE)	43	EPA Region 9 RSL [(A)]	0.005
Tertiary butyl alcohol (TBA)	0.075	RWQCB SF Bay Region ESL [(B)]	0.075
Tertiary amyl methyl ether (TAME)	N/A	No applicable action level	0.005
Ethyl tertiary butyl ether (ETBE)	N/A	No applicable action level	0.005
1,4-Dioxane	4.9	EPA Region 9 RSL [(A)]	0.100
1,1'-Biphenyl	51	EPA Region 9 RSL [(A)]	0.330
TCL SVOCs			
1,2,4,5-Tetrachlorobenzene	18	EPA Region 9 RSL [(A)]	0.330
2,2'-Oxybis(1-Chloropropane)	N/A	EPA Region 9 RSL [(A)]	0.330
2,4,5-Trichlorophenol	6,100	No applicable action level	0.330
2,4,6-Trichlorophenol	44	EPA Region 9 RSL [(A)]	0.330
2,4-Dichlorophenol	180	EPA Region 9 RSL [(A)]	0.330
2,4-Dimethylphenol	1,200	EPA Region 9 RSL [(A)]	0.330
2,4-Dinitrophenol	120	EPA Region 9 RSL [(A)]	0.670
2,4-Dinitrotoluene	1.6	EPA Region 9 RSL [(A)]	0.330
2,6-Dinitrotoluene	61	EPA Region 9 RSL [(A)]	0.330
2-Chloronaphthalene	6,300	EPA Region 9 RSL [(A)]	0.330
2-Chlorophenol	390	EPA Region 9 RSL [(A)]	0.330
2-Methylnaphthalene	310	EPA Region 9 RSL [(A)]	0.067

Table A1
Screening Levels and Reporting Limits for Soils
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Commercial Laboratories

Parameter to be Analyzed	Screening Level – Residential Scenario (mg/kg)	Source	Reporting Limit/Target Detection Limit (mg/kg)
2-Methylphenol (o-Cresol)	3,100	EPA Region 9 RSL [(A)]	0.330
2-Nitroaniline	610	EPA Region 9 RSL [(A)]	0.670
2-Nitrophenol	N/A	No applicable action level	0.670
3-3'-Dichlorobenzidine	1.1	EPA Region 9 RSL [(A)]	0.670
3-Nitroaniline	N/A	No applicable action level	0.670
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.9	EPA Region 9 RSL [(A)]	0.670
4-Bromophenyl-phenylether	N/A	No applicable action level	0.330
4-Chloro-3-methylphenol (p-Chloro-m-cresol)	6100	EPA Region 9 RSL [(A)]	0.330
4-Chloroaniline	2.4	EPA Region 9 RSL [(A)]	0.330
4-Chlorophenyl-phenylether	N/A	No applicable action level	0.330
4-Methylphenol (p-Cresol)	310	EPA Region 9 RSL [(A)]	0.330
4-Nitroaniline	24	EPA Region 9 RSL [(A)]	0.670
4-Nitrophenol	N/A	No applicable action level	0.670
Acenaphthene	3,400	EPA Region 9 RSL [(A)]	0.067
Acenaphthylene	13	RWQCB SF Bay Region ESL [(B)]	0.067
Acetophenone	N/A	No applicable action level	0.330
Anthracene	17,000	EPA Region 9 RSL [(A)]	0.067
Atrazine	2.1	EPA Region 9 RSL [(A)]	0.330
Benzaldehyde	7,800	EPA Region 9 RSL [(A)]	0.330
Benzo(a)anthracene	0.15	EPA Region 9 RSL [(A)]	0.067
Benzo(a)pyrene	0.015	EPA Region 9 RSL [(A)]	0.067
Benzo(b)fluoranthene	0.15	EPA Region 9 RSL [(A)]	0.067
Benzo(g,h,i)perylene	27	RWQCB SF Bay Region ESL [(B)]	0.067
Benzo(k)fluoranthene	1.5	EPA Region 9 RSL [(A)]	0.067
Bis(2-chloroethoxy)methane	180	EPA Region 9 RSL [(A)]	0.330
Bis(2-chloroethyl)ether	0.21	EPA Region 9 RSL [(A)]	0.330[d]
Bis(2-ethylhexyl)phthalate	35	EPA Region 9 RSL [(A)]	0.330
Butylbenzylphthalate	260	EPA Region 9 RSL [(A)]	0.330
Caprolactam	31,000	EPA Region 9 RSL [(A)]	0.330
Carbazole	N/A	No applicable action level	0.330
Chrysene	15	EPA Region 9 RSL [(A)]	0.067
Dibenzo(a,h)anthracene	0.015	EPA Region 9 RSL [(A)]	0.067

Table A1
Screening Levels and Reporting Limits for Soils
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Commercial Laboratories

Parameter to be Analyzed	Screening Level – Residential Scenario (mg/kg)	Source	Reporting Limit/Target Detection Limit (mg/kg)
Dibenzofuran	78	EPA Region 9 RSL [(A)]	0.330
Diethylphthalate	49,000	EPA Region 9 RSL [(A)]	0.330
Dimethylphthalate	0.035	RWQCB SF Bay Region ESL [(B)]	0.330
Di-n-butylphthalate	6,100	EPA Region 9 RSL [(A)]	0.330
Di-n-octylphthalate	N/A	No applicable action level	0.330
Fluoranthene	2,300	EPA Region 9 RSL [(A)]	0.067
Fluorene	2,300	EPA Region 9 RSL [(A)]	0.067
Hexachlorobenzene	0.3	EPA Region 9 RSL [(A)]	0.330
Hexachlorobutadiene	6.2	EPA Region 9 RSL [(A)]	0.330
Hexachlorocyclopentadiene	370	EPA Region 9 RSL [(A)]	0.670
Hexachloroethane	35	EPA Region 9 RSL [(A)]	0.330
Indeno(1,2,3-cd)pyrene	0.15	EPA Region 9 RSL [(A)]	0.067
Isophorone	510	EPA Region 9 RSL [(A)]	0.330
Naphthalene	3.6	EPA Region 9 RSL [(A)]	0.067
Nitrobenzene	4.8	EPA Region 9 RSL [(A)]	0.330
N-Nitroso-di-n-propylamine	0.069	EPA Region 9 RSL [(A)]	0.330
N-Nitrosodiphenylamine	99	EPA Region 9 RSL [(A)]	0.330
Pentachlorophenol	0.89	EPA Region 9 RSL [(A)]	0.670
Phenanthrene	11	RWQCB SF Bay Region ESL [(B)]	0.067
Phenol	18,000	EPA Region 9 RSL [(A)]	0.330
Pyrene	1,700	EPA Region 9 RSL [(A)]	0.067
Organochlorine Pesticides/Aroclors			
alpha-BHC	0.077	EPA Region 9 RSL [(A)]	0.0017
beta-BHC	0.27	EPA Region 9 RSL [(A)]	0.0017
delta-BHC	N/A	No applicable action level	0.0017
gamma-BHC (Lindane)	0.52	EPA Region 9 RSL [(A)]	0.0017
Heptachlor	0.11	EPA Region 9 RSL [(A)]	0.0017
Aldrin	0.029	EPA Region 9 RSL [(A)]	0.0017
Heptachlor Epoxide	0.053	EPA Region 9 RSL [(A)]	0.0017
Endosulfan I	370	EPA Region 9 RSL [(A)]	0.0017
Dieldrin	0.030	EPA Region 9 RSL [(A)]	0.0033
4,4’-DDE	1.4	EPA Region 9 RSL [(A)]	0.0033
Endrin	18	EPA Region 9 RSL [(A)]	0.0033

Table A1
Screening Levels and Reporting Limits for Soils
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Commercial Laboratories

Parameter to be Analyzed	Screening Level – Residential Scenario (mg/kg)	Source	Reporting Limit/Target Detection Limit (mg/kg)
Endosulfan II	370	EPA Region 9 RSL (A)	0.0033
4,4'-DDD	2.0	EPA Region 9 RSL (A)	0.0033
Endosulfan sulfate	370	EPA Region 9 RSL (A)	0.0033
4,4'-DDT	1.7	EPA Region 9 RSL (A)	0.0033
Methoxychlor	310	EPA Region 9 RSL (A)	0.017
Endrin ketone	18	EPA Region 9 RSL (A)	0.033
Endrin aldehyde	18	EPA Region 9 RSL (A)	0.033
alpha-Chlordane	1.6	EPA Region 9 RSL (A)	0.017
gamma-Chlordane	1.6	EPA Region 9 RSL (A)	0.017
Toxaphene	0.44	EPA Region 9 RSL (A)	0.060
Aroclor-1016	3.9	EPA Region 9 RSL (A)	0.012
Aroclor-1221	0.14	EPA Region 9 RSL (A)	0.024
Aroclor-1232	0.14	EPA Region 9 RSL (A)	0.012
Aroclor-1242	0.22	EPA Region 9 RSL (A)	0.012
Aroclor-1248	0.22	EPA Region 9 RSL (A)	0.012
Aroclor-1254	0.22	EPA Region 9 RSL (A)	0.012
Aroclor-1260	0.22	EPA Region 9 RSL (A)	0.012
Aroclor-1262	0.22	RWQCB SF Bay Region ESL(B)	0.012
Aroclor-1268	0.22	RWQCB SF Bay Region ESL(B)	0.012
TAL Metals			
Aluminum	77,000	EPA Region 9 RSL (A)	5
Antimony	31	EPA Region 9 RSL (A)	0.5
Arsenic	14[a]	Background Soil[a]	0.25
Barium	15,000	EPA Region 9 RSL (A)	0.25
Beryllium	160	EPA Region 9 RSL (A)	0.1
Cadmium	70	EPA Region 9 RSL (A)	0.25
Calcium	N/A	No applicable action level	25
Chromium (total)	120,000	EPA Region 9 RSL (A)	0.25
Cobalt	23	EPA Region 9 RSL (A)	0.25
Copper	3,100	EPA Region 9 RSL (A)	0.25
Iron	55,000	EPA Region 9 RSL (A)	5
Lead	400	EPA Region 9 RSL (A)	0.25
Magnesium	N/A	No applicable action level	25
Manganese	1,800	EPA Region 9 RSL (A)	0.25

Table A1
Screening Levels and Reporting Limits for Soils
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Commercial Laboratories

Parameter to be Analyzed	Screening Level – Residential Scenario (mg/kg)	Source	Reporting Limit/Target Detection Limit (mg/kg)
Mercury	10	EPA Region 9 RSL [(A)]	0.02
Nickel	1,500	EPA Region 9 RSL [(A)]	0.25
Potassium	N/A	No applicable action level	25
Selenium	390	EPA Region 9 RSL [(A)]	0.50
Silver	390	EPA Region 9 RSL [(A)]	0.25
Sodium	N/A	No applicable action level	25
Thallium	0.78	EPA Region 9 RSL [(A)]	0.50
Vanadium	390	EPA Region 9 RSL [(A)]	0.25
Zinc	23,000	EPA Region 9 RSL [(A)]	1
Hexavalent Chromium	0.29	EPA Region 9 RSL [(A)]	0.25
Total Petroleum Hydrocarbons			
Diesel	83	RWQCB SF Bay Region ESL [(B)]	1
Motor Oil	370	RWQCB SF Bay Region ESL [(B)]	5
Gasoline	83	RWQCB SF Bay Region ESL [(B)]	1
Dioxins / Furans			
2,3,7,8-TCDD	0.0000045	EPA Region 9 RSL [(A)]	0.0000005
1,2,3,7,8-PeCDD [c]	NA[c]	EPA TEF[c]	NA[c]
1,2,3,6,7,8-HxCDD [c]	NA[c]	EPA TEF[c]	NA[c]
1,2,3,4,7,8-HxCDD [c]	NA[c]	EPA TEF[c]	NA[c]
1,2,3,7,8,9-HxCDD [c]	NA[c]	EPA TEF[c]	NA[c]
1,2,3,4,6,7,8-HpCDD [c]	NA[c]	EPA TEF[c]	NA[c]
OCDD [c]	NA[c]	EPA TEF[c]	NA[c]
2,3,7,8-TCDF [c]	NA[c]	EPA TEF[c]	NA[c]
1,2,3,7,8-PeCDF [c]	NA[c]	EPA TEF[c]	NA[c]
2,3,4,7,8-PeCDF [c]	NA[c]	EPA TEF[c]	NA[c]
1,2,3,6,7,8-HxCDF [c]	NA[c]	EPA TEF[c]	NA[c]
1,2,3,7,8,9-HxCDF [c]	NA[c]	EPA TEF[c]	NA[c]
1,2,3,6,7,8-HxCDF [c]	NA[c]	EPA TEF[c]	NA[c]
2,3,4,6,7,8-HxCDF [c]	NA[c]	EPA TEF[c]	NA[c]
1,2,3,4,6,7,8-HpCDF [c]	NA[c]	EPA TEF[c]	NA[c]
1,2,3,4,7,8,9-HpCDF [c]	NA[c]	EPA TEF[c]	NA[c]
OCDF [c]	NA[c]	EPA TEF[c]	NA[c]

Table A1
Screening Levels and Reporting Limits for Soils
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Commercial Laboratories

Notes:

(A) EPA Region 9 Regional Screening Levels (RSLs), last updated June 2011 obtained online at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/master_sl_table_run_JUN2011.pdf

(B) California Regional Water Quality Control Board (RWQCB), San Francisco (SF) Bay Region, Environmental Screening Levels (ESLs) in Shallow Soils, (< 3 meters below ground surface), where Groundwater is a Current or Potential Source of Drinking Water, Residential Land Use (Revised May 2008)

[a] Background for arsenic in Bay Area soils is 14 mg/kg as reported in the Remedial Investigation Report (CH2M Hill, 2011)

[b] Listed in EPA Region 9 RSL as Dioxin (2,3,7,8-TCDD)

[c] The dioxin and furan concentrations for these analytes will be converted to the 2,3,7,8-TCDD equivalent using the EPA 2010 Toxicity Equivalence Factors (TEFs) (EPA, 2010), and compared to the RSL for 2,3,7,8-TCDD. Method reporting limits are acceptable

Table A2
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Commercial Laboratories

RI-SAP Table 15
Measurement Performance Criteria
Remedial Investigation
AMCO Chemical Superfund Site, Oakland, California

Parameter	Method	Reporting Limit/Target Detection Limit	Analytical Accuracy (% Recovery)	Analytical Precision (Relative % Difference)	Overall Completeness
Soil					
TCL VOCs plus MTBE and fuel oxygenates	EPA 8260B	See Table 1	Lab Limits	Lab Limits	90%
TCL SVOCs plus 1,4-Dioxane	EPA 8270C	See Table 1	Lab Limits	Lab Limits	90%
TCL Metals	EPA 6010B/6020	See Table 1	Lab Limits	Lab Limits	90%
TCL Pesticides	EPA 8081A	See Table 1	Lab Limits	Lab Limits	90%
TCL PCBs	EPA 8082	See Table 1	Lab Limits	Lab Limits	90%
TCL Dioxin/Furans	EPA 8290/8290A	See Table 1	Lab Limits	Lab Limits	90%
Percent Solids	SM A2540G (or equivalent)	0.1%	NA	20%	90%

Table A3
Screening Levels and Reporting Limits for Soils
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Contract Laboratory Program (CLP)

Parameter to be Analyzed	Screening Level – Residential Scenario (mg/kg)	Source	Reporting Limit/Target Detection Limit (mg/kg)
TCL VOCs			
Acetone	61,000	EPA Region 9 RSL [(A)]	0.010
Benzene	1.1	EPA Region 9 RSL [(A)]	0.005
Bromodichloromethane	0.27	EPA Region 9 RSL [(A)]	0.005
Bromoform	62	EPA Region 9 RSL [(A)]	0.005
Bromomethane	7.3	EPA Region 9 RSL [(A)]	0.005
Carbon disulfide	820	EPA Region 9 RSL [(A)]	0.005
Carbon tetrachloride	0.61	EPA Region 9 RSL [(A)]	0.005
Chlorobenzene	290	EPA Region 9 RSL [(A)]	0.005
Chloroethane (Ethyl Chloride)	15,000	EPA Region 9 RSL [(A)]	0.005
Chloroform	0.29	EPA Region 9 RSL [(A)]	0.005
Chloromethane	120	EPA Region 9 RSL [(A)]	0.005
Cyclohexane	7,000	EPA Region 9 RSL [(A)]	0.005
Dibromochloromethane	0.68	EPA Region 9 RSL [(A)]	0.005
Dibromochloropropane (DBCP)	0.0054	EPA Region 9 RSL [(A)]	0.005
1,2-Dibromoethane	0.034	EPA Region 9 RSL [(A)]	0.005
1,2-Dichlorobenzene	1,900	EPA Region 9 RSL [(A)]	0.005
1,3-Dichlorobenzene	7.4	RWQCB SF Bay Region ESL [(B)]	0.005
1,4-Dichlorobenzene	2.4	EPA Region 9 RSL [(A)]	0.005
Dichlorodifluoromethane	94	EPA Region 9 RSL [(A)]	0.005
1,1-Dichloroethane	3.3	EPA Region 9 RSL [(A)]	0.005
1,2-Dichloroethane	0.43	EPA Region 9 RSL [(A)]	0.005
1,1-Dichloroethene	240	EPA Region 9 RSL [(A)]	0.005
cis-1,2-Dichloroethene	160	EPA Region 9 RSL [(A)]	0.005
trans-1,2-Dichloroethene	150	EPA Region 9 RSL [(A)]	0.005
Dichloromethane (Methylene chloride)	11	EPA Region 9 RSL [(A)]	0.005
1,2-Dichloropropane	0.94	EPA Region 9 RSL [(A)]	0.005
cis-1,3-Dichloropropene	1.7	EPA Region 9 RSL [(A)]	0.005
trans-1,3-Dichloropropene	1.7	EPA Region 9 RSL [(A)]	0.005
Ethylbenzene	5.4	EPA Region 9 RSL [(A)]	0.005
2-Hexanone	210	EPA Region 9 RSL [(A)]	0.010
Isopropylbenzene (Cumene)	2,100	EPA Region 9 RSL [(A)]	0.005
Methyl acetate	78,000	EPA Region 9 RSL [(A)]	0.005
Methyl ethyl ketone (MEK)	28,000	EPA Region 9 RSL [(A)]	0.010

Table A3
Screening Levels and Reporting Limits for Soils
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Contract Laboratory Program (CLP)

Parameter to be Analyzed	Screening Level – Residential Scenario (mg/kg)	Source	Reporting Limit/Target Detection Limit (mg/kg)
Methyl isobutyl ketone (MIBK)	5,300	EPA Region 9 RSL [(A)]	0.010
Methylcyclohexane	N/A	No applicable action level	0.005
Styrene	6,300	EPA Region 9 RSL [(A)]	0.005
1,1,2,2-Tetrachloroethane	0.56	EPA Region 9 RSL [(A)]	0.005
Tetrachloroethene (PCE)	0.55	EPA Region 9 RSL [(A)]	0.005
Toluene	5,000	EPA Region 9 RSL [(A)]	0.005
1,2,4-Trichlorobenzene	22	EPA Region 9 RSL [(A)]	0.005
1,1,1-Trichloroethane	8,700	EPA Region 9 RSL [(A)]	0.005
1,1,2-Trichloroethane	1.1	EPA Region 9 RSL [(A)]	0.005
Trichloroethene (TCE)	2.8	EPA Region 9 RSL [(A)]	0.005
Trichlorofluoromethane	790	EPA Region 9 RSL [(A)]	0.005
1,1,2-Trichloro-1,2,2-Trifluoroethane	43,000	EPA Region 9 RSL [(A)]	0.005
Vinyl chloride	0.06	EPA Region 9 RSL [(A)]	0.005
Xylene(s)	630	EPA Region 9 RSL [(A)]	0.010
MTBE and Fuel Oxygenates			
Methyl tert-butyl ether (MTBE)	43	EPA Region 9 RSL [(A)]	0.005
Tertiary butyl alcohol (TBA)	0.075	RWQCB SF Bay Region ESL [(B)]	0.500
Tertiary amyl methyl ether (TAME)	N/A	No applicable action level	0.500
Ethyl tertiary butyl ether (ETBE)	N/A	No applicable action level	0.010
1,4-Dioxane	4.9	EPA Region 9 RSL [(A)]	0.100
TCL SVOCs			
1,1'-Biphenyl	51	EPA Region 9 RSL [(A)]	0.170
1,2,4,5-Tetrachlorobenzene	18	EPA Region 9 RSL [(A)]	0.170
2,2'-Oxybis(1-Chloropropane)	N/A	EPA Region 9 RSL [(A)]	0.170
2,4,5-Trichlorophenol	6,100	No applicable action level	0.170
2,4,6-Trichlorophenol	44	EPA Region 9 RSL [(A)]	0.170
2,4-Dichlorophenol	180	EPA Region 9 RSL [(A)]	0.170
2,4-Dimethylphenol	1,200	EPA Region 9 RSL [(A)]	0.170
2,4-Dinitrophenol	120	EPA Region 9 RSL [(A)]	0.330
2,4-Dinitrotoluene	1.6	EPA Region 9 RSL [(A)]	0.170
2,6-Dinitrotoluene	61	EPA Region 9 RSL [(A)]	0.170
2-Chloronaphthalene	6,300	EPA Region 9 RSL [(A)]	0.170
2-Chlorophenol	390	EPA Region 9 RSL [(A)]	0.170
2-Methylnaphthalene	310	EPA Region 9 RSL [(A)]	0.170

Table A3
Screening Levels and Reporting Limits for Soils
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Contract Laboratory Program (CLP)

Parameter to be Analyzed	Screening Level – Residential Scenario (mg/kg)	Source	Reporting Limit/Target Detection Limit (mg/kg)
2-Methylphenol (o-Cresol)	3,100	EPA Region 9 RSL [(A)]	0.170
2-Nitroaniline	610	EPA Region 9 RSL [(A)]	0.330
2-Nitrophenol	N/A	No applicable action level	0.330
3-3'-Dichlorobenzidine	1.1	EPA Region 9 RSL [(A)]	0.330
3-Nitroaniline	N/A	No applicable action level	0.330
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.9	EPA Region 9 RSL [(A)]	0.330
4-Bromophenyl-phenylether	N/A	No applicable action level	0.170
4-Chloro-3-methylphenol (p-Chloro-m-cresol)	6100	EPA Region 9 RSL [(A)]	0.170
4-Chloroaniline	2.4	EPA Region 9 RSL [(A)]	0.170
4-Chlorophenyl-phenylether	N/A	No applicable action level	0.170
4-Methylphenol (p-Cresol)	310	EPA Region 9 RSL [(A)]	0.170
4-Nitroaniline	24	EPA Region 9 RSL [(A)]	0.330
4-Nitrophenol	N/A	No applicable action level	0.330
Acenaphthene	3,400	EPA Region 9 RSL [(A)]	0.170
Acenaphthylene	13	RWQCB SF Bay Region ESL [(B)]	0.170
Acetophenone	N/A	No applicable action level	0.170
Anthracene	17,000	EPA Region 9 RSL [(A)]	0.170
Atrazine	2.1	EPA Region 9 RSL [(A)]	0.170
Benzaldehyde	7,800	EPA Region 9 RSL [(A)]	0.170
Benzo(a)anthracene	0.15	EPA Region 9 RSL [(A)]	0.170
Benzo(a)pyrene	0.015	EPA Region 9 RSL [(A)]	0.170
Benzo(b)fluoranthene	0.15	EPA Region 9 RSL [(A)]	0.170
Benzo(g,h,i)perylene	27	RWQCB SF Bay Region ESL [(B)]	0.170
Benzo(k)fluoranthene	1.5	EPA Region 9 RSL [(A)]	0.170
Bis(2-chloroethoxy)methane	180	EPA Region 9 RSL [(A)]	0.170
Bis(2-chloroethyl)ether	0.21	EPA Region 9 RSL [(A)]	0.170
Bis(2-ethylhexyl)phthalate	35	EPA Region 9 RSL [(A)]	0.170
Butylbenzylphthalate	260	EPA Region 9 RSL [(A)]	0.170
Caprolactam	31,000	EPA Region 9 RSL [(A)]	0.170
Carbazole	N/A	No applicable action level	0.170
Chrysene	15	EPA Region 9 RSL [(A)]	0.170
Dibenzo(a,h)anthracene	0.015	EPA Region 9 RSL [(A)]	0.170

Table A3
Screening Levels and Reporting Limits for Soils
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Contract Laboratory Program (CLP)

Parameter to be Analyzed	Screening Level – Residential Scenario (mg/kg)	Source	Reporting Limit/Target Detection Limit (mg/kg)
Dibenzofuran	78	EPA Region 9 RSL [(A)]	0.170
Diethylphthalate	49,000	EPA Region 9 RSL [(A)]	0.170
Dimethylphthalate	0.035	RWQCB SF Bay Region ESL [(B)]	0.170
Di-n-butylphthalate	6,100	EPA Region 9 RSL [(A)]	0.170
Di-n-octylphthalate	N/A	No applicable action level	0.170
Fluoranthene	2,300	EPA Region 9 RSL [(A)]	0.170
Fluorene	2,300	EPA Region 9 RSL [(A)]	0.170
Hexachlorobenzene	0.3	EPA Region 9 RSL [(A)]	0.170
Hexachlorobutadiene	6.2	EPA Region 9 RSL [(A)]	0.170
Hexachlorocyclopentadiene	370	EPA Region 9 RSL [(A)]	0.330
Hexachloroethane	35	EPA Region 9 RSL [(A)]	0.170
Indeno(1,2,3-cd)pyrene	0.15	EPA Region 9 RSL [(A)]	0.170
Isophorone	510	EPA Region 9 RSL [(A)]	0.170
Naphthalene	3.6	EPA Region 9 RSL [(A)]	0.170
Nitrobenzene	4.8	EPA Region 9 RSL [(A)]	0.170
N-Nitroso-di-n-propylamine	0.069	EPA Region 9 RSL [(A)]	0.170
N-Nitrosodiphenylamine	99	EPA Region 9 RSL [(A)]	0.170
Pentachlorophenol	0.89	EPA Region 9 RSL [(A)]	0.330
Phenanthrene	11	RWQCB SF Bay Region ESL [(B)]	0.170
Phenol	18,000	EPA Region 9 RSL [(A)]	0.170
Pyrene	1,700	EPA Region 9 RSL [(A)]	0.170
Organochlorine Pesticides/Aroclors			
alpha-BHC	0.077	EPA Region 9 RSL [(A)]	0.0017
beta-BHC	0.27	EPA Region 9 RSL [(A)]	0.0017
delta-BHC	N/A	No applicable action level	0.0017
gamma-BHC (Lindane)	0.52	EPA Region 9 RSL [(A)]	0.0017
Heptachlor	0.11	EPA Region 9 RSL [(A)]	0.0017
Aldrin	0.029	EPA Region 9 RSL [(A)]	0.0017
Heptachlor Epoxide	0.053	EPA Region 9 RSL [(A)]	0.0017
Endosulfan I	370	EPA Region 9 RSL [(A)]	0.0017
Dieldrin	0.030	EPA Region 9 RSL [(A)]	0.0033
4,4’-DDE	1.4	EPA Region 9 RSL [(A)]	0.0033
Endrin	18	EPA Region 9 RSL [(A)]	0.0033

Table A3
Screening Levels and Reporting Limits for Soils
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Contract Laboratory Program (CLP)

Parameter to be Analyzed	Screening Level – Residential Scenario (mg/kg)	Source	Reporting Limit/Target Detection Limit (mg/kg)
Endosulfan II	370	EPA Region 9 RSL [(A)]	0.0033
4,4'-DDD	2.0	EPA Region 9 RSL [(A)]	0.0033
Endosulfan sulfate	370	EPA Region 9 RSL [(A)]	0.0033
4,4'-DDT	1.7	EPA Region 9 RSL [(A)]	0.0033
Methoxychlor	310	EPA Region 9 RSL [(A)]	0.017
Endrin ketone	18	EPA Region 9 RSL [(A)]	0.033
Endrin aldehyde	18	EPA Region 9 RSL [(A)]	0.033
alpha-Chlordane	1.6	EPA Region 9 RSL [(A)]	0.017
gamma-Chlordane	1.6	EPA Region 9 RSL [(A)]	0.017
Toxaphene	0.44	EPA Region 9 RSL [(A)]	0.170
Aroclor-1016	3.9	EPA Region 9 RSL [(A)]	0.012
Aroclor-1221	0.14	EPA Region 9 RSL [(A)]	0.024
Aroclor-1232	0.14	EPA Region 9 RSL [(A)]	0.033
Aroclor-1242	0.22	EPA Region 9 RSL [(A)]	0.033
Aroclor-1248	0.22	EPA Region 9 RSL [(A)]	0.033
Aroclor-1254	0.22	EPA Region 9 RSL [(A)]	0.033
Aroclor-1260	0.22	EPA Region 9 RSL [(A)]	0.033
Aroclor-1262	0.22	RWQCB SF Bay Region ESL[(B)]	0.033
Aroclor-1268	0.22	RWQCB SF Bay Region ESL[(B)]	0.033
TAL Metals			
Aluminum	77,000	EPA Region 9 RSL [(A)]	20
Antimony	31	EPA Region 9 RSL [(A)]	6
Arsenic	14[a]	Background Soil[a]	1
Barium	15,000	EPA Region 9 RSL [(A)]	20
Beryllium	160	EPA Region 9 RSL [(A)]	0.5
Cadmium	70	EPA Region 9 RSL [(A)]	0.5
Calcium	N/A	No applicable action level	500
Chromium (total)	120,000	EPA Region 9 RSL [(A)]	1
Cobalt	23	EPA Region 9 RSL [(A)]	5
Copper	3,100	EPA Region 9 RSL [(A)]	2.5
Iron	55,000	EPA Region 9 RSL [(A)]	10
Lead	400	EPA Region 9 RSL [(A)]	1
Magnesium	N/A	No applicable action level	500
Manganese	1,800	EPA Region 9 RSL [(A)]	1.5

Table A3
Screening Levels and Reporting Limits for Soils
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Contract Laboratory Program (CLP)

Parameter to be Analyzed	Screening Level – Residential Scenario (mg/kg)	Source	Reporting Limit/Target Detection Limit (mg/kg)
Mercury	10	EPA Region 9 RSL [(A)]	0. 1
Nickel	1,500	EPA Region 9 RSL [(A)]	4
Potassium	N/A	No applicable action level	500
Selenium	390	EPA Region 9 RSL [(A)]	3.5
Silver	390	EPA Region 9 RSL [(A)]	1
Sodium	N/A	No applicable action level	500
Thallium	0.78	EPA Region 9 RSL [(A)]	2.5
Vanadium	390	EPA Region 9 RSL [(A)]	5
Zinc	23,000	EPA Region 9 RSL [(A)]	6
Hexavalent Chromium	0.29	EPA Region 9 RSL [(A)]	NA
Total Petroleum Hydrocarbons			
Diesel	83	RWQCB SF Bay Region ESL [(B)]	NA
Motor Oil	370	RWQCB SF Bay Region ESL [(B)]	NA
Gasoline	83	RWQCB SF Bay Region ESL [(B)]	NA
Dioxins / Furans			
2,3,7,8-TCDD	0.0000045	EPA Region 9 RSL [(A)]	NA
1,2,3,7,8-PeCDD [c]	NA[c]	EPA TEF[c]	NA
1,2,3,6,7,8-HxCDD [c]	NA[c]	EPA TEF[c]	NA
1,2,3,4,7,8-HxCDD [c]	NA[c]	EPA TEF[c]	NA
1,2,3,7,8,9-HxCDD [c]	NA[c]	EPA TEF[c]	NA
1,2,3,4,6,7,8-HpCDD [c]	NA[c]	EPA TEF[c]	NA
OCDD [c]	NA[c]	EPA TEF[c]	NA
2,3,7,8-TCDF [c]	NA[c]	EPA TEF[c]	NA
1,2,3,7,8-PeCDF [c]	NA[c]	EPA TEF[c]	NA
2,3,4,7,8-PeCDF [c]	NA[c]	EPA TEF[c]	NA
1,2,3,6,7,8-HxCDF [c]	NA[c]	EPA TEF[c]	NA
1,2,3,7,8,9-HxCDF [c]	NA[c]	EPA TEF[c]	NA
1,2,3,6,7,8-HxCDF [c]	NA[c]	EPA TEF[c]	NA
2,3,4,6,7,8-HxCDF [c]	NA[c]	EPA TEF[c]	NA
1,2,3,4,6,7,8-HpCDF [c]	NA[c]	EPA TEF[c]	NA
1,2,3,4,7,8,9-HpCDF [c]	NA[c]	EPA TEF[c]	NA
OCDF [c]	NA[c]	EPA TEF[c]	NA

Table A3
Screening Levels and Reporting Limits for Soils
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Contract Laboratory Program (CLP)

Notes:

(A) EPA Region 9 Regional Screening Levels (RSLs), last updated June 2011 obtained online at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/master_sl_table_run_JUN2011.pdf

(B) California Regional Water Quality Control Board (RWQCB), San Francisco (SF) Bay Region, Environmental Screening Levels (ESLs) in Shallow Soils, (< 3 meters below ground surface), where Groundwater is a Current or Potential Source of Drinking Water, Residential Land Use (Revised May 2008)

[a] Background for arsenic in Bay Area soils is 14 mg/kg as reported in the Remedial Investigation Report (CH2M Hill, 2011)

[b] Listed in EPA Region 9 RSL as Dioxin (2,3,7,8-TCDD)

[c] The dioxin and furan concentrations for these analytes will be converted to the 2,3,7,8-TCDD equivalent using the EPA 2010 Toxicity Equivalence Factors (TEFs) (EPA, 2010), and compared to the RSL for 2,3,7,8-TCDD. Method reporting limits are acceptable

Table A4
Screening Levels and Reporting Limits for Groundwater
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Commercial Laboratories

RI-SAP TABLE 14A

Remedial Investigation
AMCO Chemical Superfund Site, Oakland, California

Parameter to be Analyzed	Screening Level[a] (µg/L)	Source	Reporting Limit/Target Detection Limit (µg/L)
TCL VOCs			
Acetone	22,000	EPA Region 9 RSL [(A)]	5.0
Benzene	1	CA Primary MCL [(B)]	0.50
Bromodichloromethane	80	CA/EPA Primary MCL [(B,C)]	0.50
Bromoform	80	CA/EPA Primary MCL [(B,C)]	0.50
Bromoethane	N/A	No applicable action level	TBD
Carbon disulfide	1,000	EPA Region 9 RSL[(A)]	0.50
Carbon tetrachloride	0.5	CA Primary MCL [(B)]	0.50
Chlorobenzene	70	CA Primary MCL [(B)]	0.50
Chloroethane	21,000	EPA Region 9 RSL [(A)]	0.50
Chloroform	80	CA/EPA Primary MCL [(B,C)]	0.50[d]
Chloromethane	190	EPA Region 9 RSL [(A)]	0.50
Cyclohexane	13,000	EPA Region 9 RSL [(A)]	0.50
Dibromochloromethane	80	CA/EPA Primary MCL [(B,C)]	0.50[d]
Dibromochloropropane (DBCP)	0.2	CA/EPA Primary MCL [(B,C)]	0.50[d]
1,2-Dibromoethane	0.05	CA/EPA Primary MCL [(B,C)]	0.50[d]
1,2-Dichlorobenzene	600	CA/EPA Primary MCL [(B,C)]	0.50
1,3-Dichlorobenzene	65	RWQCB SF Bay Region ESL[(D)]	0.50
1,4-Dichlorobenzene	5	CA Primary MCL [(B)]	0.50
Dichlorodifluoromethane	200	EPA Region 9 RSL [(A)]	0.50
1,1-Dichloroethane	5	CA Primary MCL [(B)]	0.50
1,2-Dichloroethane	0.5	CA Primary MCL [(B)]	0.50
1,1-Dichloroethene	6	CA Primary MCL [(B)]	0.50
cis-1,2-Dichloroethene	6	CA Primary MCL [(B)]	0.50
trans-1,2-Dichloroethene	10	CA Primary MCL [(B)]	0.50
Dichloromethane (Methylene chloride)	5	CA/EPA Primary MCL [(B,C)]	0.50
1,2-Dichloropropane	5	CA/EPA Primary MCL [(B,C)]	0.50
cis-1,3-Dichloropropene	0.5	CA Primary MCL [(B)]	0.50
trans-1,3-Dichloropropene	0.5	CA Primary MCL [(B)]	0.50
Ethylbenzene	300	CA Primary MCL [(B,C)]	0.50
2-Hexanone	N/A	No applicable action level	5.0

RI-SAP TABLE 14A
Remedial Investigation
AMCO Chemical Superfund Site, Oakland, California

Parameter to be Analyzed	Screening Level[a] (µg/L)	Source	Reporting Limit/Target Detection Limit (µg/L)
Isopropylbenzene (Cumene)	680	EPA Region 9 RSL [(A)]	0.50
Methyl acetate	37,000	EPA Region 9 RSL [(A)]	0.50
Methyl ethyl ketone (2-Butanone)	7,100	EPA Region 9 RSL [(A)]	5.0
Methyl isobutyl ketone (4-methyl-2-pentanone)	2,000	EPA Region 9 RSL [(A)]	5.0
Methylcyclohexane	N/A	No applicable action level	0.50
Styrene	100	CA/EPA Primary MCL [(B,C)]	0.50
1,1,2,2-Tetrachloroethane	1	CA Primary MCL [(B)]	0.50
Tetrachloroethane (PCE)	5	CA/EPA Primary MCL [(B,C)]	0.50
Toluene	150	CA Primary MCL [(B)]	0.50
1,2,4-Trichlorobenzene	5	CA Primary MCL [(B)]	0.50
1,2,3-Trichorobenzene	29	EPA Region 9 RSL [(A)]	0.50
1,1,1-Trichloroethane	200	CA/EPA Primary MCL [(B)]	0.50
1,1,2-Trichloroethane	5	CA/EPA Primary MCL [(B,C)]	0.50
Trichloroethene (TCE)	5	CA/EPA Primary MCL [(B,C)]	0.50
Trichlorofluoromethane	150	CA Primary MCL [(B)]	0.50
1,1,2-Trichloro -1,2,2-Trifluoroethane	1,200	CA Primary MCL [(B)]	0.50
1,2,4-Trimethylbenzene	15	EPA Region 9 RSL [(A)]	5.0
1,3,5-Trimethylbenzene	370	EPA Region 9 RSL [(A)]	5.0
Vinyl chloride	0.5	CA Primary MCL [(B)]	0.50
Xylene(s)	1,750	CA Primary MCL [(B)]	1.0
MTBE and Fuel Oxygenates			
Methyl tert-butyl ether (MTBE)	13	CA Primary MCL [(B)]	0.5
Tertiary butyl alcohol (TBA)	12	RWQCB SF Bay Region ESL[(D)]	10
Tertiary amyl methyl ether (TAME)	N/A	No applicable action level	5.0
Ethyl tertiary butyl ether (ETBE)	N/A	No applicable action level	5.0
1,4-Dioxane	0.67	EPA Region 9 RSL [(A)]	2.0[d]
TCL SVOCs			

RI-SAP TABLE 14A
Remedial Investigation
AMCO Chemical Superfund Site, Oakland, California

Parameter to be Analyzed	Screening Level[a] (µg/L)	Source	Reporting Limit/Target Detection Limit (µg/L)
1,1'-Biphenyl	0.83	EPA Region 9 RSL [(A)]	5.0
1,2,4,5-Tetrachlorobenzene	11	EPA Region 9 RSL [(A)]	5.0
2,2'-Oxybis(1-Chloropropane)	N/A	No applicable action level	5.0
2,3,4,6-Tetrachlorophenol	1,100	EPA Region 9 RSL [(A)]	5.0
2,4,5-Trichlorophenol	3,700	EPA Region 9 RSL [(A)]	5.0
2,4,6-Trichlorophenol	6.1	EPA Region 9 RSL [(A)]	5.0
2,4-Dichlorophenol	110	EPA Region 9 RSL [(A)]	5.0
2,4-Dimethylphenol	730	EPA Region 9 RSL [(A)]	5.0
2,4-Dinitrophenol	73	EPA Region 9 RSL [(A)]	10
2,4-Dinitrotoluene	0.22	EPA Region 9 RSL [(A)]	5.0[d]
2,6-Dinitrotoluene	37	EPA Region 9 RSL [(A)]	5.0
2-Chloronapthalene	2,900	EPA Region 9 RSL [(A)]	5.0
2-Chlorophenol	180	EPA Region 9 RSL [(A)]	5.0
2-Methylnaphthalene	150	EPA Region 9 RSL [(A)]	5.0
2-Methylphenol (o-Cresol)	1,800	EPA Region 9 RSL [(A)]	5.0
2-Nitroaniline	370	EPA Region 9 RSL [(A)]	10
2-Nitrophenol	N/A	No applicable action level	5.0
3-3'Dichlorobenzidine	0.15	EPA Region 9 RSL [(A)]	5.0[d]
3-Nitroaniline	N/A	No applicable action level	10
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	2.9	EPA Region 9 RSL[(A)]	10[d]
4-Bromophenyl-phenylether	N/A	No applicable action level	5.0
4-Chloro-3-methylphenol (4-Chloro-m-cresol)	3,700	EPA Region 9 RSL[(A)]	5.0
4-Chloroaniline	0.34	EPA Region 9 RSL [(A)]	5.0[d]
4-Chlorophenyl-phenylether	N/A	No applicable action level	5.0
4-Methylphenol (p-Cresol)	180	EPA Region 9 RSL [(A)]	5.0
4-Nitroaniline	3.4	EPA Region 9 RSL[(A)]	10[d]
4-Nitrophenol	N/A	No applicable action level	10
Acenaphthene	2,200	EPA Region 9 RSL [(A)]	5.0
Acenapthylene	30	RWQCB SF Bay Region ESL[(D)]	5.0

RI-SAP TABLE 14A
Remedial Investigation
AMCO Chemical Superfund Site, Oakland, California

Parameter to be Analyzed	Screening Level[a] (µg/L)	Source	Reporting Limit/Target Detection Limit (µg/L)
Acetaphenone	N/A	No applicable action level	5.0
Anthracene	11,000	EPA Region 9 RSL [(A)]	5.0
Atrazine	1	CA Primary MCL [(B,C)]	3.0[d]
Benzaldehyde	3,700	EPA Region 9 RSL [(A)]	5.0
Benzo(a)anthracene	0.29	EPA Region 9 RSL [(A)]	5.0[d]
Benzo(a)pyrene	0.2	CA/EPA Primary MCL [(B,C)]	5.0[d]
Benzo(b)fluoranthene	0.029	EPA Region 9 RSL [(A)]	5.0[d]
Benzo(g,h,i)perylene	0.1	RWQCB SF Bay Region ESL	5.0[d]
Benzo(k)fluoranthene	0.29	EPA Region 9 RSL [(A)]	5.0[d]
Bis(2-chloroethoxy)methane	110	EPA Region 9 RSL[(A)]	5.0
Bis(2-chloroethyl)ether	0.012	EPA Region 9 RSL [(A)]	5.0[d]
Bis(2-ethylhexyl)phthalate	4	CA Primary MCL [(B)]	5.0[d]
Butylbenzylphthalate	N/A	No applicable action level	5.0
Caprolactam	18,000	EPA Region 9 RSL [(A)]	5.0
Carbazole	N/A	No applicable action level	5.0
Chrysene	2.9	EPA Region 9 RSL [(A)]	5.0[d]
Dibenzo(a,h)anthracene	0.0029	EPA Region 9 RSL [(A)]	5.0[d]
Dibenzofuran	37	EPA Region 9 RSL [(A)]	5.0
Diethylphthalate	29,000	EPA Region 9 RSL [(A)]	5.0
Dimethylphthalate	1.5	RWQCB SF Bay Region ESL[(D)]	5.0
Di-n-butylphthalate	3,700	EPA Region 9 RSL [(A)]	5.0
Di-n-octylphthalate	N/A	No applicable action level	5.0
Fluoranthene	1,500	EPA Region 9 RSL [(A)]	5.0
Fluorene	1,500	EPA Region 9 RSL [(A)]	5.0
Hexachlorobenzene	1	CA/EPA Primary MCL [(B,C)]	1.0
Hexachlorobutadiene	0.86	EPA Region 9 RSL [(A)]	5.0
Hexachlorocyclopentadiene	50	CA/EPA Primary MCL [(B,C)]	5.0
Hexachloroethane	4.8	EPA Region 9 RSL [(A)]	5.0[d]
Indeno(1,2,3-cd)pyrene	0.029	EPA Region 9 RSL [(A)]	5.0[d]
Isophorone	71	EPA Region 9 RSL [(A)]	5.0
Naphthalene	0.14	EPA Region 9 RSL [(A)]	5.0[d]
Nitrobenzene	0.12	EPA Region 9 RSL [(A)]	5.0[d]
N-Nitroso-di-n-	0.0096	EPA Region 9 RSL [(A)]	5.0[d]

RI-SAP TABLE 14A
Remedial Investigation
AMCO Chemical Superfund Site, Oakland, California

Parameter to be Analyzed	Screening Level[a] (µg/L)	Source	Reporting Limit/Target Detection Limit (µg/L)
propylamine			
N-Nitrosodiphenylamine	14	EPA Region 9 RSL (A)	5.0
Pentachlorophenol	1	CA/EPA Primary MCL (B,C)	0.5[d]
Phenanthrene	6.3	RWQCB SF Bay Region ESL(D)	5.0
Phenol	11,000	EPA Region 9 RSL (A)	5.0
Pyrene	1,100	EPA Region 9 RSL (A)	5.0
Organochlorine Pesticides/Aroclors			
α-hexachlorocyclohexane (alpha-BHC)	0.011	EPA Region 9 RSL (A)	0.05[d]
β-hexachlorocyclohexane (beta-BHC)	0.037	EPA Region 9 RSL (A)	0.05[d]
delta-BHC	N/A	No applicable action level	0.05
γ-hexachlorocylcohexane (gamma-BHC/Lindane)	0.2	CA/EPA Primary MCL (B)	0.05
Heptachlor	0.01	CA Primary MCL (B)	0.05[d]
Aldrin	0.004	EPA Region 9 RSL (A)	0.01[d]
Heptachlor Epoxide	0.01	CA Primary MCL (B)	0.01
Endosulfan I	220	EPA Region 9 RSL (A)	0.05
Dieldrin	0.0042	EPA Region 9 RSL (A)	0.02[d]
4,4'-DDE	0.2	EPA Region 9 RSL (A)	0.1
Endrin	2	CA/EPA Primary MCL (B,C)	0.1
Endosulfan II	220	EPA Region 9 RSL (A)	0.1
4,4'-DDD	0.28	EPA Region 9 RSL (A)	0.1
Endosulfan sulfate	220	EPA Region 9 RSL (A)	0.1
4,4'-DDT	0.20	EPA Region 9 RSL (A)	0.1
Methoxychlor	30	CA Primary MCL (B)	0.5
Endrin ketone	N/A	No applicable action level	0.1
Endrin aldehyde	N/A	No applicable action level	0.1
alpha-Chlordane	0.1	CA Primary MCL (B)	0.05
gamma-Chlordane	0.1	CA Primary MCL (B)	0.05
Toxaphene	3	CA/EPA Primary MCL (B,C)	1
Aroclor-1016	0.5	CA/EPA Primary MCL (B,C)	0.5
Aroclor-1221	0.5	CA/EPA Primary MCL (B,C)	0.5

Table A4
Screening Levels and Reporting Limits for Groundwater
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Commercial Laboratories

RI-SAP TABLE 14A
Remedial Investigation
AMCO Chemical Superfund Site, Oakland, California

Parameter to be Analyzed	Screening Level[a] (µg/L)	Source	Reporting Limit/Target Detection Limit (µg/L)
Aroclor-1232	0.5	CA/EPA Primary MCL [(B,C)]	0.5
Aroclor-1242	0.5	CA/EPA Primary MCL [(B,C)]	0.5
Aroclor-1248	0.5	CA/EPA Primary MCL [(B,C)]	0.5
Aroclor-1254	0.5	CA/EPA Primary MCL [(B,C)]	0.5
Aroclor-1260	0.5	CA/EPA Primary MCL [(B,C)]	0.5
Aroclor-1262	0.5	CA/EPA Primary MCL [(B,C)]	0.5
Aroclor-1268	0.5	CA/EPA Primary MCL [(B,C)]	0.5
TAL Metals			
Aluminum	37,000	EPA Region 9 RSL [(A)]	100
Antimony	6	CA/EPA Primary MCL [(B,C)]	10[d]
Arsenic	10 [b]	CA Primary MCL [(C)]	5
Barium	1,000	CA Primary MCL [(B)]	5
Beryllium	4	CA/EPA Primary MCL [(B,C)]	2
Cadmium	5	CA/EPA Primary MCL [(B,C)]	5
Calcium	N/A	No applicable action level	500
Chromium (total)	50	CA Primary MCL [(B)]	5
Cobalt	11	EPA Region 9 RSL [(A)]	5
Copper	1,300	CA/EPA Primary MCL [(B,C)]	5
Iron	26,000	EPA Region 9 RSL [(A)]	100
Lead	15	CA/EPA Primary MCL [(B,C)]	5
Magnesium	N/A	No applicable action level	500
Manganese	880	EPA Region 9 RSL [(A)]	5
Mercury	2	CA/EPA Primary MCL [(B,C)]	2
Nickel	100	CA Primary MCL [(B)]	5
Potassium	N/A	No applicable action level	500
Selenium	50	CA/EPA Primary MCL [(B,C)]	10
Silver	180	EPA Region 9 RSL [(A)]	5
Sodium	N/A	No applicable action level	500
Thallium	2.0	CA/EPA Primary MCL [(B,C)]	10[d]
Vanadium	180	EPA Region 9 RSL [(A)]	5
Zinc	11,000	EPA Region 9 RSL [(A)]	20
Hexavalent Chromium	0.0043	EPA Region 9 RSL[(A)]	TBD
Total Petroleum Hydrocarbons			
Diesel	100	RWQCB SF Bay Region	250[d]

Table A4
Screening Levels and Reporting Limits for Groundwater
October 2011 Amendment to the Remedial Investigation Sampling and Analysis Plan
Commercial Laboratories

RI-SAP TABLE 14A
Remedial Investigation
AMCO Chemical Superfund Site, Oakland, California

Parameter to be Analyzed	Screening Level[a] (µg/L)	Source	Reporting Limit/Target Detection Limit (µg/L)
		ESL[(D)]	
Motor Oil	100	RWQCB SF Bay Region ESL[(D)]	1000[d]
Gasoline	100	RWQCB SF Bay Region ESL[(D)]	50
Dioxins / Furans			
2,3,7,8-TCDD	0.000030	CA/EPA Primary MCL [(B)]	0. 000010
1,2,3,7,8-PeCDD [c]	NA[c]	EPA TEF[c]	TBD
1,2,3,6,7,8-HxCDD [c]	NA[c]	EPA TEF[c]	TBD
1,2,3,4,7,8-HxCDD [c]	NA[c]	EPA TEF[c]	TBD
1,2,3,7,8,9-HxCDD [c]	NA[c]	EPA TEF[c]	TBD
1,2,3,4,6,7,8-HpCDD [c]	NA[c]	EPA TEF[c]	TBD
OCDD [c]	NA[c]	EPA TEF[c]	TBD
2,3,7,8-TCDF [c]	NA[c]	EPA TEF[c]	TBD
1,2,3,7,8-PeCDF [c]	NA[c]	EPA TEF[c]	TBD
2,3,4,7,8-PeCDF [c]	NA[c]	EPA TEF[c]	TBD
1,2,3,6,7,8-HxCDF [c]	NA[c]	EPA TEF[c]	TBD
1,2,3,7,8,9-HxCDF [c]	NA[c]	EPA TEF[c]	TBD
1,2,3,6,7,8-HxCDF [c]	NA[c]	EPA TEF[c]	TBD
2,3,4,6,7,8-HxCDF [c]	NA[c]	EPA TEF[c]	TBD
1,2,3,4,6,7,8-HpCDF [c]	NA[c]	EPA TEF[c]	TBD
1,2,3,4,7,8,9-HpCDF [c]	NA[c]	EPA TEF[c]	TBD
OCDF[c]	NA[c]	EPA TEF[c]	TBD

(A) EPA Region 9 tap water Regional Screening Level (RSL), last updated June 2011.

(B) CA Department of Health Services Primary Maximum Contaminant Level (MCL) for Drinking Water.

(C) EPA Primary MCL for Drinking Water.

(D) California Regional Water Quality Control Board San Francisco Bay Region Environmental Screening Levels (ESLs) – Table F-1a Groundwater Screening Levels (Groundwater is a potential drinking water resource) May 2008

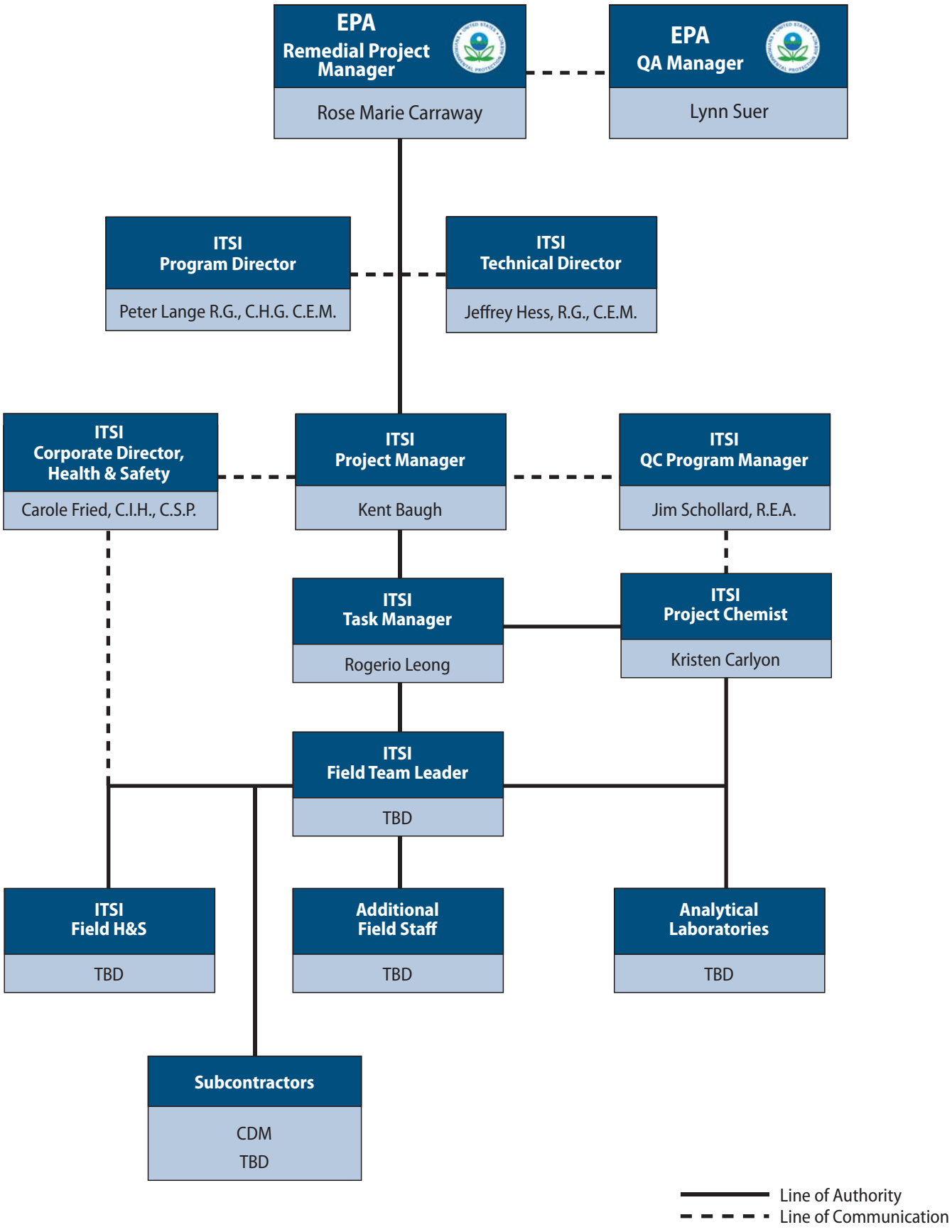
a The lower of the Federal or California Primary MCL, or EPA Region 9 tap water RSL, if Primary MCL is not available. In cases where neither MCL or RSLs are available, SF Bay RWQCB ESLs were used.

b The California Region 9 RSL for arsenic (cancer endpoint) is 0.045 µg/L.

c The dioxin and furan concentrations for these analytes will be converted to the 2,3,7,8-TCDD equivalent using the EPA 2010 Toxicity Equivalence Factors (TEFs) (EPA, 2010), and compared to the RSL for 2,3,7,8-TCDD. Method reporting limits are acceptable

d In order to meet project screening limits, the laboratory will report J-flagged estimated values down to the achievable method detection limit (MDL). If any MDL is greater than the screening limit, the method will be reviewed.

FIGURES



Innovative Technical Solutions, Inc.
A Gilbane Company

AMCO Chemical Superfund Site
Oakland, California

FIGURE 1
Project Organization Chart

EPA:\0019 TO 18 FS AMCO Chemical\15.0 Graphics\Project Org.ai

ATTACHMENT 1

STANDARD OPERATING PROCEDURES

Innovative Technical Solutions, Inc.
A Gilbane Company

Standard Operating Procedure

Field Documentation

PR-TC-01.04.01.00

Effective Date: 14 March 2011

Prepared by: *By e-mail* Date: 01 Mar 2011
Manuel Padilla, Environmental Scientist

Reviewed by: Date: 11 Mar 2011
Jim Schollard, Quality Assurance Officer

Approved by: Date: 14 Mar 2011
Jeffrey Hess, Director, Technical Services

Revision History:

Version	Changes	Affects Section/Pages	Effective Date	Approval
1.0	Initial Issue		14 Mar 2011	

This document contains proprietary information of Innovative Technical Solutions, Inc. (ITSI). ITSI retains all rights associated with these materials, which may not be reproduced without ITSI's express written permission.

Table of Contents

Page No.

List of Attachments ii
1.0 Purpose and Scope 1
2.0 Acronyms and Definitions 1
3.0 Equipment/Materials 1
4.0 Procedures 2
4.1 Daily Activity Report (DAR) 2
4.2 Other ITSI Forms 3
4.3 Federal, State, and Local Agency Forms 4
5.0 Field Records Management 4
6.0 Attachments/Forms 5
7.0 References 6

LIST OF ATTACHMENTS

Attachment A Sample Field Forms

1.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) provides an overview of required procedures for field documentation to be performed as part of an environmental site visit or field activity. This documentation occurs through the use of specific field forms and/or logbook.

Proper documentation of field activities is a crucial part of any and all field activities, both for technical and legal defensibility. The field documentation should, at a minimum, provide the basic information from the site visit or field activity, such as time onsite, the names of the crew, names of any visitors, weather conditions, activities performed, and any significant findings or observations.

In the event that site conditions change, or direction is received from client or regulatory agency personnel, potentially resulting in changes to the scope of activities specified in the approved plans (i.e., work plan, sampling and analysis plan), the field documentation should properly and adequately reflect such changes, provide the basis of each change, and fully document instructions received from client or regulatory agency personnel.

2.0 ACRONYMS AND DEFINITIONS

For purposes of this procedure, a number of terms and acronyms have the meanings defined below.

APP: Accident Prevention Plan

DAR: Daily Activity Report, a hand-written form used to document the daily field activities performed at a project site

FTL: Field Team Leader

GPS: global positioning system

HSP: Health and Safety Plan

QA: Quality Assurance

QCM: Quality Control Manager

SCL: Sample Collection Log

SAP: Sampling and Analysis Plan

SOP: Standard Operating Procedure

3.0 EQUIPMENT/MATERIALS

The list below represents the equipment and materials recommended to complete the tasks defined in the SOP:

- Camera
- GPS

- ITSI Daily Activity Report (or in some cases, a bound Field Logbook for specific programs, sites or regulatory applications)
- Other field forms as appropriate for the project
- Indelible ballpoint pen (fine-tip preferable).

4.0 PROCEDURES

The following subsections describe the procedures for field documentation. In the event that these procedures cannot be performed as written in this SOP, the field personnel must contact the individual in charge of the project (e.g., project manager) to obtain approval for deviation of procedures prior to starting field activities.

4.1 DAILY ACTIVITY REPORT (DAR)

Each Field Team Leader (FTL), Task Manager, or Site Superintendent overseeing or conducting field activities shall be responsible for completing and maintaining a DAR (or field logbook, when applicable) to document the activities performed each day in the field. At a minimum the following information shall be recorded in the DAR (or field logbook):

- Project name and project number
- Site name and location
- Date(s) of field activity
- Name of individual reporting field notes
- Name, affiliation, and responsibilities of the personnel on site. For larger projects with significant field staff, this information may be entered into the Contractor Production Report (discussed in Section 4.2)
- Arrival and departure times
- Daily weather conditions
- Chronology and location of field activities
- Pertinent field observations, including:
    - Physical description and sketch or map of the field activity location (to include details such as structures, sample points, borings, wells, stained areas, and any other pertinent information)
    - References to global positioning system (GPS) data collected, if applicable (note, all locations where information is collected (such as sample locations, water quality testing locations, photographs of key features) should be located using a GPS)
    - References to photographs of the site and site activities, as applicable, including location and direction faced when taken
- Record of daily telephone calls and/or direct contact with individuals at the site

Other pertinent information should be included, with the specific nature of this information dependent on the type of field activity. For example, if the field activity involved the collection of samples for environmental or geotechnical analysis, relevant information to include in the DAR (or field logbook) would consist of the following:

- Daily summary of equipment preparation procedures, as appropriate

- A description of sampling methodology
- Time and locations of sample collection (unless reported in an appropriate Sample Collection Log (SCL). If SCLs are used, the focus of the documentation should be on summarizing the day's activities)
- Numbers, types of samples collected, and sample identification numbers (unless reported in SCLs and summarized in a Sample Tracking Log. If SCLs are used, the emphasis should be on summarizing the day's production.)
- Management and disposal of investigation-derived wastes (IDW)

Specific field programs, sites, regulatory or weather conditions, may necessitate the use of bound field logbooks in addition to or in lieu of completing DAR forms. There are several types of acceptable logbooks, depending on the requirements of the field activity. One of two types of logbooks are recommended, if used: 1) permanently bound, sequentially numbered, pocket-sized logbook with water-resistant paper; or 2) custom logbook consisting of ITSI-approved forms printed on water-resistant paper and spiral-bound to prevent pages from being added or removed in the field. Other options exist, but care should be taken if alternate logbooks are used to make sure the selection is consistent with the underlying requirement for use of a logbook in place of a DAR.

The FTL, Task Manager, or Site Superintendent overseeing or conducting field activities will be responsible for completing and maintaining the field logbook. Each page will be sequentially numbered and dated. When using field logbooks, all entries shall be legible and each day will be documented in chronological order, reflecting the order of each day's activities as they transpire. If an event is inadvertently not recorded in proper sequence, or was missed, the item should be flagged with an asterisk (*) at the beginning and end of the entry when it is added to the logbook, along with the time of the actual entry and the author's initials.

Blank lines should not be left between logbook entries during the day. Any blank spaces should be crossed-out with a single line, initialed, and dated. Unused partial pages (i.e., at the end of each workday) should also be crossed-out, signed and dated. If field logbook duties are transferred to another party, then the individuals relinquishing and receiving the logbook will both sign and date the logbook and record the transfer time.

When completing any field documentation, forms, or field logbooks, all errors should be lined-out with a single line through the entry. Corrections or insertions must be clearly indicated and all changes must be initialed and dated by the person making the changes directly above the lined-out correction. Field personnel shall adhere to the field reporting protocol described above, and ensure that all entries are recorded in a manner consistent with this SOP.

4.2 OTHER ITSI FORMS

In addition to the DAR, the following additional ITSI forms may be needed to document specific field activities:

- Contractor Production Report (attached; Section 6.0). This form is used to record hours worked by employees and all subcontractor personnel onsite, generally by individual tradecraft. The form also covers construction equipment onsite and used each day and

any equipment or materials that are received. This form is required for many of our DoD projects in order to document total field hours for all personnel (ITSI and subcontractors) onsite.

- Contractor Quality Control Report. This series of forms is used to document the day-by-day quality control activities, including but not limited to preparatory meetings, initial inspections, follow-up or ongoing inspections, incoming materials inspections, and development of a "punch list" during activity closeout. These forms are provided in your site-specific Contractor Quality Control Plan (CQCP).
- Tailgate Safety Meeting form. This form is used to ensure all field personnel are informed of the nature of the work being performed and the safety precautions for that day. The form is provided in your site-specific Health and Safety Plan (HSP) or Accident Prevention Plan (APP).
- Equipment and Truck Inspection Checklist. This form may be required for vehicles accessing some sites, to ensure compliance with site-specific requirements (i.e., presence of fire extinguisher in the vehicle, properly operating brake lights, etc.). This form is provided in your site-specific HSP or APP.
- Visitor Sign-in Log. This form is typically used for projects with extended field periods to document 3rd-party personnel onsite. This form is provided in your site-specific HSP or APP.
- Field Change Request Form (attached; Section 6.0). This form is used to request changes while in the field to procedures specified in the approved site-specific plans (i.e., changes in sampling methodology, etc.).
- Field activity-specific forms (*e.g.*, Monitoring Well Water Level Measurement Form, Monitoring Well Purge and Sample Form, Boring Log, Excavation Log, etc.) are used to document specific field activities at environmental sites and are provided with their respective field activity SOPs and the site-specific SAP.

Feld personnel shall use these forms (and any other forms identified in the site-specific plans or by project management on a project- or task-specific basis), in addition to the DAR as described in Section 4.1, to assure that all activities are properly and fully documented.

4.3 FEDERAL, STATE, AND LOCAL AGENCY FORMS

Any forms required by federal, state, and/or local agencies (i.e., site access, hot work permits, Uniform Hazardous Waste Manifests, etc.) shall be completed and submitted in accordance with current federal and state guidance requirements and regulations. A copy of each document shall be included in the "daily field documentation package".

5.0 FIELD RECORDS MANAGEMENT

All records associated with the field activities shall be managed by the designated responsible party (*e.g.*, FTL, Task Manager, Site Supervisor, Quality Control Manager (QCM) or onsite Project Manager). Completed forms shall be gathered into "daily field documentation packages", scanned and submitted to the client, as required (i.e., daily by 10 am the next morning

for projects with Navy ROICC oversight), and also uploaded to the ITSI project server daily, if possible, or at a minimum at the end of each work week. The work packages should be kept in a binder or folder onsite during field activities, and subsequently maintained in the project files after completion of field activities.

After the field records or "daily field documentation packages" (i.e., DAR, field forms, sampling forms, etc.) have been completed, scanned and uploaded, the field records shall be reviewed by the appropriate project personnel (i.e., Project Manager, Quality Assurance (QA) Officer, Project Chemist, etc.), and corrections made as needed. All corrections shall be noted how/where, and original documents that required corrections will be attached to the back of the corrected documents and retained in the project files.

6.0 ATTACHMENTS/FORMS

Copies of the following ITSI forms are attached. Additional approved activity-specific forms are provided with their respective SOPs.

- Daily Activity Report
- Contractor Production Report
- Field Change Request Form

7.0 REFERENCES

Los Alamos National Laboratory, 2010. *SOP-5181 Environmental Programs Waste and Environmental Services for Notebook and Logbook Documentation for Environmental Directorate Technical and Field Activities.* 2010.

Environmental Standards, Inc., 2009. *Standard Operating Procedure for: Field Documentation for Tennessee Valley Authority.* 2009.

U.S. Environmental Protection Agency (USEPA) Region 4, 2007. *Operating Procedure for Logbooks,* SESDPROC-010-R3. November.

USEPA, 2011. *Contract Laboratory Program Guidance for Field Samplers,* Office of Superfund Remediation and Technology Innovation, OSWER 9240.0-47, EPA 540-R-09-03. January.

Attachment A

Sample Field Forms

- Daily Activity Report
- Contractor Production Report
- Field Change Request Form

Daily Activity Report (DAR)

Project Name:	Page of
Project No./Task Code:	Date:
Description of Work:	
Visitors / Subcontractors:	
Weather:	

Description of Field Activities

Prepared by:	Signature:

Innovative Technical Solutions, Inc.
A Gilbane Company

Contractor Production Report

(Attach Additional Sheets if Necessary

Project Name:	Page of
Project No./Task Code:	Date:

Subcontractors:

Work Performed Today

Schedule Activity No.	Work Location and Description	Employer	Number	Trade	Hours

Job Safety

Was A Tailgate Safety Meeting Held This Date? (If Yes, Attach Copy Of The Sign-In Sheet)	☐ YES	☐ NO	Total Work Hours On Job Site Today (including any Continuation Sheets)	
Were Any Vehicle/Heavy Equipment Inspections Done? (If Yes, Attach Copies of the Inspections Performed)	☐ YES	☐ NO	Cumulative Total Of Work Hours From Previous Reports	
Was Any Trenching/Confined Space/Crane/Manlift Work Done? (If Yes, Attach Statement Or Checklist Showing Inspections Performed)	☐ YES	☐ NO	Total Work Hours From Start Of Field Activity	
Were There Any Lost Time Accidents This Date? (If Yes, Attach Copy Of Completed OSHA Report)	☐ YES	☐ NO		

Schedule Activity No.	List Safety Actions Taken Today/Safety Inspections Conducted	☐ Safety Requirements Have Been Met.

Equipment/Material Received Today To Be Incorporated In Job (Indicate Schedule Activity Number)

Schedule Activity No.	Submittal #	Description of Equipment/Material Received

Construction And Plant Equipment On Job Site Today (Indicate Hours Used And Schedule Activity Number)

Schedule Activity No.	Owner	Description of Construction Equipment Used Today (include Make and Model)	Hours Used

Schedule Activity No.	Remarks

Prepared by:	Signature:

CPR 031411

Field Change Request

(Continued on next page)

Project Name:	Page 1 of 2
Project No./Task Code:	Field Change No.:
Applicable Document(s):	Document Date:

Problem Description:

Recommended Solution:

Impact on Present and Completed Work:

Requested by:	Title:	Date:

Technical and Management Review/Approval

Recommended Disposition:

Clarification: ☐ Minor Change: ☐ Major Change: ☐

Client Approval **Is Not Required**: ☐ Client Approval **Is Required**: ☐

Regulatory Agency Approval **Is Not Required**: ☐ Regulatory Agency Approval **Is Required**: ☐

ITSI Technical Reviewer

Comments:

Signature:	Date:

ITSI Project Manager

Comments:

Signature:	Date:

Innovative Technical Solutions, Inc.
A Gilbane Company

Field Change Request

(Continued from previous page)

Project Name:	Page 2 of 2
Project No./Task Code:	Field Change No.:

Client Approval (required if marked on page 1)

Approved: ☐ Rejected: ☐

Comments:

Signature:	Date:

Regulatory Agency Approval (required if marked on page 1)

Approved: ☐ Rejected: ☐

Comments:

Signature:	Date:

Final Resolution

Description of Implemented Solution:

Signature:	Date:

Innovative Technical Solutions, Inc.

Standard Operating Procedure

Creating a Sample Identification System

PR-TC-01.04.04.00

Effective Date: 23 December 2008

Prepared by: Wing Tse, Database Manager — Date: 23 Dec 2008

Reviewed by: Kristen Carlyon, Program Chemist — Date: 23 Dec 2008

Approved by: Jeffrey Hess, Program Director — Date: 23 Dec 2008

Revision History:

Version	Changes	Affects Section/Pages	Effective Date	Approval
1.0	Initial Issue		23 Dec 2008	NA

This document contains proprietary information of Innovative Technical Solutions, Inc. (ITSI). ITSI retains all rights associated with these materials, which may not be reproduced without ITSI's express written permission.

Table of Contents

Page No.

1.0 Purpose and Scope 1
2.0 Acronyms and Definitions 1
3.0 Procedures 2
3.1 Part A: Location Identifier (Mandatory) 2
3.2 Part B: Sample Identifier (Mandatory) 3
3.3 Part C: Sample Identifier (Supplemental Notation–Optional) 4
3.4 Examples of Complete Sample Numbers 6
4.0 Attachments 6
5.0 Forms 6

1.0 PURPOSE AND SCOPE

The purpose of this standard operating procedure is to develop and adhere to a systematic means of identifying our samples collected, which will allow the implementation of an automated data workflow. A standardized approach will allow the data generated in the field to be entered into our environmental data management system (eDMS), the resulting electronic data files from the laboratories to flow electronically into eDMS, and support the delivery of this data to internal customers (e.g., Project Managers) and allow us to meet our requirements for delivery of the results to the government in the correct format (e.g., ERPIMS, NIRIS, SEDD).

2.0 ACRONYMS AND DEFINITIONS

For purposes of this procedure, a number of terms and acronyms have the meanings defined below.

COC: chain-of custody
eDMS: environmental data management system
ERPIMS: Environmental Restoration Program Information Management System (USAF)
MS/MSD: matrix spike and matrix spike duplicate
FSP: field sampling plan
NIRIS: Naval Installation Restoration Information Solution (USN)
QAPP: quality assurance project plan
QC: quality control
SAP: sampling and analysis plan
SEDD: Staged Electronic Data Deliverable (EPA, USACE)

3.0 PROCEDURES

Before creating a sample identification system and developing both location and sample identifiers for a project (or individual sampling event), the specific sampling needs for the project must be established. As discussed in the SOP–Sample Tracking and Electronic Data Management, the Project Manager establishes and communicates the goals and objectives of the sampling event to the team, and provides specifics regarding the number and type of samples.

Using the information provided by the Project Manager, the Project Chemist, in collaboration with the data management staff, will establish a sample identification (ID) system for the project such that each sample location has been identified, and each sample to be collected has a unique identifier based on the mandatory and optional elements outlined below and meeting the specific requirements (e.g., number and type of characters) for each included element.

This requirement for both "location ID" and "sample ID" is based on the government databases we are required to submit our results to, including ERPIMS (Air Force), NIRIS (Navy), and SEDD (USACE). An example of a "location ID" may be monitoring well MW12 (e.g., MW12 or OU2-MW12), whereas an example "sample ID" may include the location ID information, along with additional information such as the sample matrix and date sampled (e.g., OU2-MW12-GW-010108).

Although some variation in the number and/or type of characters is permitted for most of the sample identification elements, <u>each sample number must meet the following cumulative limits (based on maximum database field length)</u>:

- Sample Location (Part A—Section 3.1): no more than fifteen (15) characters
- Sample Identification (mandatory and optional elements, Part B [Section 3.2] and Part C [Section 3.3]): no more than thirty (30) characters

Proper use of the component elements of this sample identification system is described in the following subsections, and annotated examples of complete sample IDs are presented in Section 3.4.

3.1 PART A: LOCATION IDENTIFIER (MANDATORY)

The **Location Identifier** (Location ID) consists of the corresponding to the location where the sample will be collected, is <u>a maximum of 15 characters</u> and typically consists of eight to thirteen alphanumeric characters subdivided as follows:

- **Element A1: Site or building designation**. The general "frame of reference" for the sample will be indicated by a string of four or five alphanumeric characters (e.g., IR14, B220, FTA17, ST35). [NOTE: Where existing identifiers are in common use for some or all of these designations, those identifiers generally will be used. For new projects/new locations, reference designations may be established for the convenience of project personnel.] The characters comprising this element must meet the following criteria:

- Each location-type identifier must be used consistently for all sample identifiers for a given site
- No spaces or punctuation shall be used within the element

- **Element A2: Point source**. The next four to eight alphanumeric characters will indicate the point source of the sample location. These characters must meet the following criteria:
  - Well numbers, boring location numbers, etc., shall have at least two digits (e.g., use "MW01," not "MW1." If there are more than 99 wells or borings within a site, then use 3 digits in the sample IDs for all numbers in that particular source-type for that site. (NOTE: This convention applies to identification of locations that have not been sampled by ITSI. Do not change the identifiers of wells previously sampled by ITSI or other contractors without consultation with the data management staff.)
  - Site-identifiers included in element A1 of the sample ID do not need to be repeated in this element (e.g., if the site identifier is established as "IR28," then monitoring well "28TMW01" can be noted as "TMW01" if desired.

3.2 PART B: SAMPLE IDENTIFIER (MANDATORY)

The **Sample Identifier** (Sample ID) consists of a maximum of 30 characters for all required and optional fields. Part B of the sample ID typically consists of nine to sixteen alphanumeric characters subdivided as follows:

- **Element B1: Sample Location**. The four to eight characters used in elements A1 and A2 above to designate the site or building location and point source are repeated at the beginning of the sample identification string.
- **Element B2: Sample Type**. The sample type will be designated by two letters, using the following notation:

  Water
  - GW = groundwater
  - SW = surface water

  Soil
  - SS = soil [from soil boring]
  - ST = soil [from stockpile]
  - SD = sediment

  Gas
  - SG = soil gas
  - SV = soil vapor (e.g., from SVE system)
  - AA = ambient air
  - LG = landfill gas

  Miscellaneous
  - AQ = aqueous (liquid not water)
  - OL = viscous liquid
  - TS = tissue (fish, etc.)

  - CN = concrete
  - SL = solid

- **Element B3: Sequential Sample Number:** The individual sample's place in sequence (with respect to its specific location [and event, if applicable; see Element C1, below]) will be indicated by up to three to six integers (e.g., 001, 010108). The following special cases should be observed:
  - If multiple discrete samples (e.g., soil IDW characterization samples collected from a stockpile) are to be composited by the laboratory, the sequential sample number will be followed by a (sequential) letter (e.g., 003A, 003B, 003C), and the "Special Instructions" column of the COC form for each of the "linked" samples will indicate the related samples with which it is to be composited.
  - If a single groundwater sample is collected in multiple containers, all sample labels will indicate the same sample number, and the number and type(s) of containers comprising this sample will be indicated on the COC form. If, however, the collection of a single groundwater sample is interrupted by field circumstances (e.g., insufficient well volume, equipment malfunction), then one or more additional sample ID numbers should be created for the continuation containers; these samples should be identified on the labels and COC form; and the situation leading to the interruption should be described in detail in the Field Notebook.

NOTE: Sample depths or depth intervals are not typically part of the sample identifier. They will be designated/specified in the SAP or FSP/QAPP and will be recorded on the COC forms. However, they can be included in place of the sequential sample number, and can be useful for borings with multiple sample depths. If they are used, however, then consistency in use is important, such as a consistent number of integers (e.g., 002, 105) and expressed in feet. Use of whole numbers is preferred, but if a fraction of a foot is necessary, then use an underscore rather than a decimal point (e.g., 10.5 feet should be expressed as 10_5).

3.3 PART C: SAMPLE IDENTIFIER (SUPPLEMENTAL NOTATION–OPTIONAL)

A variety of supplemental codes may be added following the mandatory sample identifier string to provide field personnel and the laboratory with additional information about the sample's context, processing, etc.

It is not necessary to include any optional codes in a sample identifier. However, any supplemental information elements that are included must be presented in the relative sequence indicated below.

- **Element C1: Event Code.** For projects where more than one round of sampling will be conducted, a sequence of three alphanumeric characters may be used to designate the event. This element will take the form of one or two letters designating the event type or interval, followed by one or two numerals indicating the event's place in sequence (e.g., "Q03" might indicate a third quarterly monitoring event; "SA4" might indicate the fourth semiannual event, etc.)

- **Element C2: Sample Treatment Information.** Two to five alphanumeric characters may be used to indicate procedures that have been or should be applied to the sample. These notations include:
    - FF = Field-filtered (0.45 micron is the most commonly used filter size. If 0.45 micron size is used, then there is no need to specify any number after the "FF" unless additional filter sizes are being used at the site).
    - FF045 = Field-filtered using an 0.45 micron filter (NOTE: filter screens should be indicated by a three-digit value in microns.)
    - FF010 = field filtered using an 0.10 micron filter
    - FF100 = field filtered using an 1.0 micron filter
    - LF = Laboratory to filter
    - MIS = Multi increment sampling (composite)
    - IDW = Investigation derived waste
    - Roll = Roll-off bin
    - Stock = Stock pile
    - Drum = Drum sample
- **Element C3: Sample Functions.** Two to five alphanumeric characters may be used to indicate the intended use for the sample (e.g., for QC/QA purposes). (Note: information that needs to be kept from the laboratory will not be coded into this element of the sample ID.)
    - DUP = Duplicate
    - MS = Matrix spike
    - MSD = Matrix spike duplicate
    - TB = Trip blank
    - EB = Equipment blank or rinsate
    - FB = Field blank
    - SB = Source blank
- **Element C4: Situational Flags.** Not commonly used, however**, t**wo or three alphanumeric characters may be used to alert laboratory and/or ITSI personnel to pay particular attention to a note or comment on the COC or in field documentation. In some instances these notes may be established in advance (e.g., when the sample IDs system is developed for a project, to flag a specific field requirement or precaution). They may also be added in the field as needed, and appended to one of more individual sample IDs on the sample label(s) and COC(s). In either case, a situational flag "code" must have a singular meaning across all project activities.

  Situational flags may include, but are not limited to:

- LN1 = Indicates that the laboratory ("L") should see the Note identified as "N1" on the COC [either in the "Special Instructions" cell for that sample, or a more generic comment for multiple samples logged on the COC form.
- LN = next "see this note" reminder
- IF1 = used to alert ITSI personnel (identified by the leading "I") to a specific sample-related comment (linked to this sample and numbered "Comment #1") in the Field logbook.

3.4 EXAMPLES OF COMPLETE SAMPLE NUMBERS

The following examples illustrate the variety of sampling activities and contexts that can be represented clearly by this sample identification structure.

Location ID	Sample ID	Comments
OU02-SB01	OU02SB01-SS012	The 12th soil sample collected in soil boring SB01 at operable unit OU02.
SMITH-SB01	SMITHSB01-SS01DUP	The first soil sample collected, representing a duplicate, at site SMITH.
ST35-SB12	ST35SB12-SS105MSMSD	Soil sample, also representing the MS/MSD sample, from a depth of 105 feet in soil boring SB12 at site ST35.
ST35-MW12	ST35MW12-GW010108FF	Field-filtered (using 0.45 micron filter) groundwater sample collected on 01/01/08 from MW-12 at site ST35

4.0 ATTACHMENTS

None.

5.0 FORMS

None.

Innovative Technical Solutions, Inc.

Standard Operating Procedure

Chain-of-Custody Procedures for Environmental Samples

PR-TC-01.04.05.00

Effective Date: 17 February 2009

Prepared by: Kristen Carlyon, Program Chemist Date: 17 Feb 2009

Approved by: Jeffrey Hess, Program Director Date: 17 Feb 2009

Revision History:

Version	Changes	Affects Section/Pages	Effective Date	Approval
1.0	Initial Issue		17 Feb 2009	NA

This document contains proprietary information of Innovative Technical Solutions, Inc. (ITSI). ITSI retains all rights associated with these materials, which may not be reproduced without ITSI's express written permission.

Table of Contents

Page No.

1.0 Purpose and Scope 1
2.0 Acronyms and Definitions 1
3.0 Procedures 2
3.1 Project and Laboratory Information (Part A) 2
3.2 Analysis Information (Part B) 2
3.3 sample Information (Part C) 3
3.4 Comments and Special Instructions (Part D) 4
3.5 Reporting Information (Part E) 4
3.6 Custody Information (Part F) 5
4.0 Attachments 5
5.0 Forms 5

1.0 PURPOSE AND SCOPE

The purpose of this standard operating procedure is to establish a protocol for initiating and maintaining a hardcopy Chain-of-Custody (COC) form. A COC must be generated for all samples collected in the field, whether in hardcopy format (as shown in this SOP), or using an acceptable computer-based software package (such as Forms2Lite). Unless a particular project has a project specific COC, uses Forms2Lite (for EPA projects where the samples will be shipped to a CLP laboratory), or is prepared using our environmental data management system (eDMS), the attached general form should be used.

The main purpose of a COC form is to insure that the possession of a sample from the time of its collection until the time of its analysis is legally traceable and can be fully documented. As secondary functions, it serves as a means for the sampler to document the condition of the samples as well as to communicate to the laboratory which analyses are required for each sample and any special handling requirements for each sample.

2.0 ACRONYMS AND DEFINITIONS

For purposes of this procedure, a number of terms and acronyms have the meanings defined below.

CLP: **c**ontract laboratory program

COC: chain-of custody

Custody: Custody is physical possession or control. A sample is in an individual's custody when it is under their immediate control so as to prevent tampering or alteration of characteristics. This includes placing the samples in a building or an area with controlled access or locking the samples in a room or vehicle.

eDMS: environmental data management system

MS/MSD: matrix spike and matrix spike duplicate

QAPP: quality assurance project plan

QC: quality control

SAP: sampling and analysis plan

3.0 PROCEDURES

The COC must be generated as close to the time of sample collection as possible and before the sample leaves the collector's custody. The COC should accompany the sample through analysis and final disposition. The information required on the COC will include, but is not limited to:

- Project number
- Project name
- Sample identification number or sample description
- Date and time of sample collection
- Number of containers
- Sample preservatives
- Analysis required
- Sampler's signature
- Additional remarks, if any, about special handling requirements, including which samples to select for matrix spiking, lab filtering (although field filtering is preferred), or about sample anomalies such as effervescence.

The following sections discuss in detail how to fill in the COC. Any errors should be corrected with a single line through and be dated and initialed.

3.1 PROJECT AND LABORATORY INFORMATION (PART A)

- Fill in the project name and number.
- Fill in the project manager's name.
- Fill in the site location.
- Fill in the laboratory name, address, contact name, and phone number.
- Fill in the date.
- Fill in the page number of the COC.

See below for an example of a completed Part A:

Project Name and Number: Air Force Base 0000.0000
Project Manager: Super PM
Site Location: ~~Anywhere~~ KIS 12/18, USA
anyplace

Laboratory Name: Environmental Laboratory
Address: 123 Lab Road Contact Name: Lab PM
Labland, FL 00000 Phone: 888-555-0000
Analysis:

Date: 12-18-08
Page: 1 of 1

As shown above, corrections to information entered on to the COC should be made by drawing a line through the incorrect entry and entering the correct information on the same form. Initial any and all corrections made to the form.

3.2 ANALYSIS INFORMATION (PART B)

- Fill in all the analyses that will be required for the samples, using a separate line for each analysis if space allows (may group metals together consistent with the nomenclature used in the site-specific Sampling and Analysis Plan [SAP] or Quality Assurance Project Plan [QAPP]). List both the name of the analysis and the method number (if known).

- List the type of container and preservative used for the analysis under each method.

See below for an example of a completed Part B:

Analysis:												
	VOC 8260	PEST 8081	Metals (TAL+SU)	SR + T1	H9							
Preservative:	ICE →											
Container Type:	BAG →											

3.3 SAMPLE INFORMATION (PART C)

- Fill in the Sample IDs (NOT location IDs – see SOP *Creating a Sample Identification System* for clarification if unsure of the difference) using a single entry for each sample (even if there are several aliquots).

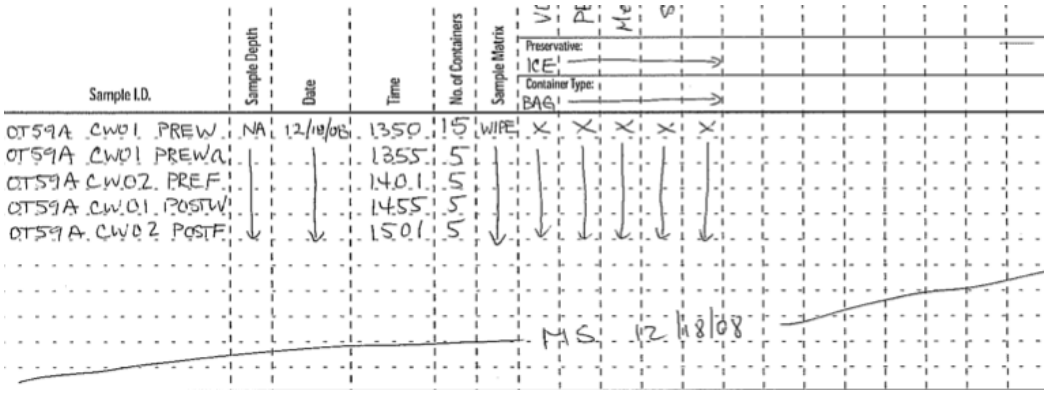
  Note: Exceptions to single entry would be if multiple filtering methods are employed for dissolved metals analysis (e.g., 1.0 micron and 0.45 micron field filters are both used on different sample aliquots and each resulting aliquot will be analyzed for the same analyses.

- For each sample, enter the sample depth (if applicable), date and time sampled, number of containers, and sample matrix. Make sure this information matches the information on the sample container labels.
- Sample duplicates should be entered as distinct samples.

  Note: Sample duplicates should not have the same time as that of the parent sample. Make sure to note the associated primary sample and correct sample collection time on the sample collection log.

- Matrix spike and matrix spike duplicate (MS/MSD) samples are not entered as separate samples. See Section 3.4 for an explanation of how to indicate MS/MSD samples.
- Enter any QC samples such as trip blanks or equipment blanks, again using a separate line for each and filling in all applicable information.
- Move to the analysis section and place an “X” under the corresponding desired analysis for each sample.
- Cross out, date and initial, any unused lines so that samples may not be added after the chain has been completed and submitted.

See below for an example of a completed Part C:



Sample I.D.	Sample Depth	Date	Time	No. of Containers	Sample Matrix	Preservative: ICE / Container Type: BAG				
OT59A CW01 PREW	NA	12/18/08	1350	15	WIPE	X	X	X	X	X
OT59A CW01 PREWa	↓	↓	1355	5	↓	↓	↓	↓	↓	↓
OT59A CW02 PREF	↓	↓	1401	5	↓	↓	↓	↓	↓	↓
OT59A CW01 POSTW	↓	↓	1455	5	↓	↓	↓	↓	↓	↓
OT59A CW02 POSTF	↓	↓	1501	5	↓	↓	↓	↓	↓	↓

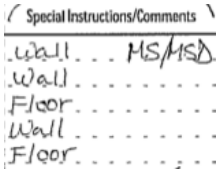
MS 12/18/08

3.4 COMMENTS AND SPECIAL INSTRUCTIONS (PART D)

The comments section should be used to document any additional information about the sample or special instructions to the laboratory. For example:

- Use the comments section to specify which sample should be used for the MS/MSD.
- Note any anomalies such as a lack of preservation for volatile samples to help ensure shortened hold times are met.

See below for an example of typical information included in Part D:



Special Instructions/Comments
Wall MS/MSD
Wall
Floor
Wall
Floor

3.5 REPORTING INFORMATION (PART E)

- Fill in the names of the sampling team.
- One member of the sampling team must sign in this section. The sample coordinator or quality control manager, if one is assigned, should also initial behind the signature, indicating they agree with the contents of the COC and have performed a bottle count and inspection of the cooler. If a sample coordinator or quality control manager is unavailable, the second member of the sample team should perform this activity and initial the COC.
- Fill in any special reporting instructions such as the name and telephone numbers for alternate contacts
- Fill in the name of the person to whom the results should be sent along with his/her fax number
- Fill in the desired turn around time for the analyses.

See below for an example of a completed Part E:

Sampled By: M. Sampler
Signature: M. Sampler
Special Instructions: alt. Contact:
Site Supervisor 865-555-0000
Fax: 865-555-0001
Send Results to: Project Chemist
(w/fax #) 480-555-0000
Turnaround Time: Normal

3.6 CUSTODY INFORMATION (PART F)

The custody section is the most important section of the COC. It is this section of the COC that establishes the traceability of samples necessary for their use in legal proceedings or for closure actions. A missing signature or date in this section can severely limit the use of or invalidate all of the analytical results for the listed samples.

- When transferring custody of the samples, the sampler signs the COC in the space indicated (indicating the company for whom he/she works next to his/her name), and fills in the date and time of transfer in the space next to the signature.
- The person receiving the samples, usually either a courier or the sample custodian at the laboratory if the samples were hand-delivered, signs the COC in the next space and fills in the date/time, also indicating the company for which he/she works.
- If the samples were shipped by FedEx or UPS, the "received" signature space is filled in with "FEDEX" or "UPS" and the airbill number is written on the COC. "FEDEX/UPS" is also filled into the next "relinquished" box. The sample custodian at the laboratory will then sign in the following "received" box and fill in the date/time.

See below for an example of a completed Part F with custody relinquishment to a courier.

Relinquished By/Affiliation:	Date:	Time:	Received By/Affiliation:	Date:	Time:
M. Sampler - ITSI	12/13/08	1530	P. Courier - Env. Lab	12/13/08	1530
P. Courier - Env. Lab	12/13/08	1645	R. Sample Tech - Env. Lab	12/13/08	1645

4.0 ATTACHMENTS

None.

5.0 FORMS

Example Chain-of-Custody Form

Innovative Technical Solutions, Inc.
2730 Shadelands Drive, Ste. 100
Walnut Creek, California 94598
(925) 946-3100 – (925) 256-8998 (fax)

Chain-Of-Custody

Project Name and Number: _____
Project Manager: _____
Site Location: _____

Laboratory Name: _____
Address: _____
Contact Name: _____
Phone: _____

Date: _____
Page: _____ of _____

Sample I.D.	Sample Depth	Date	Time	No. of Containers	Sample Matrix	Analysis: / Preservative: / Container Type:	Special Instructions/Comments

Sampled By: _____

Signature: _____

Special Instructions: _____

Send Results to: _____
(w/fax #) _____

Turnaround Time: _____

Sampler:

Courier/Airbill No.:

Relinquished By/Affiliation:	Date:	Time:	Received By/Affiliation:	Date:	Time:

Original – Laboratory Yellow – Field/Office

Innovative Technical Solutions, Inc.

Standard Operating Procedure

Subsurface Soils: Direct-Push or Drill Rig

PR-TC-02.02.01.03

Effective Date: 02 March 2010

Prepared by: Tim Watchers, P.G., Project Geologist — Date: 02 March 2010

Reviewed by: *By e-mail* Arvind Acharya, Senior Project Manager — Date: 02 March 2010

Approved by: Jeffrey Hess, Program Director — Date: 02 March 2010

Revision History:

Version	Changes	Affects Section/Pages	Effective Date	Approval
1.0	Initial Issue	NA	02 Mar 2010	NA

This document contains proprietary information of Innovative Technical Solutions, Inc. (ITSI). ITSI retains all rights associated with these materials, which may not be reproduced without ITSI's express written permission.

Table of Contents

Page No.

1.0 Purpose and Scope 1
2.0 Acronyms and Definitions 1
3.0 Procedures 2
3.1 Direct-Push Technique (DPT) 2
3.1.1 Sample Liner 3
3.2 Split-Tube Samplers 4
3.2.1 Open Sampler 4
3.2.2 Sample Sleeves 5
3.3 Equipment 5
3.4 QC Sampling 6
4.0 Required Documentation 6
5.0 Attachments 6
6.0 Forms 6
7.0 References 7

1.0 PURPOSE AND SCOPE

The purpose of this standard operating procedure (SOP) is to describe the requirements and procedures for the collection of relatively undisturbed subsurface soil samples from discrete depths during drilling activities. Typical mechanical methods associated with subsurface soil sampling activities, but not limited by this SOP, are direct push technology (DPT), hollow-stem auger (HSA), sonic, and air rotary casing hammer (ARCH).

Note: Care should be taken in the selection and use of some drilling methods for the collection of subsurface soil samples suspected to contain volatile organic compounds (VOCs). Drilling methods that generate significant heat during drilling (sonic), or that employ significant volumes of air which may become heated (ARCH and similar methods) could potentially contribute to the loss of VOCs from soil samples collected using these methods.

2.0 ACRONYMS AND DEFINITIONS

For purposes of this procedure, a number of terms and acronyms have the meanings defined below.

ARCH: air rotary casing hammer consists of a non-rotating flush-threaded casing driven in conjunction with a conventional air rotary drill string. Cuttings are cleared from the hole by bit rotation and air circulation. The cuttings are discharged through a cyclone, which separates the air from the formation cuttings to facilitate sampling and allow for the containment of the drill cuttings.

DPT: direct-push technique consists of typically small drill rigs equipped with a percussion hammer and hydraulic pressure to advance the drill string.

FSP: Field Sampling Plan

GPS: global positioning system

HSA: hollow-stem auger uses continuous flight helical augurs to penetrate the soil. As the augers are rotated, soil cuttings are conveyed to the ground surface via the auger flight.

QAPP: Quality Assurance Project Plan

SAP: Sampling and Analysis Plan

Sonic: A drilling method that uses mechanically generated vibrations to drive the drill string. The drill head, attached to drill string, consists of two counter rotating, out-of-balance rollers that cause the drill string to vibrate. Resonance occurs when the frequency of the vibrations equals to the natural frequency of the drill string. The resonance and weight of the drill string along with the downward thrust of the drill head permit penetration of the formation without the addition of drilling fluids.

VOC: volatile organic compound

3.0 PROCEDURES

This section describes various systems and methods used in the collection of subsurface soil samples. Some techniques, such as DPT, consist of both a method of advancing the drill string and associated soil sampling method together. Other techniques, such as using a split-spoon sampler equipped with stainless steel sample tubes, can be used by most drilling techniques.

3.1 DIRECT-PUSH TECHNIQUE (DPT)

The collection of subsurface soil samples using DPT can employs either single-tube or dual-tube methods. Both methods consist of advancing a drill string using hydraulic pressure and a pneumatic hammer to the target depth. The two methods are described below:

- Single-tube method, as the name implies, involves the use of a single drill string composed of drill rods and/or sample tube to advance to the target depth. Soils can be either be continuously sampled or samples collected from a discrete depth using this method.
    - Continuous sampling of the subsurface soils can be performed using sample tubes ranging in length from 2 to 5 feet containing removable liners manufactured from a variety of materials (e.g., clear PVC, stainless steel, Teflon [PTFE], and clear plastic [PETG]). When the sample tube is full, the entire assembly is brought to the surface.
    - Discrete depth samples can be collected using a sample tube equipped with a retractable drive point. The sample tube is advanced to the desired depth, at which time a narrow rod is lowered through the center of the drill rod into the sample tube to unscrew the drive point. With the drive point loosened, the sample tube is driven the required depth to fill the open sample tube. When full, the sample tube is brought to the surface.

  Note: If samples are needed from deeper layers, the entire process is repeated, introducing the possibility of cross-contamination if the sample is collected from the same borehole. After the tool is removed, sidewall material may slough into the borehole. The acceptability of sloughing cross-contamination should be decided on a case-by-case basis, depending on data quality objectives. If this minimal amount of cross-contamination is not acceptable, samples must be collected from another borehole, or an alternative method employed, such as dual-tube DPT.

- Dual-tube method involves the use of an outer drive casing and inner drive rods. The rods can be attached to either a drive point or a sample tube with liners. In the drive point mode the tool is driven to the desired sampling depth where the drive point is withdrawn and replaced with the barrel sampler. The outer casing and sampler are then driven the length of the sample tube (2 to 5 feet depending upon the equipment) at which point the sample tube is withdrawn. Continuous sampling can be carried out quickly by using multiple samplers. The dual-tube sampling

system is recommended for continuous sampling as the outer casing prevents sloughing and cross contamination from other depths.

The composition of the sample liners used to collect soil samples by DPT should be discussed with the laboratory to make certain there is no chemical reaction with the suspected constituents at the site.

3.1.1 Sample Liner

Sample collection procedures for soil samples obtained in sample tubes equipped with liners consist of the following:

1. Place a pre-cleaned liner of appropriate length in the sample tube. Advance the sampler the appropriate depth, then retrieve the sampler from the ground.
2. Retrieve the sampler with liner from the driller. Make sure to note which end represents the "top" (nearest the ground surface) and which represents the "bottom" (the deepest soil).
3. Retrieve the sample liner from the sampler. Place the sample liner on a clean work surface.
4. Observe and classify the soil in the sample liner. Record your findings on the boring log form. Note the presence of visible staining or other signs of contamination.
5. Identify the interval desired for chemical analysis. This could be a specific depth interval, or based on observations of the soil in the sample liner (e.g., visible staining, fine-grained layer, etc.).
6. Hand saw the desired interval from the sample liner. The sample interval is typically 6 inches, but the actual length may depend on diameter of the sample liner, needed sample volume, target depth, etc., and will be specified in the site-specific QAPP.
7. Collect any required VOC samples from the target end of the sample using an approved VOC sampling device (as specified in the QAPP and consistent with SOP PR-TC-02.02.01.05).
8. The ends of the cut section of sample liner are fitted with Teflon patches, and then covered with plastic friction caps. (The end cap diameter can be stretched by hand if difficult to fit over the ends. Tipping the cap open to the side and partially sliding over the end of the tube and while twisting and pushing down helps.) The end caps should fit snugly. Security tape may be placed around the end caps to prevent tampering, if specified in the QAPP.
9. The soil samples are then cleaned and labeled with the sample ID, date and time, depth interval, and requested analyses. Record the sample on the chain-of-custody form and complete the sample collection log, as appropriate. Record the sample interval on the boring log.

10. Place the soil samples into plastic zip-lock type bags and place them in an iced and insulated cooler.

3.2 SPLIT-TUBE SAMPLERS

A split-tube (also known as split-spoon) sampler consists of a split-barrel typically of 18 inches in length (but can range in length to 5 feet) that can be left open or lined with pre-cut brass or stainless steel sample sleeves. Typically the split spoon sampler is driven to the target depth using a 140-pound hammer ahead of the drill bit while drilling has stopped, although split-tube samplers can be placed and advanced during drilling. In loose soils, a plastic or stainless steel sand catcher can be placed just inside of the sampler's drive shoe to help retain the sample during retrieval.

3.2.1 Open Sampler

Sample collection procedures for soil samples obtained from split-tube samplers left open (without sample sleeves) consist of the following:

1. Advance a clean sampler the appropriate depth, then retrieve the sampler from the ground.
2. Retrieve the sampler from the driller. Make sure to note which end represents the "top" (nearest the ground surface) and which represents the "bottom" (the deepest soil).
3. Place the sampler on a clean work surface, and break open the sampler by unscrewing the sampler head and sampler shoe from the ends of the sampler and separating the two halves of the sampler tube to expose the soil core.
4. Observe and classify the soil in the sampler tube and the soil remaining in the sample shoe (from the tip of the sampler). Record your findings on the boring log form. Note the presence of visible staining or other signs of contamination.
5. Identify the interval desired for chemical analysis. This could be a specific depth interval, or based on observations of the soil in the sample sleeves (e.g., visible staining, fine-grained layer, etc.).
6. Collect the desired soil using a sampling spoon (clean stainless steel or Teflon, or disposable one-time use) and place into clean glass sample jars provided by the laboratory (due to the exposure of the soil core to the atmosphere, this method is not appropriate for soils suspected as containing VOCs). Security tape may be placed around the cap to prevent tampering, if specified in the QAPP.
7. The soil samples are then cleaned and labeled with the sample ID, date and time, depth interval, and requested analyses. Record the sample on the chain-of-custody form and complete the sample collection log, as appropriate. Record the sample interval on the boring log.
8. Place the soil samples into plastic zip-lock type bags and place them in an iced and insulated cooler.

3.2.2 Sample Sleeves

Sample collection procedures for soil samples obtained from split-tube samplers equipped with 6-inch sample sleeves consist of the following:

1. Place the appropriate number of pre-cleaned 6-inch-long brass or stainless steel sleeves in the split-tube sampler. Advance the sampler the appropriate depth, then retrieve the sampler from the ground.
2. Retrieve the sampler with sleeves from the driller. Make sure to note which end represents the "top" (nearest the ground surface) and which represents the "bottom" (the deepest soil).
3. Retrieve the sampler with sleeves from the driller. Place the sampler on a clean work surface, and break open the sampler by unscrewing the sampler head and sampler shoe from the ends of the sampler and separating the two halves of the sampler tube to expose the sample sleeves.
4. Observe and classify the visible soil in the ends of the sample sleeves and the soil remaining in the sample shoe (from the tip of the sampler). Record your findings on the boring log form. Note the presence of visible staining or other signs of contamination.
5. Identify the interval desired for chemical analysis. This could be a specific depth interval, or based on observations of the soil in the sample sleeves (e.g., visible staining, fine-grained layer, etc.).
6. Collect any required VOC samples from the target end of the sample using an approved VOC sampling device (as specified in the QAPP and consistent with SOP PR-TC-02.02.01.05).
7. The ends of the sample sleeve are fitted with Teflon patches, and then covered with plastic friction caps. (The end cap diameter can be stretched by hand if difficult to fit over the ends. Tipping the cap open to the side and partially sliding over the end of the tube and while twisting and pushing down helps.) The end caps should fit snugly. Security tape may be placed around the end caps to prevent tampering, if specified in the QAPP.
8. The soil samples are then cleaned and labeled with the sample ID, date and time, depth interval, and requested analyses. Record the sample on the chain-of-custody form and complete the sample collection log, as appropriate. Record the sample interval on the boring log.
9. Place the soil samples into plastic zip-lock type bags and place them in an iced and insulated cooler.

3.3 EQUIPMENT

Besides the equipment mentioned above in each procedure, the following additional items may be required for this procedure:

- Commercial sampler and appropriate liners or sample sleeves

- Approved VOC sampling device (if needed for collection of VOC samples)
- Measuring tape
- Sample container(s), labels, coolers, etc., as specified in the SAP or FSP
- GPS unit
- Field logbook or sample collection logs and boring logs
- Knife or flat edged tool to cut open the remaining core for soil classification
- Munsell® soil color chart
- Dilute hydrochloric acid, if presence of carbonate soils is possible

3.4 QC SAMPLING

If sampling equipment is re-used between samples (i.e., sampler), then equipment rinsate samples should be collected to verify proper decontamination between samples. A minimum of one equipment rinsate sample per major sampling device should be collected per event, if not more frequently (i.e., one per day).

4.0 REQUIRED DOCUMENTATION

The following records generated as a result of implementation of this procedure must be maintained as quality records.

- GPS coordinates
- Soil Boring Log
- Chains of Custody
- Field notes

5.0 ATTACHMENTS

None.

6.0 FORMS

None.

7.0 REFERENCES

Ohio Environmental Protection Agency, 2005. *Use of Direct Push Technologies for Soil and Ground Water Sampling, Technical Guidance for Ground Water Investigations, Chapter 15*, February.

U.S. Environmental Protection Agency (USEPA). *Soil and Soil-Gas Samplers.* http://www.clu-in.org/characterization/technologies/soilandsoilgassamp.cfm, 28 February 2010.

Innovative Technical Solutions, Inc.
A Gilbane Company

Standard Operating Procedure

Soil: Volatile Organic Compound (VOC) Sampling

PR-TC-02.02.01.05 v1.1

Effective Date: 05 October 2011

Reviewed by: Kristen Carlyon, Program Chemist — Date: 02 March 2010

Reviewed by: Evelyn Dawson, Program Chemist — Date: 02 March 2010

Approved by: Jeffrey Hess, Program Director — Date: 02 March 2010

Revision History:

Version	Changes	Affects Section/Pages	Effective Date	Approval
1.0	Initial Issue	NA	02 Mar 2010	NA
1.1	Addition of Terra Core System to SCDs, and updated procedures for field preservation of soil using SCDs.	3.2 and 3.3	05 Oct 2011	JHess

This document contains proprietary information of Innovative Technical Solutions, Inc. (ITSI). ITSI retains all rights associated with these materials, which may not be reproduced without ITSI's express written permission.

Table of Contents

Page No.

1.0 Purpose and Scope 1
2.0 Acronyms and Definitions 1
3.0 Procedures 2
3.1 Use of Multi-Function Sampling Device 2
3.1.1 Encore Sampler 2
3.1.2 Core N' One™ Sampling System 3
3.1.3 Additional Analytical Requirements 3
3.1.4 Method Incompatibilities 4
3.2 Use of Sub-Coring Device and Field Preservation 5
3.2.1 Lock N' Load™ Sampling System 5
3.2.2 EasyDraw Syringe® and PowerStop Handle® 5
3.2.3 Terra Core® Sampler 6
3.2.4 Additional Analytical Requirements 7
3.2.5 Method Incompatibilities 9
3.3 Use of Sub-Coring Device and Empty Vial 9
3.3.1 Lock N' Load™ Sampling System 10
3.3.2 EasyDraw Syringe® and PowerStop Handle® 10
3.3.3 Terra Core® Sampler 11
3.3.4 Additional Analytical Requirements 11
3.3.5 Method Incompatibilities 12
3.4 Equipment 12
3.5 Quality Control Samples 13
3.5.1 Trip Blanks 13
3.5.2 Temperature Blanks 13
3.5.3 Matrix Spike and Matrix Spike Duplicate Samples 13
3.5.4 Other Field Quality Control Samples 14
4.0 Required Documentation 14
5.0 Attachments 14
6.0 Forms 14
7.0 References 15

1.0 PURPOSE AND SCOPE

The purpose of this standard operating procedure is to describe the requirements and procedures for the collection, packaging and transport of soil samples for the analysis of volatile organic compounds (VOCs). This SOP is focused on the preparation and preservation of soil samples in compliance with United States Environmental Protection Agency (USEPA) Method 5035 (USEPA, 1997) and updated USEPA Method 5035A (USEPA, 2002) and associated agency guidance documents such as the United States Department of Defense (USDoD) Quality Systems Manual, Version 4.1 (DoD, 2009).

Note: There are several approaches to the collection of VOC soil samples. However, the methods and their associated sampling and/or storage devices are not interchangeable. Also, each of the methods has limitations in their application and use, so the decision on which method to use should consider both the benefits and limitations of each method.

2.0 ACRONYMS AND DEFINITIONS

For purposes of this procedure, a number of terms and acronyms have the meanings defined below.

DQOs: data quality objectives

GPS: global positioning system

"high concentration": refers to concentrations of a volatile organic compound (VOC) greater than 200 ug/kg

"low concentration": refers to concentrations of a volatile organic compound (VOC) typically ranging from 0.5 ug/kg to 200 ug/kg

MFSD: multi-function sampling device

ml: milliliter

MS: matrix spike

MSD: matrix spike duplicate

PTFE: polytetrafluoroethylene

QAPP: Quality Assurance Project Plan

SCD: sub-coring device

USACE: United States Army Corps of Engineers

USEPA: United States Environmental Protection Agency

VOA: volatile organic analysis

VOC: volatile organic compound

3.0 PROCEDURES

The intent of this SOP is to present several acceptable procedures for the collection of VOC soil samples, consistent with EPA Method 5035A. The actual selected procedure will be specified in the project-specific QAPP. However, the following two steps are applicable to all the methods described in this SOP:

1. When the concentration of VOCs is unknown, a sample set typically is comprised of three (3) sub-samples of 5 grams of soil each.
2. To determine VOC concentrations on a dry weight basis, in the absence of an additional sample aliquot of sufficient volume to determine dry weight basis, a separate container (2-ounce jar or 40 ml vial) should be filled with soil that is co-located with each sample.

Each procedure has its own set of benefits and limitations. Selection of the appropriate procedure should be based primarily on which procedure best addresses the data quality objectives (DQOs) while considering the limitations imposed by field conditions and sampling requirements. Attachment A provides a brief discussion of some of the limitations of the specific procedures. Some of the limitations of the different procedures include:

3.1 USE OF MULTI-FUNCTION SAMPLING DEVICE

Multi-function sampling devices (MFSDs), such as the En Core® Sampler, act as both a coring tool and sample storage container, allowing for the collection of soil samples directly into the storage container with zero or minimal headspace. Currently approved MFSDs include the following:

- En Core® Sampler
- Core N' One™ soil sampling system

The procedures for the collection of the soil samples using the approved MFSDs are provided below. A soil sample typically is comprised of a minimum of 3 MFSDs containing 5 grams of soil each.

3.1.1 Encore Sampler

3.1.1.1 Required Equipment

- En Core® T-Handle
- En Core® Samplers

3.1.1.2 Sampling Procedure

1. Assemble the En Core® Sampler by holding the coring body and pushing the plunger rod down until the small o-ring rests against the tabs. Depress the locking lever on the En Core® T-handle and place the plunger end of the coring body into the open end of the T-handle. Align the two slots on the coring body with the two locking pins in the T-handle. Twist the coring body clockwise to lock the pins in the slots. Finally, check to ensure that the coring body is locked in place.

2. Collect the En Core® sample by grasping the T-Handle with the open end of the coring body facing the soil sample. Using the T-Handle, push the sampler into soil until coring body is completely full. The coring body is full when the small o-ring is centered in the viewing hole in the T-Handle. Remove the sampler from the soil. Push and twist cap on the exposed end of the coring body until the ridges on the coring body snap into the grooves of the cap. Check to ensure that cap is properly secured.

3. Prepare the sample for shipment by removing the T-Handle from the En Core® Sampler by depressing the locking lever on T-Handle and then twist and pull the En Core® Sampler from T-Handle. Lock the plunger by rotating the extended plunger rod fully counter-clockwise until the wings rest firmly against the tabs. Attach the completed circular label to the cap of the coring body.

4. Return the full En Core® Sampler to the zipper bag. Seal the bag and immediately place the bag in an ice chest filled with ice.

3.1.2 Core N' One™ Sampling System

3.1.2.1 Required Equipment

- Core N' One™ Soil Handle
- Core N' One™ Soil Capsules

3.1.2.2 Sampling Procedure

1. Remove capsule from zip lock and insert prongs into the slots of the Core N' One™ handle. Make a one-quarter turn to the right to lock the capsule in place.
2. Unscrew the capsule cap and bore the beveled edge opening into the soil. You can determine if you have taken a full 5 gram sample by holding the capsule up to the light. The dark shading of the soil should be at the top level of the cap threads.
3. Screw the cap tight. The edge of the cap should touch the center rib of the capsule.
4. Insert the capsule into the zip lock for transport to the lab.

3.1.3 Additional Analytical Requirements

Using MFSDs require specific handling procedures for the samples after collection and by the analytical laboratory.

Field preservations options include the following:

a) Place the samples in an iced cooler and chill and maintain the sample at 4 ± 2°C, and deliver the samples to the laboratory quickly to allow for analysis or extraction of the samples by the laboratory within 48 hours of sample collection time.

b) Place the samples in a freezer and chill and maintain the sample at < -7°C, and deliver the samples to the laboratory quickly to allow for analysis or extraction of the samples by the laboratory within 48 hours of sample collection time.

Although alternative a) is the normal procedure for most soils, alternative b) is necessary where biologically active soils potentially containing aromatic hydrocarbons (i.e., benzene).

Extraction options for the analytical laboratory include the following:

1) Analysis of the sample within 48 hours of sample collection.
2) Extrude core into unpreserved VOA vial at the laboratory. The laboratory then freezes the sample at < -7°C. The sample must then be analyzed within 14 days of the sample collection date.
3) Extrude core into preserved VOA vial at the laboratory. For low-level analysis, the soil can be extruded, weighed and preserved with either: a) sodium bisulfate solution (not recommended, see Section 3.1.4 below); or b) reagent-grade extractant water. For high-level analysis, the soil must be extruded, weighed, and preserved with methanol. After extrusion of the soil into an appropriate extraction fluid, the sample must be analyzed within 14 days of the sample collection date.

Additionally, in order to determine VOC concentrations on a dry weight basis, in the absence of one or more additional sample aliquots of sufficient volume to determine dry weight basis, a separate container (2-ounce jar or 40 ml vial) should be filled with soil that is co-located to each sample collection point. Sample nomenclature that links this sample to the VOC sample containers that comprise a sample set should be used.

3.1.4 Method Incompatibilities

Biologically active samples may result in the rapid loss of aromatic hydrocarbons during the initial 48 hours after sampling, and thus should be immediately chemically preserved or frozen using dry ice.

Sample preservation with sodium bisulfate solution presents four potential problems:

i. Acid preservation may cause the chemical breakdown of certain reactive VOC compounds in the soil sample, specifically styrene, acrylonitrile, vinyl chloride, and 2- chloroethylvinyl ether.

ii. In soil samples with a high proportion of organic material, acid preservation may generate acetone as a byproduct.

iii. Calcareous soil samples may effervesce upon contact with sodium bisulfate solution and cause VOC loss.

iv. Calcareous soil samples may increase the pH of the preservation fluid above 2.0, producing a sample in an unpreserved state. Accordingly, the soils at the site should be evaluated for potential problems prior to sampling activities. In cases where preservation by acid is a potential problem, an alternate sample collection method should be utilized.

3.2 USE OF SUB-CORING DEVICE AND FIELD PRESERVATION

An alternative to using MFSDs consists of using sub-coring devices (SCDs) and field preservation of the samples. Benefits of this method include less-expensive sampling devices (e.g., Lock N' Load™), and potentially longer holding times. However, SCDs and field preservation involves more physical handling of the samples in the field, including weighing of the samples, potentially impacting production rates. Also, preservatives for low- or high-level analysis pose significant problems themselves. This method should be used with caution and only after full consideration of the inherent problems in the method.

Approved SCDs include:

- Lock N' Load™ sampling system
- EasyDraw Syringe®
- Terra Core® Sampler

The procedures for the collection of the soil samples using the approved SCDs are provided below. A soil sample typically is comprised of a minimum of 3 field preserved vials containing 5 grams of soil each.

3.2.1 Lock N' Load™ Sampling System

3.2.1.1 Required Equipment

- Lock N' Load™ soil handle
- Lock N' Load™ soil syringe
- VOA vials with preservative (pre-tared)

3.2.1.2 Sampling Procedure

1. Insert Lock N' Load™ Syringe into Lock N' Load™ Handle at base opening. Turn the locking portion of the syringe into the O gram setting. Remove end cap from the Lock N' Load™ Syringe. Position the Lock N' Load™ Handle to the desired soil sample volume (5 grams in triplicate). To do this, slide the slot portion of the handle down the fitted track, then turn the handle one quarter to the right at the desired setting.
2. Push the syringe into the soil until the plunger portion of the syringe makes contact with the base of the Lock N' Load™ Handle.
3. Transfer the soil from the syringe into a pre-tared 40 ml VOA vial containing the appropriate preservative, if any, by turning the Lock N' Load™ Handle one quarter to the left (back to the fitted track) and pushing down. Slightly tilt the VOA vial to avoid splashing and potentially losing some of the preservative. Avoid getting dirt on the threads of the vial. Cap the vial and store the sample at 4± 2° C until time of analysis.

3.2.2 EasyDraw Syringe® and PowerStop Handle®

3.2.2.1 Required Equipment

- PowerStop Handle®

- EasyDraw Syringe®
- VOA vials with preservative (pre-tared)

3.2.2.2 Sampling Procedure

1. Load Sampling Device. Insert the EasyDraw Syringe® into the appropriate slot on the Powerstop Handle® and remove end cap from syringe. For low-level analysis, insert syringe into one of the three positions of the device for collection of 5 gram samples. Use the heavy position for dense clay, the light position for dry sandy soil, and the medium position for all others.
2. Collect Sample. Push the EasyDraw Syringe® into freshly exposed soil. Continue pushing until the soil column inside the syringe has forced the plunger to the stopping point. The soil plug should be flush with the mouth of the sampler. The EasyDraw Syringe® delivers approximately 5, 10 or 13 grams. Actual weight will be determined at the laboratory.
3. Eject Sample Into Vial. Remove the syringe from the Powerstop Handle®. Insert syringe into open end of a pre-tared 40-ml VOA vial containing the appropriate preservative, if any. Extrude the sample into the vial by pushing on the syringe plunger. Slightly tilt the VOA vial to avoid splashing and potentially losing some of the preservative. Avoid getting dirt on the threads of the vial. Cap the vial and store the sample at 4± 2° C until time of analysis.

3.2.3 Terra Core® Sampler

3.2.3.1 Required Equipment

- Terra Core® Sampler
- VOA vials with preservative (pre-tared)

3.2.3.2 Sampling Procedure

1. With the plunger seated in the handle, push the Terra Core® into freshly exposed soil until the sample chamber is filled. A filled chamber will deliver approximately 5 or 10 grams of soil.
2. Wipe all soil or debris from the outside of the Terra Core® sampler. The soil plug should be flush with the mouth of the sampler. Remove any excess soil that extends beyond the mouth of the sampler.
3. Rotate the plunger that was seated in the handle top 90° until it is aligned with the slots in the body. Place the mouth of the sampler into the 40ml VOA vial containing the appropriate preservative and extrude the sample by pushing the plunger down. Slightly tilt the VOA vial to avoid splashing and potentially losing some of the preservative, and quickly place the lid back on the 40ml VOA vial. Avoid getting dirt on the threads of the vial. Cap the vial and store the sample at 4± 2° C until time of analysis.

3.2.4 Additional Analytical Requirements

Using field preservation requires specific handling procedures for the samples after collection and by the analytical laboratory. Requirements vary depending on the specific preservation method, so care needs to be taken to follow the specific procedure carefully.

Common to all field preservation methods:

- Verify the tare weight of the VOA vial before extruding the sample into the vial._Thus, before extruding the soil samples into the pre-tared 40-ml VOA vials preserved with one of the preservatives identified below, the vials are re-weighed in the field to verify that the weight is within 0.1g of the lab-measured weight. The vials should also be visually inspected for signs of leakage and be discarded if any are present. The soil samples are then extruded, taking care not to splash the preservative out of the vial.
- No additional labels may be placed on the pre-tared vials, as this would alter the apparent weight of the vial.
- In order to determine VOC concentrations on a dry weight basis, in the absence of one or more additional sample aliquots of sufficient volume to determine dry weight basis, a separate container (2-ounce jar or 40 ml vial) should be filled with soil that is co-located to each sample collection point. Sample nomenclature that links this sample to the VOC sample containers that comprise a sample set should be used.

Preservation options include the following:

a) Field preservation with methanol. After extruding the soil samples into pre-tared 40-ml VOA vials preserved with methanol, the samples are kept chilled at 4 ± 2°C in a cooler and shipped with adequate ice to ensure that 4 ± 2°C is maintained during transport to the laboratory. The samples must arrive at the laboratory within 48 hours of the sample collection time. The vials are weighed again at the stationary laboratory to verify that no methanol was lost during transport. The laboratory must prepare and analyze the samples within 14 days of the sample collection date. This technique applies only to high-level analysis so it should be used only if detection limits of greater than 200 ug/kg are appropriate.

b) Field preservation with sodium bisulfate solution. After extruding the soil samples into pre-tared 40-ml VOA vials preserved with sodium bisulfate solution, the samples are kept chilled at 4 ± 2°C in a cooler and shipped with adequate ice to ensure that 4 ± 2°C is maintained during transport to the laboratory. The samples must arrive at the laboratory within 48 hours of the sample collection time. The laboratory must prepare and analyze the samples within 14 days of the sample collection date. This preservation technique provides detection limits to approximately 0.5 ug/kg (low-level analysis). However, sample preservation with sodium bisulfate solution presents four potential problems:

    i) Acid preservation may cause the chemical breakdown of certain reactive VOC compounds in the soil sample, specifically styrene, acrylonitrile, vinyl chloride, and 2- chloroethylvinyl ether.

ii) In soil samples with a high proportion of organic material, acid preservation may generate acetone as a byproduct.

iii) Calcareous soil samples may effervesce upon contact with sodium bisulfate solution and cause VOC loss.

iv) Calcareous soil samples may increase the pH of the preservation fluid above 2.0, producing a sample in an unpreserved state. Accordingly, the soils at the site should be evaluated for potential problems prior to sampling activities. In cases where preservation by acid is a potential problem, an alternate sample collection method should be utilized.

c) Field extraction into reagent water and analysis within 48 hours. After extruding the soil samples into pre-tared 40-ml VOA vials containing reagent-grade extractant water, the samples are kept chilled at 4 ± 2°C in a cooler and shipped with adequate ice to ensure that 4 ± 2°C is maintained during transport to the laboratory. Upon receipt of the samples, the laboratory chills the vials to 4 ± 2°C and analyzes the samples within 48 hours of the sample collection time. This technique applies to samples for low-level and high-level analysis.

Note: Extruding soil samples into vials containing reagent-grade extractant water may have an adverse effect on sample results in that water may actually promote bacterial degradation of aromatic hydrocarbons. Likewise, some VOCs may be unstable in reagent water, such as 1,1,2,2-tetrachloroethane. Accordingly, reagent water-filled vials should only be used for chemicals that do not readily biodegrade or breakdown.

d) Field extraction into reagent water and field freezing. After extruding the soil samples into pre-tared 40-ml VOA vials containing reagent-grade extractant water, the samples are frozen to <-7°C in a cooler in the field and shipped with adequate dry ice to ensure that <-7°C is maintained during transport to the laboratory. The vials should not be frozen below -20°C due to potential problems with the vial seals. A temperature blank should be included with the samples so that the laboratory can verify the temperature upon receipt and the arrival temperature of the samples should be annotated on the chain-of-custody form. During the freezing process, the vials should be stored in a 45° angle to prevent water expansion from shattering the vials. To avoid potential rupture of the PTFE-lined septum caps, the dry ice should not directly contact the top of the vials. The laboratory must immediately freeze the sample vials to <-7°C upon receipt. The samples may be held at <-7°C for up to 7 days prior to analysis from the sample collection date. This technique applies to samples for low-level and high-level analysis. This option is used in the situations where it is difficult or impossible to deliver the samples to the laboratory within 48 hours of the sample collection time.

e) Field extraction into reagent water and laboratory freezing. After extruding the soil samples into pre-tared 40-ml VOA vials containing reagent-grade extractant water, the samples are kept chilled at 4 ± 2°C in a cooler and shipped with adequate ice to ensure that 4 ± 2°C is maintained during transport to the laboratory. The laboratory must receive and immediately freeze the vials to <-7°C within 48 hours of the sample collection time. During the freezing process, the vials should be stored in a 45° angle to prevent water expansion from shattering the vials. The samples may be held at <-7°C for up to 7 days prior to analysis from the

sample collection date. The vials should not be frozen below -20°C due to potential problems with the vial seals. This technique applies to samples for low-level and high-level analysis.

3.2.5 Method Incompatibilities

3.2.4.1 Aromatic Hydrocarbons

Chemicals, such as aromatic hydrocarbons (e.g., benzene), are subject to VOC loss by biodegradation under certain sampling procedures. Accordingly, to obtain aromatic hydrocarbon soil concentrations that are representative of site conditions, only a subset of the available options are available for use. To reduce the biological activity in soil contaminated with aromatic hydrocarbons, soil samples should be preserved with methanol or sodium bisulfate solution in the field, or frozen in the field at <-7°C in non-preserved VOA vials. Under no circumstances should soil samples contaminated with aromatic hydrocarbons be collected in the field with VOA vials containing reagent-grade extractant water. The introduction of unpreserved water to the soil sample may enhance the biodegradation of the aromatic hydrocarbons.

3.2.4.2 Chemical Reactions

Acid preservation of soil by sodium bisulfate solution, whether done in the field or in the stationary laboratory, may cause the chemical breakdown of certain compounds, including vinyl chloride. Some olefins, ketones, esters, ethers, and sulfides may react under low pH conditions, yielding analytical results that are not representative of soil conditions. Hence, precaution should be taken when preserving soil samples with sodium bisulfate solution when these compounds are present. If the degree of potential chemical reaction is unknown, an alternative procedure should be used.

3.2.4.3 Calcareous Soil

Calcareous soil samples may react upon contact with sodium bisulfate solution, causing VOC loss through effervescence and potentially cause failure of the VOA vial septum through pressure buildup. Additionally, when soil samples are highly calcareous in nature, the sodium bisulfate preservative solution may not be strong enough to reduce the pH of the aqueous solution to below 2.0, potentially rendering the preservative useless. If carbon dioxide is generated due to carbonate reaction with the acid, the carbon dioxide in the VOA vial may interfere with the detector of the analytical equipment. Hence, precaution should be taken when preserving soil samples with sodium bisulfate solution when carbonates are present.

3.3 USE OF SUB-CORING DEVICE AND EMPTY VIAL

An alternative to using SCDs with field preservation consists of field extruding the samples into clean VOA vials. Benefits of this method include use of less-expensive SCDs and potentially longer holding times. However, the empty vial method involves more physical handling of the samples in the field, including weighing of the samples, potentially impacting production rates. This method should be used with caution and only after full consideration of the inherent problems in the method.

Soil samples for the empty vial method are collected using a sub-coring device. Approved sub-coring devices include:

- Lock N' Load™ sampling system
- EasyDraw Syringe®
- Terra Core® Sampler

The procedures for the collection of the soil samples using the approved sub-coring devices are provided below. A soil sample typically is comprised of a minimum of 3 empty vials containing 5 grams of soil each.

3.3.1 Lock N' Load™ Sampling System

3.3.1.1 Required Equipment

- Lock N' Load™ soil handle
- Lock N' Load™ soil syringe
- VOA vials (pre-tared)

3.3.1.2 Sampling Procedure

1. Insert Lock N' Load™ Syringe into Lock N' Load™ Handle at base opening. Turn the locking portion of the syringe into the O gram setting. Remove end cap from the Lock N' Load™ Syringe. Position the Lock N' Load™ Handle to the desired soil sample volume (5 grams in triplicate). To do this, slide the slot portion of the handle down the fitted track, then turn the handle one quarter to the right at the desired setting.
2. Push the syringe into the soil until the plunger portion of the syringe makes contact with the base of the Lock N' Load™ Handle.
3. Transfer the soil from the syringe into a pre-tared empty 40 ml VOA vial by turning the Lock N' Load™ Handle one quarter to the left (back to the fitted track) and pushing down. Avoid getting dirt on the threads of the vial. Cap the vial and store the sample at 4± 2° C until time of analysis.

3.3.2 EasyDraw Syringe® and PowerStop Handle®

3.3.2.1 Required Equipment

- PowerStop Handle®
- EasyDraw Syringe®
- VOA vials (pre-tared)

3.3.2.2 Sampling Procedure

1. Load Sampling Device. Insert the EasyDraw Syringe® into the appropriate slot on the Powerstop Handle® and remove end cap from syringe. For low-level analysis, insert syringe into one of the three positions of the device for collection of 5 gram samples. Use the heavy position for dense clay, the light position for dry sandy soil, and the medium position for all others.

2. Collect Sample. Push the EasyDraw Syringe® into freshly exposed soil. Continue pushing until the soil column inside the syringe has forced the plunger to the stopping point. The soil plug should be flush with the mouth of the sampler. The EasyDraw Syringe® delivers approximately 5, 10 or 13 grams. Actual weight will be determined at the laboratory.
3. Eject Sample Into Vial. Remove the syringe from the Powerstop Handle®. Insert syringe into open end of a pre-tared empty 40-ml VOA vial. Extrude the sample into the vial by pushing on the syringe plunger. Avoid getting dirt on the threads of the vial. Cap the vial and store the sample at 4± 2° C until time of analysis.

3.3.3 Terra Core® Sampler

3.3.3.1 Required Equipment

- Terra Core® Sampler
- VOA vials (pre-tared)

3.3.3.2 Sampling Procedure

1. With the plunger seated in the handle, push the Terra Core® into freshly exposed soil until the sample chamber is filled. A filled chamber will deliver approximately 5 or 10 grams of soil.
2. Wipe all soil or debris from the outside of the Terra Core® sampler. The soil plug should be flush with the mouth of the sampler. Remove any excess soil that extends beyond the mouth of the sampler.
3. Rotate the plunger that was seated in the handle top 90° until it is aligned with the slots in the body. Place the mouth of the sampler into the 40ml VOA vial containing the appropriate preservative and extrude the sample by pushing the plunger down. Slightly tilt the VOA vial to avoid splashing and potentially losing some of the preservative, and quickly place the lid back on the 40ml VOA vial. Avoid getting dirt on the threads of the vial. Cap the vial and store the sample at 4± 2° C until time of analysis.

3.3.4 Additional Analytical Requirements

Using the empty vial method requires specific handling procedures for the samples after collection and by the analytical laboratory. Requirements vary depending on the specific preservation method, so care needs to be taken to follow the specific procedure carefully.

Handling options include the following:

a) Field extraction and analysis within 48 hours. After extruding the soil samples into pre-tared empty 40-ml VOA vials, the samples are kept chilled at 4 ± 2°C in a cooler and shipped with adequate ice to ensure that 4 ± 2°C is maintained during transport to the laboratory. Upon receipt of the samples, the laboratory chills the vials to 4 ± 2°C and analyzes the samples within 48 hours of the sample collection time. This technique applies to samples for low-level and high-level analysis.

b) Field extraction and laboratory freezing. After extruding the soil samples into pre-tared empty 40-ml VOA vials, the samples are kept chilled at 4 ± 2°C in a cooler and shipped with adequate ice to ensure that 4 ± 2°C is maintained during transport to the laboratory. The laboratory must receive and immediately freeze the vials to <-7°C within 48 hours of the sample collection time. The samples may be held at <-7°C for up to 14 days prior to analysis from the sample collection date. The vials should not be frozen below -20°C due to potential problems with the vial seals. This technique applies to samples for low-level and high-level analysis.

c) Field extraction and laboratory preservation. After extruding the soil samples into pre-tared empty 40-ml VOA vials, the samples are kept chilled at 4 ± 2°C in a cooler and shipped with adequate ice to ensure that 4 ± 2°C is maintained during transport to the laboratory. The samples must arrive at the laboratory within 48 hours of the sample collection time. The laboratory then must preserve the sample using methanol. The laboratory must prepare and analyze the samples within 14 days of the sample collection date. This technique applies only to high-level analysis so it should be used only if detection limits of greater than 200 ug/kg are appropriate.

d) Field extraction and field freezing. After extruding the soil samples into pre-tared empty 40-ml VOA vials, the samples are immediately frozen to <-7°C and shipped with adequate dry ice to ensure that <-7°C is maintained during transport to the laboratory. The laboratory must receive and immediately freeze the vials to <-7°C. The samples may be held at <-7°C for up to 14 days prior to analysis from the sample collection date. The vials should not be frozen below -20°C due to potential problems with the vial seals. This technique applies to samples for low-level and high-level analysis.

Additionally, in order to determine VOC concentrations on a dry weight basis, in the absence of one or more additional sample aliquots of sufficient volume to determine dry weight basis, a separate container (2-ounce jar or 40 ml vial) should be filled with soil that is co-located to each sample collection point. Sample nomenclature that links this sample to the VOC sample containers that comprise a sample set should be used.

3.3.5 Method Incompatibilities

Biologically active samples may result in the rapid loss of aromatic hydrocarbons during the initial 48 hours after sampling, and thus should be immediately chemically preserved or frozen. Thus, the use of field freezing is required when using the empty vial method for biologically active samples suspected of containing aromatic hydrocarbons.

3.4 EQUIPMENT

Specific equipment requirements are discussed in the procedures above. In addition to the materials identified above, many of the procedures require the following:

- Appropriate clean laboratory-provided pre-tared VOA vials with selected preservative
- A scale capable of weighing 100 grams and accurate to ± 0.1 grams.

3.5 QUALITY CONTROL SAMPLES

QC samples are important to measure potential impacts to the accuracy and representativeness of the VOC samples collected. Specific QC samples important to the procedures presented in this SOP include:

- Trip blanks
- Temperature blanks
- MS/MSD samples
- Other recommended QC samples

3.5.1 Trip Blanks

Soil samples can be contaminated by diffusion of VOCs through the septum on VOA vials or through the seal on MFSDs during shipment and storage. Trip blanks are samples that accompany the environmental samples during the sampling operations and transport to the laboratory. The trip blanks may be prepared with laboratory grade methanol, sodium bisulfate solution, or reagent water, dependent on the field methods, and could also consist of laboratory-certified soil, and can be carried through sampling and handling protocols as a check on such contamination.

Generally one trip blank should be used for each field sample cooler, as specified in the QAPP. However, at a minimum, one trip blank should be used per day. The trip blank should remain unopened throughout sampling operations and labeled by date, such as TB022510-01 (for cooler no. 1 trip blank sent on February 25, 2010), or similar nomenclature as specified in the QAPP.

3.5.2 Temperature Blanks

Temperature blanks should be used so that the laboratory can verify the temperature upon receipt of the samples. In the case of field freezing, the temperature blanks should be frozen upon arrival at the laboratory. The temperature of the samples upon arrival should be annotated on the chain-of-custody form and also mentioned in the laboratory narrative that accompanies the analytical results. A temperature blank routinely consists of a vial filled with blank water (deionized water is acceptable).

3.5.3 Matrix Spike and Matrix Spike Duplicate Samples

An important measure of the performance of an analytical method relative to the specific sample matrix of interest is the matrix spike and matrix spike duplicate (MS/MSD). The MS/MSD is an important aspect of an overall quality assurance program for a project. When soil sampling, a MS/MSD sample should be collected for each analytical method at a frequency of five (5) percent of the field samples, unless otherwise specified in the site-specific QAPP. The MS/MSD sample should be prepared in a fashion similar to the other samples. Samples taken for MS/MSD should be labeled as such and specified on the chain-of-custody form. The primary purpose of MS/MSD analyses is to establish the applicability of the overall analytical approach to the specific sample matrix from the site.

Each sample set designated for MS/MSD analysis should be collected in triplicate (e.g., if using En Core® Samplers, then nine 5-gram sample containers would be required).

3.5.4 Other Field Quality Control Samples

Field quality control samples to demonstrate the integrity of the field samples should also be collected as required by the site-specific QAPP. Field duplicates should be collected at a minimum frequency of 10 percent of the samples. Field blanks and equipment rinsate blanks, if required, should be collected each day, or as specified in the site-specific QAPP.

4.0 REQUIRED DOCUMENTATION

The following records generated as a result of implementation of this procedure must be maintained as quality records.

- GPS or survey coordinates for each sample location
- Chains of Custody
- Sample collection logs, including recorded weights of samples placed in vials.
- Field notes

5.0 ATTACHMENTS

Attachment A. Limitations to VOC Soil Sampling Procedures

Attachment B. Various Options for the Collection of Soil Samples for VOC Analyses

6.0 FORMS

None.

7.0 REFERENCES

California Environmental Protection Agency, Department of Toxic Substances Control (DTSC), 2004. *Guidance Document for the Implementation of USEPA Method 5035: Methodologies for Collection, Preservation, Storage, and Preparation of Soils to be Analyzed for Volatile Organic Compounds*. November.

United States Department of Defense (USDoD), 2009. *Quality Systems Manual, Version 4*.1 April.

United States Environmental Protection Agency (USEPA), Office of Solid Waste, 1997. *Method 5035, Closed-System Purge-and-Trap Extraction for Volatile Organics in Soil and Waste Samples.* June. Part of methods compendium SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Update III* (Method 5035).

USEPA, Office of Solid Waste, 2002. *Method 5035A, Closed-System Purge-and-Trap Extraction for Volatile Organics in Soil and Waste Samples.* July. Part of methods compendium SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Update III* (Method 5035). Updated method.

ATTACHMENT A. LIMITATIONS TO VOC SOIL SAMPLING PROCEDURES

Each of the sampling and preservation procedures has their own set of benefits and limitations. Selection of the appropriate procedure should be based primarily on which procedure best addresses the data quality objectives (DQOs) while considering the limitations imposed by field conditions and sampling requirements. Some of the limitations of the different procedures include:

- Multi-Functional Sampling Devices. When the MFSDs are received by the laboratory, the soil subcores within the MFSDs are extruded into VOA vials for analysis. As the soil subcores pass from the MFSDs to the VOA vials during the extrusion process, the soil subcores are open to ambient air and VOC loss could occur. This VOC loss could yield analytical results that are potentially biased low. Users of MFSDs must recognize this limitation when evaluating the data quality objectives for their project.
- Field Chemical Preservation. Chemical preservation of VOA vials in the field with sodium bisulfate solution (low-level analysis) or methanol (high-level analysis) is considered to yield better representativeness for VOC analysis of soil. The introduction of chemical preservatives in the field inhibits VOC loss by biodegradation. Also, VOC loss due to sample handling at the laboratory is minimized in that the sample aliquot is placed in a VOA vial in the field that contains the required preservative, sodium bisulfate or methanol, and stir stick and therefore each VOA vial does not need to be reopened by the laboratory as syringes may be used through the septum cap. However, field preservation has significant limitations that may ultimately prohibit its use on some sites. One issue is that storage of methanol used in preservation may absorb non-site specific VOCs during storage and transport. When the concentration levels of VOCs are not known to be low or high (above 200 ug/kg), multiple VOCs vials containing sodium bisulfate, methanol, and no preservative, will need to be processed in the field for each sample location.
- Empty Vial Technique. The extractant fluid, whether methanol, sodium bisulfate solution, or reagent water, must be added by the stationary laboratory to the VOA vials after the soil has been sealed into the vials in the field. To do this, the PTFE-lined septum caps must be pierced for the introduction of the extraction fluid into the VOA vials. After the introduction of the extraction fluid, the vials must be stirred or sonicated to promote the partitioning of the VOCs into the extraction fluid. Upon completion of the stirring or sonication, the sample is then analyzed for VOC concentration. During the stirring or sonication, VOCs can escape from the VOA vial through the pierced septum. Hence, the Empty Vial Technique may potentially yield analytical results that are biased low. Users of the Empty Vial Technique must recognize this limitation when evaluating the data quality objectives for their project.

ATTACHMENT B. VARIOUS OPTIONS FOR THE COLLECTION OF SOIL SAMPLES FOR VOC ANALYSES

Option	Sample Collection	Sample Container	Field Preservation	Laboratory Procedure	Holding Time (DTSC/EPA)	Reporting Limt
3.1(a)1	MFSD[1]	MFSD	Cool to 4 ± 2°C	Analyze w/in 48 hrs of sample collection	48 hours	Low/High
3.1(a)2	MFSD	MFSD	Cool to 4 ± 2°C	Extrude sample w/in 48 hrs into unpreserved VOA and freeze to < 7°C	7 days / 14 days	Low/High
3.1(a)3	MFSD	MFSD	Cool to 4 ± 2°C	Extrude sample w/in 48 hrs into methanol preserved VOA and cool to 4±2°C	14 days	High
3.1(a)3	MFSD	MFSD	Cool to 4 ± 2°C	Extrude sample w/in 48 hrs into sodium bisulfate preserved VOA and cool to 4±2°C	14 days	Low/High
3.1(a)3	MFSD	MFSD	Cool to 4 ± 2°C	Extrude sample w/in 48 hrs into reagent-grade extractant water VOA and cool to 4±2°C	14 days	Low/High
3.1(b)	MFSD	MFSD	Freeze to < 7°C	Use of any of the above laboratory procedures and associated holding times	—[3] / See above	See above
3.2(a)	SCD	VOA	Preserve with methanol and cool to 4 ± 2°C	Cool sample to 4±2°C	14 days	High
3.2(b)	SCD	VOA	Preserve with sodium bisulfate and cool to 4 ± 2°C	Cool sample to 4±2°C	14 days	Low/High
3.2(c)	SCD	VOA	Extract into reagent-grade water and cool to 4 ± 2°C	Analyze w/in 48 hrs of sample collection	48 hours	Low/High
3.2(d)	SCD	VOA	Extract into reagent-grade water and freeze to < 7°C	Freeze sample to < 7°C	7 days / 14 days	Low/High
3.2(e)	SCD	VOA	Extract into reagent-grade water and cool to 4 ± 2°C	Freeze sample w/in 48 hrs to < 7°C	7 days / 14 days	Low/High
3.3(a)	SCD	VOA	Cool to 4 ± 2°C	Cool to 4±2°C	48 hours	Low/High
3.3(b)	SCD	VOA	Cool to 4 ± 2°C	Freeze sample w/in 48 hrs to < 7°C	14 days	Low/High
3.3(c)	SCD	VOA	Cool to 4 ± 2°C	Extrude sample w/in 48 hrs into methanol preserved VOA and cool to 4±2°C	14 days	High
3.3(d)	SCD	VOA	Freeze to < 7°C	Freeze to < 7°C	14 days	Low/High

[1] Multi-Function Sampling Device (e.g., EnCore Sampler).
[2] Sub-Coring Device (e.g., Lock N' Load sampling system)
[3] Freezing of MFSDs are not recommended by DTSC due to the potential for damage to their seals.

Innovative Technical Solutions, Inc.

Standard Operating Procedure

Sample Handling, Packaging and Shipping

PR-TC-02.04.01.01 v1.2

Effective Date: 06 August 2010

Prepared by: Kristen Carlyon, Program Chemist — Date: 30 September 2009

Reviewed by: Evelyn Dawson, Program Chemist — Date: 30 September 2009

Approved by: Jeffrey Hess, Program Director — Date: 30 September 2009

Revision History:

Version	Changes	Affects Section/Pages	Effective Date	Approval
1.0	Initial Issue	NA	30 Sep 2009	NA
1.1	Added perchlorate to the Sample Preservation and Storage Requirements Table.	Attachment A	24 Feb 2010	JHess
1.2	Remove references to SOPs currently under revision for inclusion of CLP procedures.	Pgs 4-5	06 Aug 2010	JHess

This document contains proprietary information of Innovative Technical Solutions, Inc. (ITSI). ITSI retains all rights associated with these materials, which may not be reproduced without ITSI's express written permission.

Table of Contents

1.0 Purpose 3
2.0 Scope and Applicability 3
3.0 Acronyms and Definitions 3
4.0 Equipment and Materials 4
5.0 Procedure 4
5.1 General 4
5.2 Sample Containers and Preservation 5
5.3 Sample Identification and Labels 5
5.4 Chain of Custody 5
5.4.1 Chain-of-Custody Forms 6
5.4.2 Custody Seals 6
5.5 Packaging for Shipment 7
5.5.1 Labeling 7
6.0 Attachments 8
7.0 Forms 8
8.0 References 8

1.0 PURPOSE

The objective of this procedure is to establish a uniform method for the handling of environmental samples. This includes using the appropriate sample containers and preservatives, following correct chain-of-custody procedures, and using appropriate sample shipment methods.

2.0 SCOPE AND APPLICABILITY

This procedure will be used during the collection and handling of all types of environmental media, including but not limited to, groundwater, surface water, soil, sediment, and air samples.

This procedure applies to the shipping and packing of all non-hazardous samples. Non-hazardous samples are those that do not meet any hazard class definitions found in 49 CFR 107-178, including materials designated as Class 9 materials and materials that represent Reportable Quantities (hazardous substances). In general, most soil, air, and aqueous samples do not meet any of DOT's hazardous materials definitions. However, samples for which screening has shown a potential hazard sufficient to meet a DOT definition or that are derived from a source known or suspected to meet a DOT definition must be packaged and shipped in accordance with applicable DOT and/or IATA requirements.

3.0 ACRONYMS AND DEFINITIONS

For purposes of this procedure, a number of terms and acronyms have the meanings defined below.

°C: degrees Celcius

Bubble wrap: Plastic sheeting with entrained air bubbles; used for protective packaging purposes.

CFR: Code of Federal Regulations

CLP: Contract Laboratory Program

COC: Chain-of-custody

Cooler: Any hard-sided insulated container meeting DOT or IATA general packaging requirements.

DOT: U.S. Department of Transportation.

IATA: International Air Transport Association.

Packing material: Styrofoam beads ("peanuts"), or equivalent

PPE: Personal protective equipment.

QAPP: Quality Assurance Project Plan

Shipping container: *see* Cooler

VOA vial: 40-mL glass vial used for the collection of samples for volatile organic analysis.

4.0 EQUIPMENT AND MATERIALS

Equipment and materials that may be required to implement this SOP include the following:

- Bubble wrap
- Packing material
- Tape (packing tape, duct tape, or other tear-resistant material)
- Large plastic trash bags
- Ziploc bags (freezer grade, gallon and quart sizes)
- Ice
- Custody seals
- "This Side Up" arrows
- Address labels and/or airbills
- Chain of Custody forms
- Black waterproof pen (e.g., fine-point Sharpie marker).

5.0 PROCEDURE

5.1 GENERAL

The following method outlines general considerations for sample handling in the field and maintaining sample custody after collection.

Environmental samples are collected in the field in order to evaluate whether conditions in soil gas, soil, surface water, groundwater or atmosphere are hazardous. These samples therefore, should be handled with the utmost care to maintain sample integrity, so that analytical data represent field conditions as closely as possible. In addition, sample care, custody, and control are extremely important for establishing that sample integrity was maintained between field crews and the laboratory.

General considerations for handling during sampling are:

- Always wear proper PPE when handling samples.
- Wrap sample container in a way that is both protective of the sample container and other surrounding sample containers.
- Document all procedures thoroughly in field logbooks and/or on sampling forms. There is never "too much information".

Samples must be stabilized for transport from the field to the laboratory through the use of the proper sample containerization and preservation. This is due to the potential chemical and/or biological degradation that may occur after samples are collected. Typical sample containerization and preservation are presented in Table 1. Unless otherwise indicated in the site-specific QAPP, sample containers should be cooled immediately after completion of sampling and maintained at a temperature not to exceed 4 ± 2 °C until received by the laboratory.

5.2 SAMPLE CONTAINERIZATION AND PRESERVATION

The appropriate sample container types, volumes, preservatives, and holding time requirements for soil and groundwater samples for the most commonly requested analyses are listed in Table 1, Sample Preservation and Storage Requirements.

Methods of sample preservation are intended to retard biological action, retard hydrolysis, and reduce sorption effects. Preservation methods are generally limited to pH control, chemical addition, refrigeration, and protection from light.

All sample containers will be properly labeled and monitored for temperature control in the field and during laboratory transport and storage. Temperature blanks will be used in all coolers containing samples requiring preservation at reduced temperature (e.g., 4 ± 2 °C).

5.3 SAMPLE IDENTIFICATION AND LABELS

All samples will be properly labeled to prevent misidentification of samples. Generally, preprinted sample labels are encouraged to enhance legibility and reduce transcription errors at the laboratory. The label will be affixed to the sample container prior to transportation to the laboratory and will generally contain the following information (except when using CLP):

- Project name, number, and location
- Site name
- Name of collector
- Date and time of collection
- Sample identification number
- Preservative, if any
- Requested test methods or analyses.

See the site-specific QAPP for any additional sample identification protocols.

5.4 CHAIN OF CUSTODY

Chain-of-custody (COC) procedures are implemented to ensure that all samples are traceable from the time that they is collected until they, or their derived data, are used. A sample is considered to be “in custody” under the following conditions:

- It is in personal possession.

- It is in personal view after being in personal possession.
- It was in personal possession when it was properly secured.
- It is in a designated secure area.

Sample custody will be documented through the use of COC forms. These forms will be used to track sample custody from the point of sample collection through sample disposal. The security of samples will be ensured by the use of the procedures described below.

5.4.1 Chain-of-Custody Forms

A COC form will be filled out for and will accompany every group of samples sent to the analytical laboratory, to document sample care, custody, and control from the time of collection to sample receipt.

The following information will be recorded on the COC form:

- COC form number
- Company name, address, and telephone number
- Company contact person
- Laboratory name, address, and telephone number
- Laboratory contact person
- Sample identification
- Date and time of collection
- Sampler's name
- Analytical method(s) requested
- Sample volume (e.g., three 40-milliliter [mL] vials)
- Sample matrix (e.g., soil or groundwater)
- Preservative (e.g., hydrochloric acid [HCl])
- Request for matrix spike analysis or other QC analysis
- Signatures of individuals releasing and accepting samples
- Times of release and acceptance of samples
- Air bill number if shipping by commercial courier
- Any comments to identify special conditions or requests.

5.4.2 Custody Seals

Custody seals will be used when samples are shipped via courier service, and must be placed on the shipping container so that the seals have to be broken before the container can be opened. The seal must be signed and dated by the field personnel. Custody seals are not deemed

necessary when the samples will be in the continuous possession of project, field, or laboratory personnel.

5.5 PACKAGING FOR SHIPMENT

Samples will be packaged for shipment as follows:

- Use tape to seal off the cooler drain on the inside and outside to prevent leakage.
- Place packing material (bubble wrap and/or other adsorbent material) on the bottom of the shipping container (cooler) to provide a soft impact surface.
- Place a 55-gallon or equivalent plastic bag into the cooler (to minimize the possibility of leakage during transit).
- Place each sample bottle or set of volatile organic analysis (VOA) vials in a separate plastic bag and seal the bag. Squeeze air from the bag before sealing.
- Starting with the largest glass containers, wrap each container with sufficient bubble wrap to ensure the best chance to prevent breakage of the container.
- Pack the largest glass containers in bottom of the cooler, placing packing material between the containers to partially cover the sample containers (more than halfway) to avoid breakage from bumping. Cardboard separators may be placed between the containers at the discretion of the shipper.
- Double-bag ice chips or cubes in gallon or quart freezer-grade Ziploc plastic bags and wedge the ice bags between the sample containers.
- Add bagged ice across the tops of the samples.
- Continue filling the shipping container in the same manner (e.g., using bubble-wrap and ice) with smaller sample containers/vials.
- When the container is sufficiently full (or all samples have been packed), seal the inner protective plastic bag (with twist-ties and/or packing tape), and place additional packing material on top of the bag to minimize shifting of containers during shipment.
- Tape a gallon Ziploc bag to the inside of the cooler lid, place one copy of the completed COC document for the shipment inside, and seal the bag shut.
- Tape the shipping container (cooler) shut using packing tape, duct tape, or other tear-resistant adhesive strips. Taping should be sufficient to ensure that the lid will not open during transport.
- Place custody seals on two separate portions of the cooler, to provide evidence that the lid has not been opened prior to receipt by the intended recipient.

5.5.1 Labeling

Label the shipping container/cooler as follows:

- Attach a “This Side Up” arrow securely to each side of the cooler. Affix "fragile" or other labels on the cooler as appropriate.

- Attach a label with the name and address of the receiver and the shipper to the top of the cooler.
- If the cooler is to be shipped by overnight carrier, attach a properly completed airbill to the top of the cooler.

6.0 ATTACHMENTS

- Attachment A: Sample Preservation and Storage Requirements

7.0 FORMS

The following forms are attached:

- Chain of Custody Form

8.0 REFERENCES

ITSI, 2006. *Final Chemical Data Quality Management Plan, 8(a) Remedial Action Contract Number N68711-005-D-6403*. January.

U.S. Army Corps of Engineers (USACE), 2001. *Requirements for the Preparation of Sampling and Analysis Plans.* EM200-1-3.

U.S. Department of Transportation Regulations, 49 CFR Parts 108-178.

International Air Transport Association (IATA), Dangerous Goods Regulations, current edition.

Attachment A

Sample Preservation and Storage Requirements
PR-TC-02.04.01.01 v1.2

Matrix	Analytical Group	Preparation* / Analytical Method	Containers (number, size and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/analysis)
Water	VOC	Gasoline Range Organics (GRO) 5030B / 8015B	3 X 40 mL VOA vials with Teflon septa	HCL to pH < 2 / 4°C	14 days analysis
Water	VOC	GCMS VOCs 5030B / 8260B	3 X 40 mL VOA vials with Teflon septa	HCL to pH < 2 / 4°C	14 days analysis
Water	VOC	GC VOCs 5030B / 8021B	3 X 40 mL VOA vials with Teflon septa	HCL to pH < 2 / 4°C	14 days analysis
Water	SVOC	Phenols 3510C, 3520C / 8041A	2 X 1.0 liter amber glass with Teflon liners	4°C	7 days extraction 40 days analysis (after extraction)
Water	SVOC	Organochlorine Pesticides 3510C, 3520C / 8081A	2 X 1.0 liter amber glass with Teflon liners	4°C	7 days extraction 40 days analysis (after extraction)
Water	SVOC	Polychlorinated Biphenyls (PCBs) 3510C, 3520C / 8082	2 X 1.0 liter amber glass with Teflon liners	4°C	7 days extraction 40 days analysis (after extraction)
Water	SVOC	Organophosphorus Pesticide 3510C, 3520C / 8141A	2 X 1.0 liter amber glass with Teflon liners	4°C	7 days extraction 40 days analysis (after extraction)
Water	SVOC	Chlorinated Herbicides 8151A / 8151A	2 X 1.0 liter amber glass with Teflon liners	4°C	7 days extraction 40 days analysis (after extraction)
Water	SVOC	GCMS SVOC 3510C, 3520C, 3535A / 8270C	2 X 1.0 liter amber glass with Teflon liners	4°C	7 days extraction 40 days analysis (after extraction)
Water	SVOC	Dioxins and Furans 8280A / 8280A; 8290 / 8290	2 X 1.0 liter amber glass with Teflon liners	4°C	30 days extraction 45 days analysis (after extraction)
Water	SVOC	Polycyclic Aromatic Hydrocarbons 3510C, 3520C / 8310	2 X 1.0 liter amber glass with Teflon liners	4°C	7 days extraction 40 days analysis (after extraction)
Water	SVOC	Nitroaromatics and Nitramines 8330A / 8330A; 8330B / 8330B	2 X 1.0 liter amber glass with Teflon liners	4°C	7 days extraction 40 days analysis (after extraction)
Water	SVOC	Diesel and Oil Range Organics (DRO and ORO) 3510C, 3520C / 8015B	2 X 1.0 liter amber glass with Teflon liners	4°C	7 days extraction 40 days analysis (after extraction)
Water	Metals	ICP-AES Metals 3005A, 3010A, 3015A, 3020A, 3050B, 3051A / 6010B	1 X 500 mL plastic (HDPE)	NO3 to pH < 2	6 months analysis
Water	Metals	ICP-MS Metals 3005A, 3010A, 3015A, 3020A,	1 X 500 mL plastic (HDPE)	NO3 to pH < 2	6 months analysis

Attachment A

Sample Preservation and Storage Requirements
PR-TC-02.04.01.01 v1.2

Matrix	Analytical Group	Preparation* / Analytical Method	Containers (number, size and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/analysis)
		3050B, 3051A / 6020			
Water	Metals	Mercury by CVAA 7470A / 7470A	1 X 500 mL plastic (HDPE)	NO3 to pH < 2	28 days analysis
Water	Inorganic	Hexavalent Chromium 7196A / 7196A 7197 / 7197	1 X 250 mL plastic HDPE)	4°C	24 hours analysis
Water	Inorganic	Anions by IC 300.0 / 300.0 9056A / 9056A	1 X 250 mL plastic HDPE)	4°C	48 hours for nitrate, nitrite, and orthophosphate analysis 28 days for chloride, sulfate, bromide, and fluorideanalysis
Water	Inorganic	Nitrate and Nitrite as N Total 353.2 / 353.2	1 X 250 mL plastic (HDPE)	H2SO4 to pH <2 / 4°C	28 days analysis
Water	Inorganic	Kjeldahl Nitrogen 351.2 / 351.2	1 X 250 mL plastic (HDPE)	H2SO4 to pH <2 / 4°C	28 days analysis
Water	Inorganic	Chemical Oxygen Demand (COD) 410.2 / 410.2	1 X 250 mL plastic (HDPE)	H2SO4 to pH <2 / 4°C	28 days analysis
Water	Inorganic	Alkalinity SM2320B / SM2320B 310 / 310	1 X 250 mL plastic (HDPE)	4°C	14 days analysis
Water	Inorganic	Total Dissolved Solids (TDS) SM2540C / SM2540C 160.1 / 160.1	1 X 250 mL plastic (HDPE)	4°C	7 days analysis
Water	Inorganic	pH SM4500-H+B / SM4500-H+B 150.1 / 150.1	1 X 250 mL plastic (HDPE)	4°C	24 hours analysis
Water	Inorganic	Conductivity SM2510B / SM2510B 120.1 / 120.1	1 X 250 mL plastic (HDPE)	4°C	28 days analysis
Water	Inorganic	Perchlorate 6850 / 6850	1 X 125-ml plastic (HDPE)	20°C/ Store sample with headspace	28 days analysis
Soil	VOC	Gasoline Range Organics (GRO) 5035 / 8015B	3 X 5g EnCore®	4°C or frozen	analysis - 24 hours or 7 days if frozen

Attachment A

Sample Preservation and Storage Requirements
PR-TC-02.04.01.01 v1.2

Matrix	Analytical Group	Preparation* / Analytical Method	Containers (number, size and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/analysis)
Soil	VOC	GCMS VOCs 5035 / 8260B	3 X 5g EnCore®	4°C or frozen	analysis - 24 hours or 7 days if frozen
Soil	VOC	GC VOCs 5035 / 8021B	3 X 5g EnCore®	4°C or frozen	analysis - 24 hours or 7 days if frozen
Soil	SVOC	Phenols 3540C, 3550C / 8041A	brass, stainless steel or teflon™ sleeves with teflon™ end caps or 4 oz glass jar	4°C	extraction - 14 days analysis - 40 days
Soil	SVOC	Organochlorine Pesticides 3540C, 3541, 3550C / 8081B	brass, stainless steel or teflon™ sleeves with teflon™ end caps or 4 oz glass jar	4°C	extraction - 14 days analysis - 40 days
Soil	SVOC	Polychlorinated Biphenyls (PCBs) 3540C, 3541, 3550C / 8082	brass, stainless steel or teflon™ sleeves with teflon™ end caps or 4 oz glass jar	4°C	extraction - 14 days analysis - 40 days
Soil	SVOC	Organophosphorus Pesticides 3540C, 3541, 3550B / 8141A	brass, stainless steel or teflon™ sleeves with teflon™ end caps or 4 oz glass jar	4°C	extraction - 14 days analysis - 40 days
Soil	SVOC	Chlorinated Herbicides 8151A / 8151A	brass, stainless steel or teflon™ sleeves with teflon™ end caps or 4 oz glass jar	4°C	extraction - 14 days analysis - 40 days
Soil	SVOC	GCMS SVOCs 3540C, 3541, 3545A, 3550C, 3560, 3561 / 8270C	brass, stainless steel or teflon™ sleeves with teflon™ end caps or 4 oz glass jar	4°C	extraction - 14 days analysis - 40 days
Soil	SVOC	Dioxins and Furans 8280A / 8280A; 8290 / 8290	brass, stainless steel or teflon™ sleeves with teflon™ end caps or 4 oz glass jar	4°C	extraction - 30 days analysis - 45 days
Soil	SVOC	Polycyclic Aromatic Hydrocarbons 3540C, 3550C / 8310	brass, stainless steel or teflon™ sleeves with teflon™ end caps or 4 oz glass jar	4°C	extraction - 14 days analysis - 40 days
Soil	SVOC	Nitroaromatics and Nitramines 8330A / 8330A;	brass, stainless steel or teflon™ sleeves with teflon™ end caps or 4 oz glass jar	4°C	extraction - 14 days analysis - 40 days
Soil	SVOC	Nitroaromatics and Nitramines 8330B / 8330B	1.5 grams of soil in specially prepared locking plastic bag	4°C	extraction - 14 days analysis - 40 days
Soil	SVOC	Diesel and Oil Range Organics 3540C, 3541, 3545A, 3550C, 3560 / 8015B	brass, stainless steel or teflon™ sleeves with teflon™ end caps or 4 oz glass jar	extraction - 14 days analysis - 40 days	extraction - 14 days analysis - 40 days

Attachment A

Sample Preservation and Storage Requirements
PR-TC-02.04.01.01 v1.2

Matrix	Analytical Group	Preparation* / Analytical Method	Containers (number, size and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/analysis)
Soil	Metals	ICP-AES 3050B / 6010B	1 X 4 oz glass jar	4°C	analysis - 6 months
Soil	Metals	ICP-MS 3050B / 6020	1 X 4 oz glass jar	4°C	analysis - 6 months
Soil	Metals	Mercury by CVAA 7471A / 7471A	1 X 4 oz glass jar	4°C	analysis - 28 days
Soil	Inorganics	Conductivity 9050A/ 9050A	1 X 4 oz glass jar	4°C	analysis - 28 days
Soil	Inorganics	Hexavalent Chromium 7196A / 7196A 7197 / 7197	1 X 4 oz glass jar	4°C	analysis - 24 hours
Soil	Inorganics	pH 9045D / 9145D	1 X 4 oz glass jar	4°C	analysis - 24 hours
Soil	Inorganics	Perchlorate 6850 / 6850	1 X 4 oz amber jar	< 20 °C, Store with headspace	analysis - 28 days

*Extraction methods are not limited to the ones listed in the table above. Please refer to the individual methods, EPA Method 3500 and Chapters 2 and 3 from (SW846 for guidance in choosing the appropriate extraction procedure.

Abbreviations:
AES = Atomic Emission Spectrometry
°C = degrees centigrade
CVAA = Cold Vapor Atomic Absorption
GC = Gas Chromatography
HCl = Hydrochloric Acid
H2SO4 = Sulfuric Acid
IC = Ion Chromatography
ICP = Inductively Coupled Plasma
mL = milliliters
MS = Mass Spectrometry
oz = ounce
SVOC = Semi-volatile Organic Compounds
VOA = Volatile Organic Analysis
VOC = Volatile Organic Compounds

Innovative Technical Solutions, Inc.

Standard Operating Procedure

Sample Tracking and Electronic Data Management

PR-TC-02.12.02.00

Effective Date: 30 September 2009

Prepared by: Kristen Carlyon, Program Chemist Date: 30 September 2009

Reviewed by: Wing Tse, Database Manager Date: 30 September 2009

Approved by: Jeffrey Hess, Program Director Date: 30 September 2009

Revision History:

Version	Changes	Affects Section/Pages	Effective date
1.0	Initial Issue		30 Sep 2009
1.1	Clarification of Project Chemist responsibilities, and corrections to section numbering.	Pages 2-4	30 Sep 2009

This document contains proprietary information of Innovative Technical Solutions, Inc. (ITSI). ITSI retains all rights associated with these materials, which may not be reproduced without ITSI's express written permission.

Table of Contents

Page No.

1.0 Purpose and Scope 1
2.0 Acronyms and Definitions 1
3.0 Procedures and Responsibilities 2
3.1 Field Staff Responsibilities 2
3.1.1 Notification of Sampling 2
3.1.2 Chain-of-Custody 3
3.1.3 Sample Coordinates and Other Field Notes 3
3.2 Project Chemist Responsibilities 4
3.2.1 Development of SAP or FSP/QAPP and Appropriate Location and Sample IDs 4
3.2.2 Creation of Sample Tracking Log 4
2.2.3 Receipt of Data and Data Uploads 5
2.2.4 Reconciliation of Invoices 5
3.3 Data Management Group Responsibilities 5
3.3.1 Support Input of Field Data 5
3.3.2 Upload of Sample Information to Database 5
2.3.3 Creation of Final EDDs 6
4.0 Required Documentation 6
5.0 Attachments 6
6.0 Forms 6
7.0 References 7

List of Figures

Figure	Title
1	ITSI Data Management Workflow

1.0 PURPOSE AND SCOPE

The purpose of this standard operating procedure is to describe the requirements and procedures for tracking environmental samples in a manner that will provide a systematic means of notifying our electronic data management group (including our chemists, database administrators, and other interested parties) of upcoming sampling events, ensuring the correct samples are collected and correct analyses are requested, tracking the receipt of analytical data from the laboratory for the sampling efforts, facilitate upload of electronic data to the database from the field crew and laboratories, and provide a reference for reconciliation of laboratory invoices.

2.0 ACRONYMS AND DEFINITIONS

For purposes of this procedure, a number of terms and acronyms have the meanings defined below.

COC: Chain-of-Custody form

CDQMP: Chemical Data Quality Management Plan

DQO: Data Quality Objective

EDD: Electronic Data Deliverable

eDMS: Environmental Data Management System, ITSI's in-house environmental data management system.

ERPIMS: Environmental Restoration Program Information Management System

FSP: Field Sampling Plan

Geotracker: A database and geographic information system (GIS) hosted by the California State Water Resources Control Board (SWRCB) that provides online access to environmental data.

GPS: Global Positioning System

LIMS: Laboratory Information Management System

NIRIS: Naval Installation Restoration Information Solution

ORP: Oxidation-reduction potential

PID: Photo-ionization detector

QAPP: Quality Assurance Project Plan

SAP: Sampling and Analysis Plan

SEDD: Staged Electronic Data Deliverable

XRF: X-ray fluorescence

3.0 PROCEDURES AND RESPONSIBILITIES

Systematic sample tracking and efficient data management require that the procedures presented in this SOP be followed by all parties involved in the flow of environmental data. Figure 1 outlines the flow of sample information and laboratory results from initial sampling through reporting of the validated results. Responsibilities, by role, for managing the accurate collection and reporting of the data are discussed below and specific procedures are presented in Sections 3.1-3.3.

- **Project Manager**. Establishes and communicates the goals and objectives (DQOs) of the sampling event to the team, and providing specifics regarding the number and type of samples, analytical methods, and any special reporting requirements. Authorizes payment of laboratory and validation invoices upon successful submittal of complete EDD.
- **Field Personnel**. Responsible for the proper collection of environmental samples according to the approved SAP or FSP/QAPP. Responsible for accurate, defensible documentation of sample collection per CDQMP and all project planning documents.
- **Sample Coordinator**. Responsible for tracking the samples from time of collection through laboratory acceptance. Updates the Sample Tracking Log daily. Reconciles coolers contents against COCs prior to transfer to laboratory. Inputs COC and field information, including sample coordinates and field parameters, into eDMS daily. Submit samples to the laboratory. Sends COCs, Sample Collection Logs and other field forms to project team. Resolves completeness issues with laboratory (e.g. broken bottles, missing samples, etc.).
- **Project Chemist** (or designee). Prepares SAP or FSP/QAPP and sample tracking log. Sets up site in eDMS and portal, if necessary. Loads eQAPP and sample schedule into eDMS. Uploads project planning documents to ITSI project portal. Reviews COC and field information in eDMS. Reviews LIMS login report and resolves analytical issues with laboratory. Assists lab in data upload of results. Reviews and approves results/validation qualifiers, releasing data for use. Updates Sample Tracking Log once samples are in the laboratory and for subsequent activities (e.g., data validation). Notify Project Manager upon successful submittal of completed EDDs.
- **Data Management Staff**. Work with Project Chemist on setting up project and/or site, if new. Identify EDD reporting requirements (ERPIMS, NIRIS, SEDD, etc.) based on Contract and Task Order requirements. Manage any new user accounts needed based on staffing of project team. Work with Project Chemist on designation of sample IDs (and new location IDs, if required). Runs completeness test on EDDs against COCs to insure all data has been received, and finalize data in eDMS.

3.1 FIELD STAFF RESPONSIBILITIES

3.1.1 Notification of Sampling

At the beginning of each project involving the acquisition of environmental data, a preliminary meeting will be held by the project manager, project chemist and members of the electronic data

management group to discuss the data quality objectives (DQOs), sampling requirements, and plan out preparation of the SAP or FSP/QAPP (including location and sample IDs). Once fieldwork is scheduled, a meeting between the project manager, project chemist and the field personnel prior to deployment will be conducted to discuss the specific requirements of the project. Specific information regarding the number and type of samples to be collected will be presented, along with recommended field procedures, sequence of work, and identity of the primary and secondary analytical laboratories. Sample naming protocols will be discussed to insure proper sample identification in the field and on Chain-of-Custodies (COCs). The electronic data management group will be notified of the start of sampling at this time.

For multi-phase or recurring projects such as quarterly monitoring, both the project chemist and electronic data management group will be notified prior to the beginning of each sampling event, and a copy of the Sample Tracking Log will be provided to all interested parties prior to the initiation of sampling (The SAP or FSP/QAPP should contain a copy, but please provide updated version if any changes have been made prior to field sampling).

3.1.2 Chain-of-Custody

During field sampling activities, a copy of the COC will be forwarded daily by the sample coordinator to both the ITSI Project Office (to the Project Chemist) and ITSI Corporate Office (to the electronic data management group).

- If paper COCs are used, then ITSI COCs with a unique identification number should be used and can be requested through the COC coordinator (Dan Wedeking at 925-946-3349) in ITSI's Corporate Office prior to the beginning of sampling. The location and sample IDs and the sample depths (top and bottom) for non-aqueous samples should be written on the copies of the COCs. The COCs may be uploaded to the server or emailed directly to the ITSI Offices. If upload to the server is chosen, the ITSI offices will be notified by email at the time of the first upload. In those cases where there is no internet access available, COCs are to be faxed daily and sent by FedEx at the end of each week.
- If Forms II Lite is used, a copy of the output files should be forwarded electronically to the Project Chemist and electronic data management group, along with a copy of the hard copy COC from the field printer for reference.

Once the data management system is fully deployed, the information from the COCs will be entered into the system daily from the field by the sample coordinator, where connectivity is available. If no connectivity is available, the project team will arrange for the information to be entered by others from the COCs provided to the project and Corporate offices.

3.1.3 Sample Coordinates and Other Field Notes

Along with the COCs, the sample coordinator will forward (GPS) sample coordinates to be loaded into the Sample Tracking Log (or online data management system) for each sample collected, with the exception of waste and some process samples, or recurring sample locations where coordinates already exist (e.g., previously surveyed monitoring wells). Please confirm the existence of valid coordinates for each sample location prior to sampling, otherwise collect GPS coordinates just in case. In addition, all field notes including boring logs, water levels, and field measurements will be entered in the online data management system (once fully deployed) no

later than weekly (ideally on a daily basis), and/or sent on a daily basis to the data management group for entry into the system.

3.2 PROJECT CHEMIST RESPONSIBILITIES

3.2.1 Development of SAP or FSP/QAPP and Appropriate Location and Sample IDs

The Project Chemist is responsible for preparation of the SAP or QAPP/FSP and development of appropriate location and sample IDs. A list of location IDs and their associated sample IDs should be sent to the data manager or their designee for approval before they are incorporated in the sampling plan. The location and sample IDs should conform to the location and sample ID nomenclature requirements listed in SOP PR-TC-01.04.04.00. Once the project plans are approved by the client, the Project Chemist shall set up the site in the eDMS and the portal and upload the eQAPP to eDMS and the work plan to the portal.

3.2.2 Creation of Sample Tracking Log

The project chemist shall develop a Sample Tracking Log at the inception of the project. The log shall track the following items:

Pre-Sampling Post-Sampling

- Location ID
- Sample ID
- Sample matrix
- Required analyses
- Sample Date
- Date Submitted to Lab
- Laboratory Sample ID
- Status of data packages.

3.2.2.1 QC of Entry of COCs in eDMS

The project chemist will QC the data entry of the COC information entered into eDMS. The sample identifications, analyses requested, sampling methods, dates and times of sample collections, and proper assignment of quality control samples will all be checked. The Project Chemist will also verify that the Sample Tracking Log has been updated, and will update the log if it has not been updated.

3.2.2.2 Cross-checking of Laboratory Receipt Form

Upon receipt of the samples by the laboratory, a completed chain-of-custody and laboratory receipt form shall be forwarded to the Project Chemist and crosschecked to the Sample Tracking Log (or online data management system) within 48 hours. Transcription errors and any minor differences will be resolved right away and documented through email correspondence. Major problems will be documented through the use of corrective action forms.

3.2.3 Receipt of Data and Data Uploads

As laboratory data packages are prepared and submitted to ITSI, receipt of these data packages will be recorded on the Sample Tracking Log (or online data management system). The Project Chemist will assist the lab in data upload of results. If not directly submitted, the electronic data deliverables (EDDs) in acceptable format (Enhanced ERPIMS unless otherwise approved) will be forwarded to the electronic data management group right away. The completeness of the EDDs will be verified upon receipt by the electronic data management group. eDMS will screen the results against the eQAPP. The Project Chemist will then review and approve the results in eDMS, checking the tracking log for completeness.

Validation using eDMS or a third-party validator occurs at this point. The validation codes are applied to eDMS and a validation report is prepared. The Project Chemist reviews and approves the qualifiers and again updates the Sample Tracking Log. At this point the data is approved for general use.

Upon completion of the receipt of the last sample for the sampling event (for example, one complete round of groundwater monitoring), a copy of the completed Sample Tracking Log will be forwarded to the electronic data management group for organization purposes

3.2.4 Reconciliation of Invoices

Upon receipt of laboratory invoices, the Project Chemist or his designee will cross-check the invoices against the sample tracking log to verify the receipt by ITSI of all billed sample analyses, completed final data packages, and EDDs (accepted by the electronic data management group) before notifying the project manager that the invoices should be authorized for payment.

3.3 DATA MANAGEMENT GROUP RESPONSIBILITIES

3.3.1 Support Input of Field Data

The data management group will support the Project Chemist and sample coordinator in promptly entering field data into the online data management system until the online data management system is fully deployed, following that, in cases where access by the field staff is limited.

3.3.2 Upload of Sample Information to Database

The data management group will use the information in the sample tracking log and the COCs as they are received in preparation for the upload of the electronic data deliverables (EDDs) directly from the laboratory or from laboratory provided electronic files.

Upon receipt of the sample-tracking log, the electronic data management group will review the log. Any immediate potential problems (for example, the use of the dash '-' instead of an underscore '_' in the laboratory data system) that may follow in the preparation of the EDD will be identified and corrected.

3.3.2.1 Entry of COC s

The data management group will enter the COC information into eDMS. The sample identifications, analyses requested, sampling methods, dates and times of sample collections, and proper assignment of quality control samples will all be cross-checked for accuracy. The Sample Tracking Log will be updated as each COC is entered.

3.3.2.2 Entry of Other Field Data

Other data to be entered by the electronic data management group will include water levels, field stability parameters (dissolved oxygen, ORP, turbidity, etc.), and GPS or survey coordinates. Additional data may include results of XRF field sampling, immunoassay test kit sampling, PID measurements, or other information deemed important by the Project Manager for data review and analysis, and ultimately for reporting to the client.

3.3.3 Creation of Final EDDs

The data management group will consolidate the validated EDDs from the in-house and/or third-party data validation firm, and input the field information needed to complete the required EDD package. The final EDD will then be submitted to the government in the required format (ERPIMS, NIRIS, Geotracker, etc.)

4.0 REQUIRED DOCUMENTATION

The following records generated as a result of implementation of this procedure must be maintained as quality records.

- GPS coordinates for each sample collected
- Field notes
- Chains of Custodies
- Sample Collection Logs
- Sample Tracking Form.

5.0 ATTACHMENTS

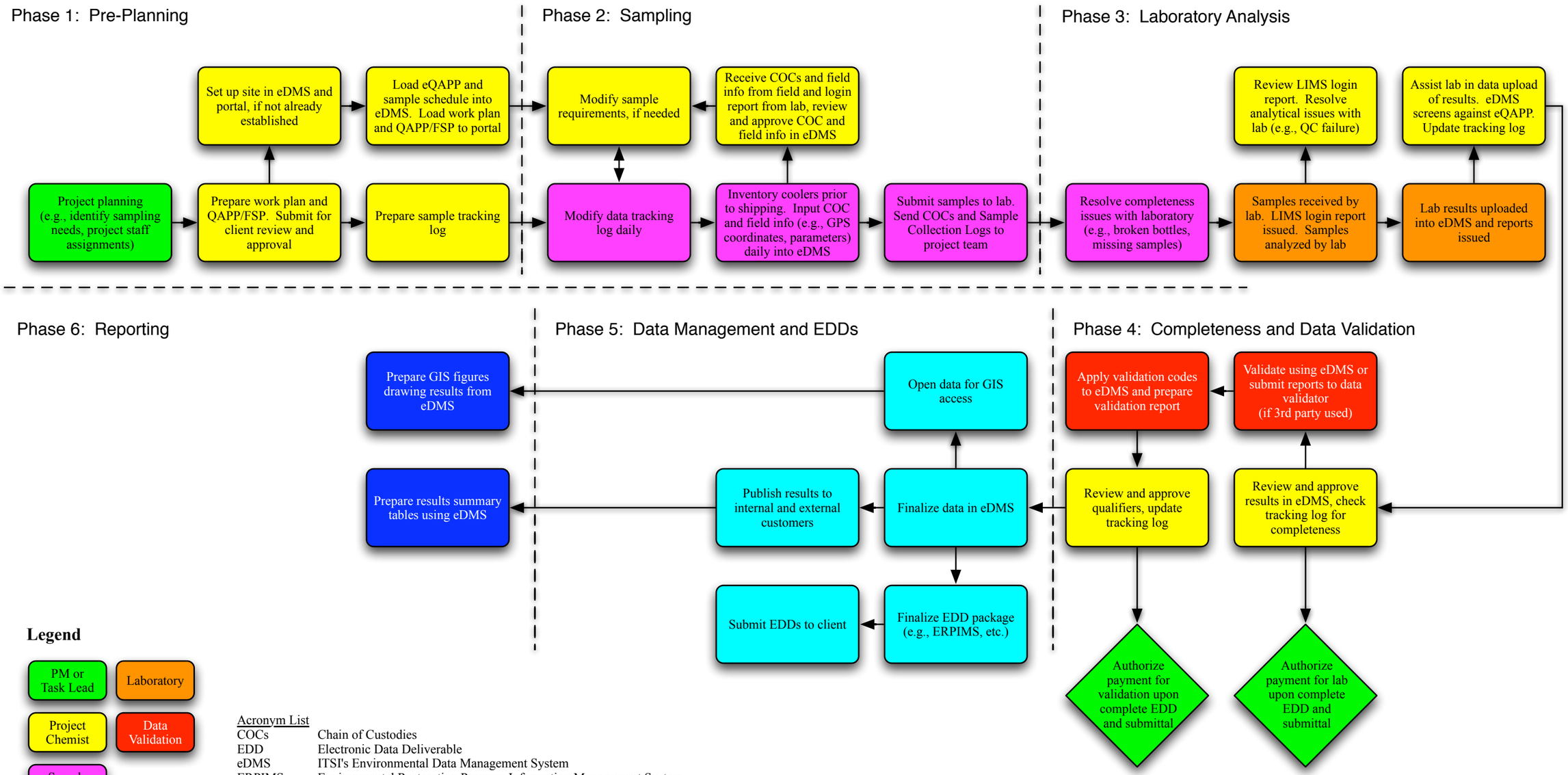
None.

6.0 FORMS

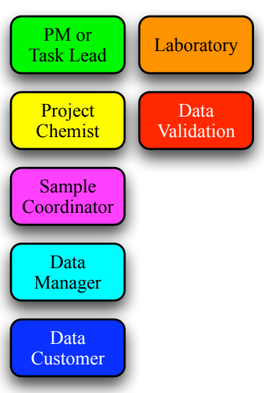
- Sample Tracking Log

7.0 REFERENCES

ITSI, 2004. *Data Management Program: Planning, Collection, Analysis, Verification/Validation, and Reporting of Chemical Data from Environmental Sampling Events, Version 1.1*. January



Legend



Acronym List

COCs	Chain of Custodies
EDD	Electronic Data Deliverable
eDMS	ITSI's Environmental Data Management System
ERPIMS	Environmental Restoration Program Information Management System
eQAPP	Electronic Quality Assurance Project Plan
FSP	Field Sampling Plan
GIS	Geographic Information Systems
GPS	Global Positioning System
LIMS	Laboratory Information Management System
PM	Project Manager
QAPP	Quality Assurance Project Plan
QC	Quality Control

Figure 1
ITSI Data Management Workflow

Sample Tracking Log

Event	Location ID	Sample Type	Field QC	Date Sampled	Time	Sample ID	Date Shipped	Date Received	Chain of Custody	Laboratory Work Order No.	Laboratory Sample No.	Analyses					Report Received	EDD Received	Data on eDMS	Notes
												TPH-DRO & MO by EPA 8015B	VOCs by EPA 8260	SVOCs by EPA 8270C	Title 22 Metals by 6010/6020/7000	Percent Moisture by ASTM D2216				

Innovative Technical Solutions, Inc.
A Gilbane Company

Standard Operating Procedure

Data Review, Verification, and Validation

PR-TC-04.01.00.00

Effective Date: 27 July 2011

Prepared by: Kristen Carlyon, Senior Chemist — Date: 07 Jul 2011

Reviewed by: Evelyn Dawson, Program Chemist — Date: 20 Jul 2011

Approved by: Jeffrey Hess, Director, Technical Services — Date: 27 Jul 2011

Revision History:

Version	Changes	Affects Section/Pages	Effective date
1.0	Initial Issue	NA	27 July 2011

This document contains proprietary information of Innovative Technical Solutions, Inc. (ITSI). ITSI retains all rights associated with these materials, which may not be reproduced without ITSI's express written permission.

Table of Contents

Page No.

1.0 Purpose and Scope 1
2.0 Acronyms and Definitions 1
3.0 Background 2
3.1 General Requirements 2
3.2 Regulatory Basis 3
3.3 Specific Client Requirements 4
4.0 Procedures 5
4.1 Stage 1 Verification 5
4.1.1 Manual Stage 1 5
4.1.2 Electronic Stage 1 Using eDMS 6
4.2 Stage 2A Validation 6
4.3 Stage 2B Validation 8
4.4 Stage 3 and 4 Validation 9
5.0 Required Documentation 10
6.0 Attachments 10
7.0 Forms 10
8.0 References 11

1.0 PURPOSE AND SCOPE

The purpose of this standard operating procedure (SOP) is to describe the requirements and procedures for data review and data validation, using both automated and manual procedures. Use of the procedures outlined in this SOP for procedures other than by an experienced data reviewer should be done with great caution.

2.0 ACRONYMS AND DEFINITIONS

For purposes of this procedure, a number of terms and acronyms have the meanings defined below.

ADR: automated data review; an automated validation of electronic data deliverables against project and contract requirements entered into ITSI's database, eDMS.

CDQMP: Chemical Data Quality Management Plan

COC: chain-of-custody

DAR: Data Assessment Report

DQAR: Data Quality Assessment Report

% D: percent difference (also termed percent drift)

DV: data validation; the analyte- and sample-specific process that determines the analytical quality of a specific set of data.

EDD: electronic data deliverable; an electronic file containing, in a specific electronic format, laboratory data; an EDD is produces for each sample delivery group, and is used for uploading data to the eDMS. .

eDMS: environmental data management system.

GCMS: gas chromatography/mass spectrometry

ID: identification

MS/MSD: matrix spike/matrix spike duplicate

QA: quality assurance

QC: quality control

QAPP: Quality Assurance Project Plan

QRT: qualified results table

RPD: relative percent difference

RSD: relative standard deviation

SDG: sample delivery group; a group of samples that is reported together under one laboratory identification number.

SAP: Sampling and Analysis Plan

SOP: standard operating procedure

3.0 BACKGROUND

There are many competing procedures for the review and validation of chemical data. This SOP attempts to harmonize these differing procedures utilizing the most recent regulatory guidelines and the latest technology. The sections below provide the necessary background information used in developing these harmonized procedures.

3.1 GENERAL REQUIREMENTS

ITSI's Chemical Data Quality Management Plan (CDQMP) outlines the general requirements for the review and/or validation of chemical data. As outlined in the CDQMP, the following items (as applicable to the analytical method(s) used to generate the data) are considered and evaluated in a routine review of laboratory-generated data:

- Laboratory reports and chain of custody documentation, to check for errors and omissions;
- Laboratory case narratives, to check for anomalies and exceedances of QA/QC requirements;
- Laboratory reports, to check for correct reporting limits and units;
- Extraction and analysis holding times;
- Method blank, trip blank, equipment blank, ambient blank, and rinse water blank data (to note any detected analytes and their respective concentrations);
- Surrogate compounds, the spiking levels, the resulting concentrations, and the percent recoveries;
- Laboratory control samples, the spiking levels, resulting concentrations, and percent recoveries;
- Laboratory duplicate samples, field duplicate samples, and relative percent differences (or replicates and relative standard deviation [RSD]).
- MS/MSD samples, the spiking levels, resulting concentrations, percent recoveries, and relative percent differences between the MS and MSD; and,
- Reporting limit verification standard (low-level standard check).

In addition to the routine review procedure described above, more rigorous data validation will be conducted at a frequency prescribed in the project-specific sampling and analysis plan (SAP) or quality assurance project plan (QAPP). These reviews will evaluate the above items, plus each of the following (as applicable to the subject analytical methodology):

- Instrument initial calibrations, calibration levels, individual compound response factors for each level, and RSD or correlation of the response factors;

- Instrument continuing calibrations, calibration levels, individual compound response factors, and the percent difference (%D) between the response factor and the response factor in the initial calibration;
- Internal standard area counts and retention times, to compare to method-specified acceptance criteria;
- GC/MS tuning data and instrument performance checks, to compare to method-specified acceptance criteria;
- Data for serial dilution analyses, interference check samples, post-digestion spikes, method of standard additions, linear range determinations, instrument detection limits, inter-element correction factors, and the analysis record (metals analyses only);
- Raw data, including chromatograms, to check for correct transcription, interpretation, manual integrations, and compound identification;
- Injection logs for all instruments used for analysis of project sample;
- Preparation logs for all project samples and associated QA/QC samples;
- Date and time of analysis of project samples and associated QA/QC samples.

3.2 REGULATORY BASIS

The general requirements outlined in Section 3.1 were evaluated against guidelines and procedures outlines in the 2009 *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* by the U.S. Environmental Protection Agency (EPA) (EPA, 2009). This guidance document establishes specific terminology for data review and validation efforts. This terminology is being adopted here to facilitate a clear understanding by both the reviewer and the ultimate user of the data regarding the specific level of review and validation to which the data was subjected. This terminology is outlined below.

Table 1. Description of "Stages" Terminology

Stage	Validation Description	Label Codes
–	Not validated	NV
1	Completeness	S1VE, S1VM
2A	Completeness and sample-related QC	S2AVE, S2AVM, S2AVEM
2B	Completeness and both sample-related and instrument-related QC	S2BVE, S2BVM, S2BVEM
3	Completeness, both sample-related and instrument-related QC, and recalculation checks	S3VE, S3VM, S3VEM
4	Completeness, both sample-related and instrument-related QC, recalculation checks and review actual instrument outputs	S4VE, S4VM, S4VEM

The possible label codes are based on a combination of what "Stage" of review and/or validation was performed, and whether the review and/or validation was performed manually (M), electronically (E), or both (EM).

3.3 SPECIFIC CLIENT REQUIREMENTS

Based on a review of various client requirements (e.g. Department of Defense data item descriptions, NAVFAC-SW Environmental Work Instruction #1, *Chemical Data Validation* (NAVFAC-SW, 2001), etc.) and their governing CDQMPs, the following table outlines the general guidelines for the review and/or validation of chemical data for various clients:

Table 2. Cross-Walk of Validation Requirements

Client	Target Validation Level	Equivalent Stage
Department of Defense		
Air Force/AFCEE	Level III	2A
	Expanded Level III	2B
	Level IV	3
Army/USACE	Level III	2A
	Expanded Level III	2B
	Level IV	3
Navy	Level III	2B (3rd party)
	Level IV	3 (3rd party)
Other Federal Agencies		
EPA	Tier 1A	1
	Tier 1B	2A or 2B
	Tier 2	4 (on subset of results)
	Tier 3	4

There may be specific contracts that require components of SEDD 2B as part of their Level III validation specifications; **ALWAYS** check the master contract language when specifying DV services under this SOP. As contract-specific requirements are identified, please send them to jhess@itsi.com so they may be incorporated into this SOP in a future update.

4.0 PROCEDURES

The specific protocols used are outlined below for the review and validation of analytical data consistent with our CDQMP and the EPA "Stage" approach.

4.1 STAGE 1 VERIFICATION

Stage 1 verification, commonly referred to as a completeness check (or level II verification), of the laboratory analytical data package consists of verification of compliance and sample receipt conditions. The following items are considered and evaluated during Stage 1 verification of the sample delivery group (SDG):

- Chain-of-custody documentation including laboratory receipt information,
- Laboratory case narrative and summary report,
- Laboratory report signed by official laboratory representative
- Requested samples analyzed,
- Requested analytes, reporting limits and units, ~~and~~

Stage 1 can be completed either manually, electronically within eDMS, or a combination of the two.

4.1.1 Manual Stage 1

Specific procedures for manual Stage 1 verification are provided below:

1. Verify the laboratory report clearly identifies the laboratory receiving the samples and performing the analyses and that the laboratory report is signed by an official laboratory representative.
2. Review laboratory case narrative for anomalies and QC issues.
3. Verify the analytical methods specified in the QAPP were performed, and if substitutions were made, verify written instructions from the ITSI Project Chemist specifying/allowing the substitution.
4. Review cooler receipts and sample login files for potential issues that may affect the usability of the samples (presence of custody seals, etc.) or validity of the reported results (receiving temperatures, etc.).
5. Verify all the target compounds identified in the QAPP for each of the analyses were reported by the laboratory.
6. Verify all the analyses for each of the samples listed on the chain-of-custodies were completed, the dates are present when the analyses were performed, the analyses were performed within the specified holding times, the requested reporting limits were obtained, and the results appropriately qualified.
7. Document review with Stage 1 Verification Checklist, included here as Attachment A. File completed checklist on server in the project folder in the Data Validation subfolder.

4.1.2 Electronic Stage 1 Using eDMS

Much of a Stage 1 verification is by nature manual. Specific procedures for electronic Stage 1 verification incorporating eDMS are provided below:

1. Perform steps 1 through 4 as written above.
2. From the ITSI Projects Portal (https://edms.itsi.com), select the project in which you would like to run your report from the drop-down menu.
3. From the grey menu bar, select "Reports>Data Review Reports>ADR Report".
4. A new screen will pop up. In "Status" choose "Loaded and Certified", and a list of available SDGs should appear. Choose an SDG, and fill in the rest of the fields as appropriate. These are report headers and used for documentation purposes. At a minimum, fill in the data review quality control (QC) level S1VEM (per Table 1 in Section 3.2).
5. Select "View Reports" and the bookmarked ADR Report will generate.
6. Verify that the total number of analyses presented in the "ADR Summary" match the total number of analyses requested on the COC. If there is a discrepancy, use the detailed "Batch Report" for more in-depth review.
7. Verify that there were no holding time exceedances by reviewing the "QC Outliers Report."
8. Review the "Qualified Results" and "Detected Results" to verify requested reporting limits were attained.
9. Document review using Stage 1 Validation Checklist. File completed checklist in the project library on eDMS and/or on server in project folder in Data Validation subfolder.

4.2 STAGE 2A VALIDATION

Stage 2A validation (which can include some or all of the components of level III validation, depending on client) will evaluate and consider the items listed above for completeness, in addition to following:

- Extraction and analysis holding times,
- Method blank, trip blank, equipment blank and ambient blank data,
- Surrogates,
- Matrix spikes and matrix spike duplicates,
- Field duplicates,
- Laboratory control samples, and
- Laboratory duplicates.

Stage 2A can be performed manually, but is preferentially performed electronically using eDMS. The following steps apply when performing automated data review (ADR) for Stage 2A within eDMS:

1. Generate the ADR Report by following the instructions in Section 4.1.2 steps 2 through 5.
2. From the "Select a format" pull down menu, select "excel", and click on export. A multi-page excel workbook will be generated. (Note: Some formatting of file will be required if file is to be included as appendix to a report. The preferred approach is to make any required changes to the information and rerun the report and export as a pdf.)
3. On the first sheet, verify all samples are being reported with the correct IDs. Verify the correct parameters were evaluated (i.e. if there were field duplicates, verify that they were considered.)
4. Generate a Field Duplicate Report, if applicable, by choosing "Reports>Data Review Reports>Field Duplicate Report." Fill in the desired title of the report, select the event from the pull-down menu, select the SDG from the next pull-down menu, check that the correct parent and duplicate sample are identified, check that the correct limits are displayed for organic and inorganic duplicate RPDs and update as necessary, and finally click "View Report". Export the report in desired format (i.e. Excel, pdf, or Word, by clicking down arrow next to "Select a format" and then clicking on "Export." Note if there are any qualified outliers.
5. Skip to "QC Outlier Report" and review. Verify that both the correct control limits and correct warning limits were used to qualify the data. Check the outliers against the case narrative and check 10% against the hard copy.
   a. eDMS uses upper and lower warning limits (UWL and LWL, respectively) to specify where the system will qualify data, and upper and lower control limits to specify where the system will reject data. While planning documents will provide most warning limits, control limits are often not specified. ITSI default control limits are as follows:

Class of Analysis	Lower Control Limit	Upper Control Limit
Organics	10%	UWL + 10%
Inorganics	50%	UWL + 10 %

   b. **Note**: If incorrect control or warning limits are discovered, send an email to the database manager or specialist with a correction request.
6. Make any necessary changes to "Qualified Results" in **bold** type, and note both the change and the reason for it in the narrative comments section on Sheet 4.
7. Edit/add qualifiers as necessary in the database by selecting "Tools>Sample Qualification" in the ITSI Project Portal.
8. To review the entry/editing of the qualifiers, generate the QRT by choosing "Reports>Data Review Reports>Qualified Result Report." Fill in the title of the report in the "Custom Title" window, then select the desired SDG from the pull-down menu at the top of the screen and click <View Report>. Use the report thus generated to check that all qualifiers were entered accurately.

9. Make any necessary changes by following the instructions in step 7.
10. When review process is complete and any necessary changes have been made, generate the final QRT report by following the instructions in step 8. Export the report in desired format (i.e. Excel, pdf, or Word, by selecting format from pull-down menu and clicking "Export."
11. When reports have been generated and review process is complete select <Finalize Qualifiers> from main screen, followed by <Approve SDG>.
12. Save the excel workbook with review changes, the QRT, and the Field Duplicate Report together in a file named with the SDG number.
13. Write the Data Assessment Report (DAR) or Analytical Data Quality Report (ADQR) as required by the QAPP.

4.3 STAGE 2B VALIDATION

For 2B validation, the following additional information will be reviewed:

- Initial and continuing calibration standards,
- Initial and continuing calibration blanks (for inorganic and metals analyses),
- Serial dilutions and post spikes, where applicable,
- Reporting limit verification standard, and
- Instrument tune and performance checks.

These additional steps apply when performing an ADR for 2B within eDMS:

1. Manually review those elements of the Stage 2B not covered by the ADR using the applicable sections of the Stage 2B Validation Checklist, presented as Attachment B. These items include:
    - Initial and continuing calibration standards
    - Initial and continuing calibration blanks
    - Serial dilutions and post spikes, where applicable
    - Reporting limit verification standard
    - Instrument tune and performance checks
2. Additional qualification of data may result from the manual review. The manual information will be reported in the narrative comments section on Sheet 4 of the ADR report.
3. Edit/add qualifiers as necessary in the database by selecting "Tools>Sample Qualification" in the ITSI Project Portal.
4. To review the entry/editing of the qualifiers, generate the QRT by choosing "Reports>Data Review Reports>Qualified Results Report." Fill in the desired title of the report, then select the desired SDG from the pull-down menu at the top of the screen and click <View Report>. Use the report thus generated to check that all qualifiers were entered accurately.
5. Make any necessary changes by following the instructions in Section 4.2 step 7.

6. When review process is complete and any necessary changes have been made, generate the final QRT report by following the instructions in Section 4.2 step 8. Export the report in desired format (i.e. Excel, pdf, or Word, by selecting format from pull-down menu and clicking "Export."
7. Generate a Field Duplicate Report, if applicable, by choosing "Reports> Data Review Reports>Field Duplicate Report." Fill in the desired title of the report, select the event from the pull-down menu, select the SDG from the next pull-down menu, check that the correct parent and duplicate sample are identified, check that the correct limits are displayed for organic and inorganic duplicate RPDs and update as necessary, and finally click "View Report". Export the report in desired format (i.e. Excel, pdf, or Word, by clicking down arrow next to "Select a format" and then clicking on "Export."
8. When reports have been generated and review process is complete select <Finalize Qualifiers> from main screen, followed by <Approve SDG>.
9. Save the excel workbook with review changes and the QRT together in a file named with the SDG.
10. Write the Data Assessment Report (DAR) or Analytical Data Quality Report (ADQR) as required by contract.

4.4 STAGE 3 AND 4 VALIDATION

Stage 3 validation will evaluate and consider the raw data associated with items reviewed in Stages 2A and 2B, in addition to following:

- Internal standards and retention times
- Method of standard additions, linear range determinations, instrument detection limits, and inter-element correction factors (metals analyses only)
- Method detection limit studies
- Sequence logs
- Preparation logs

For a Stage 4 review, add the review of the following instrument outputs:

- Raw data of chromatograms and spectra.

The following additional steps apply when performing the ADR within eDMS:

1. Manually review the raw data for calibrations, internal standards and retention times, tunes, serial dilutions, post-spikes, interference check samples, and MDLs, and perform raw data recalculations, and, if specified, review raw chromatograms and spectra using the Stage 3 and 4 Validation Checklists and Worksheets (Attachment C).
2. Edit and review qualifiers as necessary in the database by following the instructions in Section 4.2 steps 7 and 8.
3. When reports have been generated, select <Finalize Qualifiers> from main screen.

4. Update and save the excel workbook with review changes and the QRT together in a file named with the SDG.
5. Write the DAR or DQAR, as required.
6. Submit validation package with all supporting documentation for peer review. When review process is complete, the data is approved for use in the database by selecting <Tools> from the main menu, and then <Data Approval> from the drop-down menu. Selecting "Unapproved" from the File Status drop-down menu and " Laboratory" from the File Type menu will return a list of SDGs with finalized qualifiers. Click on the checkmark icon to the left of the file name to approve the SDG.

5.0 REQUIRED DOCUMENTATION

The following records generated as a result of implementation of this procedure must be maintained as quality records.

- ADR workbook for each SDG.
- QRT.
- Field duplicate report.
- DAR or DQAR (as required).
- Validation and Verification Checklists

6.0 ATTACHMENTS

A. Stage 1 Verification Checklist
B. Stage 2 Validation Checklists
C. Stage 3 & 4 Validation Checklists and Worksheet

7.0 FORMS

None.

8.0 REFERENCES

Innovative Technical Solutions, Inc. (ITSI), 2010. *Chemical Data Quality Management Plan (CDQMP)*, March.

U.S. Department of the Navy, Southwest Divsion (NAVFAC-SW), 2001. *Environmental Work Instruction #1, Data Validation Guidelines for Chemical Analysis of Environmental Samples*. 28 November.

U.S. Army Corps of Engineers (USACE), 2005. EM 200-1-10, *Guidance for Evaluating Performance-Based Chemical Data*. 30 June.

U.S. Environmental Protection Agency (USEPA), 2009. EPA 540-R-8-005, *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use*. January.

Stage 1 Verification Checklist

Project Name: Project No.:

Laboratory: SDG #:

Reviewer: Organization:

CATEGORY		COMMENTS
SAMPLE RECEIPT FORM		
☐	Cooler temperature within control limits	
☐	Samples received intact within holding time	
RECONCILIATION OF CHAIN-OF-CUSTODY TO SDG		
☐	Sample IDs correct	
☐	Requested analysis received	
☐	Sample time and date received correct	
☐	Chain of custody maintained (i.e. signatures and line-outs)	
REVIEW OF SDG		
Review case narrative		
☐	Check for analytical holding times	
Review laboratory package		
☐	Verify analyses requested on COC for each sample were completed	
☐	Verify analytical methods specified in QAPP were performed, else written variance on file.	
☐	Verify all the target compounds identified in the QAPP for each of the analyses were reported by the laboratory.	
☐	Verify requested reporting limits were obtained, and that results were appropriately reported and qualified.	
☐	Check type of package requested (ie Level III, Level IV) was received.	

Stage 2 Review Checklist: Metals

Project Name: Project No.:

Laboratory: SDG #:

Reviewer: Organization:

Category	**Method_____**	**Notes**
COC		
Custody Trail		
Temperature/Condition		
Receipt anomalies		
Sample/Methods check		
Case Narrative		
Anomalies (DQFs)		
Samples		
Collection date		
Extraction date		
Analysis date		
Holding time		
Batching		
Lab qualifiers		
Blank		
Method blank		
Equipment blank		
Calibration (Stage 2b only)		
ICAL		
ICV		
CCV		
LLCCV		
Precision/Accuracy		
MS/MSD		
LCS/LCSD		
Quantitation		
PQLs		
Dilution Factor		
Results		
Field Duplicates		
RPD in criteria		

Stage 2 Metals Checklist 072711.doc

Stage 2 Review Checklist: Organics

Project Name: Project No.:

Laboratory: SDG #:

Reviewer: Organization:

Category	**Method_____**	**Notes**
COC		
Custody Trail		
Temperature/Condition		
Receipt anomalies		
Sample/Methods check		
Case Narrative		
Anomalies		
Samples		
Collection date		
Extraction date		
Analysis date		
Holding time		
Batching		
Surrogate recoveries		
Lab qualifiers		
Calibration (Stage 2b only)		
ICAL		
ICV		
CCV		
Blank		
Method blank		
Trip blank		
Equipment blank		
Precision/Accuracy		
MS/MSD		
LCS/LCSD		
Quantitation		
PQLs		
Dilution Factor		
Results (i.e. correct analytes)		
Field Duplicates		
RPD within limits		

Stage 2 Organic Checklist 072711.doc

Stage 3 & 4 Review Checklist: Metals

Project Name: Project No.:

Laboratory: SDG #:

Reviewer: Organization:

Category	**Method_____**	**Notes**
COC		
Custody Trail		
Temperature/Condition		
Receipt anomalies		
Sample/Methods check		
Case Narrative		
Anomalies (DQFs)		
Samples		
Collection date		
Extraction date		
Analysis date		
Holding time		
Internal standard		
Batching		
Lab qualifiers		
Blank		
Method blank		
Calibration blank		
Equipment blank		
Calibration		
ICAL		
ICV		
CCV		
LLCCV		
Precision/Accuracy		
MS/MSD		
LCS/LCSD		
Post digestion spike		
Serial dilution		
Reporting Limit Std.		
Instrument		
ICSA		
ICSAB		
Tune		

Stage 3 & 4 Review Checklist: Metals

Project Name: Project No.:

Laboratory: SDG #:

Reviewer: Organization:

Quantitation		
PQLs		
Dilution Factor		
Results - Recalc		
Field Duplicates		
RPD in criteria		

Stage 3-4 Metals Checklist 072711.doc

Stage 3 & 4 Review Checklist: Organics

Project Name: Project No.:

Laboratory: SDG #:

Reviewer: Organization:

Category	**Method_____**	**Notes**
COC		
Custody Trail		
Temperature/Condition		
Receipt anomalies		
Sample/Methods check		
Case Narrative		
Anomalies		
Samples		
Collection date		
Extraction date		
Analysis date		
Holding time		
Batching		
Surrogate recoveries		
Internal standard recoveries		
Lab qualifiers		
Blank		
Method blank		
Trip blank		
Equipment blank		
Calibration		
ICAL		
ICV		
CCV		
Precision/Accuracy		
MS/MSD		
LCS/LCSD		
Instrument		
Tune		
Breakdown Standard		

Stage 3 & 4 Review Checklist: Organics

Project Name: Project No.:

Laboratory: SDG #:

Reviewer: Organization:

Quantitation		
PQLs		
Dilution Factor		
Results (RT, Ions, Rel. Itens.)		
Retention times		
Major ions present		
Relative intensities		
Column/Detector RPD		
Confirmation		
Result Recalculation		
Field Duplicates		
RPD within limits		
Review Chromatograms/Spectra (Stage 4 only)		

Stage 3-4 Organic Checklist 072711.doc

ATTACHMENT 2

TECHNICAL MEMORANDUM: COMPARISON OF HOLLOW STEM AUGER AND MUD ROTARY DRILLING METHODS FOR THE INSTALLATION OF 6-INCH GROUNDWATER EXTRACTION WELLS AT THE AMCO CHEMICAL SUPERFUND SITE

Technical Memorandum

To:	Rose Marie Caraway, EPA
From:	Rogerio Leong, ITSI and Kent Baugh, ITSI
cc.	Pete Lange, ITSI
Date:	June, 2011
Subject:	Comparison of Hollow Stem Auger and Mud Rotary Drilling Methods for the Installation of 6-inch Groundwater Extraction Wells at the AMCO Chemical Superfund Site
Contract / TO:	EP-S9-08-03, Task Order 0018 **ITSI DCN:** 07163.0019.0058

1.0 Introduction

At the request of the U.S. Environmental Protection Agency (EPA), Innovative Technical Solutions, Inc. (ITSI) has prepared this technical memorandum presenting a comparison of hollow stem auger (HSA) and direct mud rotary drilling methods for the installation of 6-inch (or larger) groundwater extraction wells at the AMCO Chemical Superfund Site (the Site). The objective of this comparison is to establish the basis for recommending which of the two drilling methods is technically appropriate and cost-effective for the planned well installation activities. These wells will be installed for the upcoming aquifer pumping test to evaluate hydrogeologic conditions of the Union Pacific property at the Site and downgradient of the Site.

2.0 Past Drilling Experiences at AMCO Chemical Superfund Site

As part of the remedial investigation at the Site, monitoring wells were installed and sampled to characterize the nature and extent of contaminants in groundwater. As a result of past environmental investigation, the conceptual model for the Site includes the Upper Aquifer defined by three depth units. The upper unit extends to approximately 15 feet below ground surface (bgs); the middle unit extends to approximately 35 feet bgs; and the lower unit terminates between 60 and 70 feet bgs. The current groundwater monitoring network consists of 41wells that includes 6 monitoring wells installed by Union Pacific and 35 monitoring wells installed by EPA since contaminants were first discovered in groundwater beneath the Site. Of the 35 EPA monitoring wells, 12 are 6-inch diameter and 23 are 4-inch diameter. Several drilling companies have been contracted to install wells across the Site to date. Sonic and HSA drilling methods were used to install the existing monitoring wells. Information provided by these drilling companies was considered when performing this drilling method comparison.

In October 2009, CH2M HILL oversaw the installation of the twelve, 6-inch diameter monitoring wells. WDC Exploration (Richmond, California) was contracted to install the 6-inch monitoring wells. Eight-inch HSA pilot boreholes were drilled for each monitoring well. A Central Mining Equipment (CME) 75 limited-access, HSA drilling rig and a CME 85 HSA drilling rig were used to drill the pilot boreholes. Upper and middle unit wells were completed to 15 and 35 feet bgs, respectively. Pilot boreholes for the deep unit were terminated after

penetrating a minimum depth into the underlying aquitard, with completion depths between 60 and 70 feet bgs.

During installation of the 6-inch diameter wells, unconsolidated heaving sands were encountered in each borehole at depths greater than 25 feet bgs. The unconsolidated material encountered in these boreholes is overlain by a relatively dense unit that, when breached by drilling processes, creates a pathway for unconsolidated material to move vertically in the borehole due to differences in the hydrostatic pressure of each subsurface unit. Heaving conditions present significant problems when using the HSA drilling method. Loose, unconsolidated material will travel up inside the hollow auger and can effectively halt the advancement of the borehole. Typically, this condition can be mitigated by filling the augers with fluid (usually potable water) and securing the connection between each drilling auger with fiber cording (nylon or cotton rope) to minimize fluid loss.

The most recent drilling activities at the Site were performed by Greg Drilling and Testing (Martinez, California) as part of the 2010-2011 ITSI Cone Penetrometer Testing-Membrane Interface Probe (CPT-MIP) investigation . HSA was used to collect groundwater and soil samples at targeted depths beyond the capability of the CPT-MIP equipment for this Site. Consistent with the observation made by CH2M HILL, heaving sands were encountered in each borehole drilled past 25 feet bgs. In some boreholes, collection of samples at specific target depths was prevented due to heaving conditions. To counter the effects of heaving sands at two locations, 4-inch diameter conductor casing was installed with the mud rotary drilling method to investigate depths beyond 70 feet bgs.

2.1 Hollow-Stem Auger Drilling Method and Well Construction

The HSA drilling method uses the Archimedean principal to remove drill cuttings from a borehole. Five-foot lengths of drilling pipe (flights) are vertically rotated into the earth by a hydraulic motor. After each auger flight is rotated (drilled) into the ground, additional auger flights are added to advance the borehole. Drill cuttings travel up the flights to ground surface. Based on the type and stability of subsurface material encountered during the drilling process, the borehole may remain open when augers are removed. Obviously, unconsolidated subsurface material (typically silts and sands) can present caving problems in HSA boreholes. When a HSA borehole encounters saturated subsurface material (including the portions of the formation to be screened), drilling generally can be continued for a short distance. However, in subsurface conditions typically encountered at the Site, the borehole may not remain open when the augers are removed.

Under typical drilling conditions where heaving sands are not a concern, the auger joints are removed from the borehole when the targeted depth is reached for well construction or for further drilling by a different drilling method.

If heaving conditions are encountered during initial borehole drilling, modified methods are used for well construction. All auger flights are removed from the borehole and potable water is added to the borehole as the augers are removed to equalize subsurface hydrostatic pressure and stabilize subsurface conditions. A wooden plug is fitted into the bottom of the lead auger and the

auger flights are drilled back into the borehole to the target depth for the well screen. During this re-drilling process, the borehole is kept full of potable water. The wooden plug is then knocked out of the lead auger and well screen and casing are quickly installed in the auger column. Individual auger joints are removed from the borehole as filtration material (graded sand) is added to the auger column around the well screen. In many instances when constructing wells in heaving conditions with the HSA method, addition of screen filtration material may not be possible. In these cases, the formation sand is used as the well screen filtration material. Well construction can then proceed by the successive removal of auger joints and the addition of the remaining well construction material (bentonite strata seal material, transition sand and sanitary seal cement).

HSA wells that are construction under heaving conditions predictably require more aggressive well development to remove fine grained sediments (silt and clay particles) from the screened interval.

2.2 Direct Mud Rotary Method and Well Construction

Direct mud rotary drilling utilizes fluid to help advance the borehole. Drilling fluid is circulated during the drilling process under hydraulic pressure through hollow, 20-foot long drill pipe and drill bit into the borehole.

Direct mud rotary drilling is typically used for the installation of wells at depths that are beyond the capability of other methods and when subsurface conditions become unstable. Drilling fluid (mud) is normally a mixture of sodium bentonite clay and potable water. The drilling fluid is used to:

(1) Remove drill cuttings from the borehole,
(2) Create a layer of clay sized particles along the borehole wall for stability
(3) Stabilize subsurface pressures in the borehole
(4) Hold drill cuttings in suspension when circulation is interrupted
(5) Release sand and cuttings at ground surface
(6) Lubricate the drilling pipe and bit.

Once drilling fluid reaches the surface, solid material larger than clay/silt sized particles is removed by passing the drilling mud over a series of oscillating screens of various sizes. The drilling fluid that falls through the screens is collected in a tank and pumped back into the borehole through the drill pipe and drill bit. Samples of the drill cuttings can be collected from the borehole at a variety of locations along the fluid circulation stream.

Well construction in mud rotary boreholes requires the management of drilling fluids before and as well construction materials are added to the borehole. Once the targeted depth of the borehole is reached, the viscosity and density of the drilling fluid must be reduced to the point where borehole stability is maintained and the borehole fluid is as equal to the viscosity of the fluid (usually potable water) that will be used to install the well screen filtration sand and other well construction material. This can be accomplished by slowly adding potable water to the borehole as circulation continues from the borehole's total depth.

When the borehole fluids have been "balanced," the drill pipe is removed and the well screen, casing and other well construction materials can be installed.

Development of wells constructed in mud rotary boreholes generally requires more aggressive techniques than those typically used on HSA-drilled wells.

2.3 Comparison of Hollow-Stem Auger and Direct Mud Rotary Methods

Method	Drilling Principle	Depth (Feet)	Advantages	Disadvantages
Hollow-Stem Auger	Successive 5-foot lengths of auger flights are rotated into the ground to create a borehole. Cuttings are brought to the surface by the rotation of the auger	150	• Relatively inexpensive when compared to mud rotary. • Fairly simple, quick setup time and moderately fast operation. • Rigs are highly mobile and can reach most drilling sites. • No drilling fluid or lubricants used, eliminating contamination from additives. • Can be used to avoid borehole caving. • Hollow-stem allows formation water to be sampled during drilling via screened auger or advancing a well point ahead of the augers. • Small-diameter wells can be built inside hollow-stem flights. • Hollow-stem allows the collection of split-spoon samples, continuous sampling possible.	• Application limited to unconsolidated or semi-consolidated (weathered rock) materials. Compacted or gravelly materials are typically hard to penetrate. • Problems controlling heaving sands. • Smears borehole wall when drilling in clay-rich environments, creating well development problems. • Well points yield small quantities of water at slow rates. • Small diameter well screen may be problematic to develop. Screen may become clogged if thick clays are penetrated. • Cannot run a complete suite of geophysical logs without maintaining borehole full of fluid. • Generates investigation-derived wastes (IDW) as soil cuttings which will require proper management of storing, profiling, transportation and disposal to a permitted facility.
Direct Mud Rotary	Rotating bit breaks formation; cuttings are brought to the surface by circulation drilling fluid (mud). Mud is pumped down the interior of the drill pipe out the bit, and up the annulus between the drill stem and borehole wall. Cuttings	150+	• Drilling is rapid in all types of geologic materials, unconsolidated and consolidated • Borehole remains stable by keeping it full of fluid and from formation of a mud cake on borehole walls • Geologic cores can be collected • A complete suite of geophysical logs can be obtained in the open borehole	• More expensive than HSA, requires experienced driller and more support equipment than HSA; surface conductor casing generally required. • Drilling fluids mix with formation water, may infiltrate formation and can be difficult to remove. • Geological logging by visual inspection is only fair, can miss fine-grained strata and composition. • Location of water-bearing zones during drilling may be difficult to detect without borehole geophysics.

Mud Rotary (cont'd)	are separated from the drilling fluid over oscillating screens and circulated back down the drill pipe.		• Smaller rigs can reach most drilling sites	• Drilling fluid circulation can be lost or difficult to maintain in gravel, • Difficult drilling in framework-supported (little fine-grained aquifer matrix) boulder and cobble zones due to circulation issues. • Circulation of drilling mud through a contaminated zone can create a hazard at ground surface and cross-contaminate clean zones without proper drilling fluid management • Organic drilling fluids can interfere with bacterial and/or organic-related analyses and are not allowed; • Generates IDW as soil cuttings and mud which will require proper management of storing, profiling, transportation and disposal to a permitted facility. The mud rotary method typically generates 30-40% more IDW than the HSA.

3.0 Discussion and Recommendation

In most instances, subsurface geology and hydrogeology are the most important factors in determining the appropriate drilling method. The choice of drilling method should be based on expected performance when geologic and hydrogeological conditions, contaminant type and presence, and the nature and scope of the investigation are considered.

Geologic and hydrogeological conditions at AMCO affecting the choice of methods include:

- Material Cohesiveness: When drilling through cohesive material, an open borehole can often be maintained and a well can be installed directly. However, when penetrating formations prone to slough or collapse, the drilling method must be able to maintain borehole stability.

- Heaving Sands: Some equipment may be limited in its ability to drill below the water table, particularly in loose granular soils. With some methods, sand or gravel can flow into the borehole, making sample retrieval and well installation difficult and less precise.

Due to the presence of the heaving sands at the Site, use of the HSA method is problematic when the desired sampling or well installation depth is greater than 25 feet bgs. As differential pressures within the auger column and formation are increased by the retrieval of sampling equipment, water and sediments rise inside the auger column. As a result, the "plug" of sediment inside the hollow auger interferes with the collection of formation samples, the installation of the monitoring well, or even additional drilling. An important factor to consider during the installation of monitoring wells is the integrity of open borehole walls which allows for placement of well casings and screens free of interferences and construction of a continuous filter pack and seal within the annular space. Installing wells while borehole walls are collapsing will result in improper construction and functionality of a well. Also, the design of extraction wells requires a larger borehole diameter than those normally constructed for monitoring wells. A larger diameter hole will likely increase the instability of the borehole walls resulting in borehole collapse at this Site.

Past lessons learned at this Site indicate that the HSA drilling method is problematic when attempting to collect soil samples and install monitoring wells at depths where heaving conditions occur. An open borehole can be maintained if the mud rotary drilling method is employed because the borehole is constantly filled with a fluid that is dense enough to equalize subsurface hydrostatic formation pressures, Appropriate, pre-construction borehole fluid management will result in relatively normal well construction and development.

Drilling costs are also taken into consideration when selecting the most suitable drilling method. Costs of mud rotary drilling are generally slightly higher than the HSA method due to drilling fluid management costs. Even though the costs for mud rotary drilling are typically slightly higher than HSA, this is likely not the case for this Site. The potential problems and associated added field time using the HSA method in formations containing heaving sands, and past experience at this site installing 6-inch diameter wells, will very likely cause field delays, added time for well installation, and even the potential to compromise the usability of the resulting well.

Based on these issues and considerations, the direct mud rotary drilling method is considered to be more cost-effective drilling method at this Site by mitigating difficulties with heaving sands and facilitating proper well installation.

4.0 Limitations

The limited objective of this report, the ongoing nature of the project, and the evolving knowledge of site conditions and chemical effects on the environment and human health all must be considered when evaluating the report because subsequent facts may become known that may make this document premature or inaccurate.

This report has been prepared by ITSI, under the review of registered professionals. The conclusions and recommendations in this report are based upon ITSI's data evaluation. The interpretation of the data and the conclusions drawn were governed by ITSI's experience and professional judgment.

Kent Baugh, Ph.D., P.E. # C28941 Project Manager/Senior Engineer	Peter J. Phillips, C57 # 513877 Senior Geologist

ATTACHMENT 3

FIELD FORMS

Project _____

Project Number _____

Location _____

Surface Elevation _____

Logged By _____

Date Drilled _____

Total Depth _____

Boring Diameter _____

Drillers _____

Method _____

Boring No. _____

Sheet _____ Of _____

Boring Location Sketch

N

Depth (Feet)	Sample Interval	Blow Counts	PID (ppm) B-zone/stem/sample	Water Level	Well Construction	Lithology / USCS	DESCRIPTION
5							
10							
15							
20							
25							
30							

Casing Diameter _____ Casing Length _____ From _____ To _____

Screen Size _____ Screen Length _____ From _____ To _____

Sand Type _____ From _____ To _____

Bentonite Type _____ From _____ To _____

Cement/Grout _____ From _____ To _____

Surface Completion _____

ITSI Innovative Technical Solutions, Inc.
A Gilbane Company

Sampling Method (SMCODE)	Description
AC	Air Canister
AL	Air-Lift Sampler
AP	Air Lift Pump
AS	Ashing
AT	Sampling Train
AV	Sparge and Vent Pre-Treatment Collection Port
B	Bailer
BL	Undisturbed Bulk Sample
BP	Gas Operated Bladder Pump
BR	Brass (California) Ring
C	Continuous Flight Auger
CC	Core Sampler
CF	Flow Weighted Composite
CH	Charcoal Sampling Tube
CL	Clover Leaf Dredge Sampler
CN	Cone Penetrometer
CP	Centrifugal Pump
CR	Cutting Returns
CS	Composite Sample
CT	Time Weighted Composite
CU	Cryogenic Preconcentrator Tube
CY	Cyclone Method of Sampling Drill Cuttings
D	Disturbed Bulk Sample
DF	DIFFUSIVE SAMPLER
DS	Dredge Sampler (Brass, Etc.)
DT	Driven Tube
E1	Electrical Submersible Pump (Pre-1982)
E2	Electrical Submersible Pump (1982+)
EC	ENCORE SOIL SAMPLER
EK	Eckman Dredge Sampler
ES	Environmentalist's Subsoil Probe
FC	Cassette Filter
G	Grab
GB	Geoprobe
GD	Electrical Submersible Pump (Gear-Driven)
GP	Gas-operated, double acting Piston Pump
H	Hollow Stem Auger
HA	Hand Auger
HB	Hand Bucket Auger
HC	Hammer - AMS Core Sampler
HP	Hydropunch
HR	Electrical Submersible Pump (Helical Rotor)

Sampling Method (SMCODE)	Description
HS	Hand Core Sampler - Shallow Water Usage
HU	High-Volume Air Sampler with Puf Resin
HV	High Volume Air Sampler
HX	High-Volume Air Sampler with XAD Resin
HY	HYDRASLEEVE
KS	Kemmerer Sampler
LF	LOW-FLOW (SLOW PURGE) GROUNDWATER PUMPING
LV	Low Volume Continuous Air Sampler
LY	Lysimeter
MT	EMFLUX CARTRIDGE, TENAX MEDIA, PASSIVE SOIL/GAS SAMPLING
NA	Not Applicable
NB	NISKIN BOTTLE
NC	Nickel Coated Brass Bomb Sampler
NQ	NQ Wireline Rock Coring/ASTM-D2113
NS	Non-Submersible Pump
NX	NX Rock Coring/ASTM-D2113
PI	Piston Pump
PN	PONAR
PP	Peristaltic Pump
PR	Stainless Steel Soil Gas Probe with a Retractable Inlet Sleeve, Active Process.
PS	Passive Soil Gas Sampling Probe
RS	Hollow Glass Sampling Rod
S	Drive Sample - 2 inch/ASTM-D1586
SA	Summa Passivated Air Canister
SC	Scraped From Exposed Surface
SD	DEPTH INTEGRATING SEDIMENT SAMPLER
SI	Simulprobe
SL	Suction Lift Pump
SP	Submersible Pump
SS	Split Spoon
ST	Submersible Turbine Pump
SV	SVE Air permeability system, utilizing stainless steel soil gas sampling canisters
SY	Syringe
T	Shelby Tube/ASTM-D1587
TP	Tubing for Groundwater Sampling (e.g. Polyethylene Tubing)
TS	Thief Sampler and/or Thief Type Sampler
U	Tube Sampler - 3 inch/ASTM-D3550
VF	Emission isolation flux chamber, utilizing stainless steel soil gas canisters
VS	Van Dorn Sampler
W	Swab Or Wipe
WD	DEPTH SPECIFIC GROUNDWATER SAMPLER
WF	Wellhead Faucet (Grab Sample From)

CMCCODE	Name
AH	Air Rotary Casing Hammer
P	Air-Percussion
AR	Air-Rotary
AM	Air-Rotary, Mud Rotary
AW	Air-Rotary, Water Rotary
B	Bored or Augered
C	Cable-Tool
CS	Chilled Shot
CP	Cone Penetrometer
CO	Coring
MR	Direct Circulation Rotary, Mud
WR	Direct Circulation Rotary, Wash
DH	Down the Hole Hammer
W	Drive and Wash
V	Driven
DR	Dual Rotary
DT	Dual Tube Air
D	Dug
GP	Geoprobe
HA	Hand Augered
HI	Historical (Not an AFCEE Valid Value)
HS	Hollow Stem Auger
HP	Hydropunch
J	Jetted
NA	Not Applicable; Not a Bore Hole, Well, Test
Pit	
Z	Other
PJ	Pneumatic Jack Hammer
RA	Reverse Circulation Rotary, Air
RM	Reverse Circulation Rotary, Mud
RW	Reverse Circulation Rotary, Water
R	Rotary Wash
RD	Rotosonic Drill
SS	Solid Stem Auger
SN	Sonication
SP	Strataprobe
T	Trenching (Backhoe, etc.)

General Chemistry

ALK	Alkalinity	Cl	Chloride
BOD	Biochemical Oxygen Demand	ClO4	Perchlorate
COD	Chemical Oxygen Demand	F	Fluoride
DOC	Dissolved Organic Carbon	H2	Hydrogen
Moi	Moisture	NH3	Ammonia
pH	pH	NO2	Nitrite
TDS	Total Dissolved Solids	NO3	Nitrate
TKN	Total Kjeldahl Nitrogen	OPO4	Orthophosphate
TOC	Total Organic Carbon	SO3	Sulfite
TSS	Total Suspended Solids	SO4	Sulfate

Innovative Technical Solutions, Inc.
A Gilbane Company

Sample Collection Log

PROJECT:
PROJECT NO.:
SITE LOCATION:
Date:

Sample ID	Sample Date	Time Sampled	Sample Beginning Depth	Sample Ending Depth	Construction Method Code	Sample Method Code	NAD83 UTM	Sampled By	SAMPLE DESCRIPTION / ANALYSIS	FINAL SAMPLE DISPOSITION

TOTAL SAMPLES :

SAMPLER(S) SIGNATURE(S)

APPENDIX B

AIR MONITORING PLAN

Technical Memorandum

To:	Ms. Rose Marie Caraway, US EPA RPM
From:	Mr. Kent Baugh, ITSI/Walnut Creek and Yash Nyznyk/CDM
Date:	November 3, 2011
Subject:	**Air Monitoring During Soil Characterization Field Activities at the Source Area, AMCO Chemical Superfund Site, Oakland, California**
Contract/TO:	EP-S9-08-03/ TO 0018 **ITSI DCN:** 07163.0019.0067

1.0 INTRODUCTION

This Technical Memorandum (TM) was prepared to establish field measurement and air monitoring practices that will be performed to evaluate potential air quality impacts during the drilling and soil sampling activities in the source area as part of the Soil Characterization at the AMCO Chemical Superfund site (Site). This expanded air monitoring is being conducted in response to questions and concerns relative to possible impacts to nearby residents that were raised at the October 17, 2011 Community Advisory Group meeting. Due to subsurface, volatile organic compound (VOC) levels at the source area of the Site, action levels as described in Section 3.1.1 of the Work Plan (ITSI, 2011b) for the soil characterization and the site-specific Health and Safety Plan (ITSI, 2011a) have been established that would trigger an upgrade in personal protective equipment (PPE) to Level C for field personnel performing the drilling and sampling. Level C PPE includes air purifying respirators.

ITSI is conducting the air monitoring as part of the soil characterization remedial investigation activities for the EPA under Remedial Action Contract (RAC) number EP-S9-08-03, Task Order 0018. Air monitoring, including sampling and analysis, will be performed prior to and during the soil characterization activity in the source area. The air monitoring will be performed consistent with the procedures and methods described in the *Field Sampling Analysis Plan for Testing and Analysis of Vapor Intrusion* (ITSI, 2009) and the site-specific health and safety plan (ITSI, 2011a). Details of field activities for the soil characterization are described in the Work Plan (ITSI, 2011b).

1.1 *Background Information on VOC Emissions during Drilling*

The source area is the portion of the Site in the vicinity of monitoring wells MW-13 and MW-14. Present in these two wells is free product in the form of non-aqueous phase liquid (NAPL). Elevated contaminant concentrations, notably VOCs, are present in the subsurface at the source area. Additional air monitoring will be performed while drilling and collecting soil samples in the source area to address the concerns of residents in the vicinity of the Site with regard to possible exposure to VOCs. As stated above, action levels for VOCs have been established that will

trigger PPE upgrades to Level C for field personnel, as well as stop field activities until engineering controls can be implemented to control VOC emissions (ITSI, 2011a and ITSI, 2011b). Workers performing the drilling and sampling have a potential for exposure from VOCs, and that is the reason for the action levels. Previous drilling and/or sampling in the source area have not resulted in any known health threats to nearby residents. During prior drilling in the source area to install monitoring well RMW-02-13, the following details were noted on the soil boring log (CH2M-Hill, 2011):

- No PID (photo-ionization detector) detections in breathing zone, or perimeter.
- Maximum of 8.6 ppm (PID reading) in the drill casing.

In addition, when a soil sample from RMW-02-13 and collected at a depth of 5 feet was allowed to equilibrate in a zipped, plastic bag, a PID reading of 465 ppm was reported for VOCs in the bag's headspace (CH2M-Hill, 2011). The PID readings in the breathing zone (above) are significant because PID readings for soil collected from within the borehole were elevated. The above field data show that elevated VOC levels in the subsurface did not result in VOC levels in the air that would impact workers or nearby residents.

1.2 *Objectives*

The objectives of the air monitoring activities described in this TM are to:

- Quantify VOC levels resulting from the soil characterization in the source area at both the drilling location and the Site's perimeter.
- Assess potential residential exposure based on the results from this air monitoring.

2.0 Air Monitoring and Sampling Design

VOC emissions can occur from intrusive activities, such as drilling and soil sampling, if VOC contamination is present in the subsurface. Previous field activities and associated air monitoring have shown that the source area is the portion of the Site with elevated VOC concentrations in the subsurface. In locations without elevated subsurface VOC contamination, VOC emissions from drilling have not been detected or very low levels based on PID readings (CH2M-Hill, 2011). At locations without elevated VOC concentrations in the subsurface, field personnel will not need air purifying respirators.

Table 1 provides the locations and other details for the air samples that will be collected and analyzed to evaluate potential air quality impacts from drilling activities at the source area. The air quality sampling design is described below.

- Sample ambient air at the Site prior to the start of drilling activities at the source area. The ambient air quality data will provide background conditions which will establish the baseline for the evaluation. Ambient air sampling will occur at four locations: (1) the fence line dividing the Site from the nearest residence located at 1428 3rd Street, (2) the

source area (near MW-14), (3) the Large Vacant Lot at the northern fence adjacent to 356 Center Street, and (4) adjacent to the playground area at the eastern end of Prescott Park.

- Sample air during active drilling in the source area. Air samples will be collected at: (1) the fence adjacent to the property located at 1428 3rd Street, (2) the source area near the boring where drilling is occurring, (3) approximately ten feet west of the drilling location and between the drill rig and the fence line sampling location, (4) the Large Vacant Lot at the northern fence adjacent to 356 Center Street, and (5) adjacent to the playground area at the eastern end of Prescott Park. The air sampling locations at the fence adjacent to 1428 3rd Street, the Large Vacant Lot, and Prescott Park will be the same as for the ambient air sampling.
- In addition to collecting air samples during active drilling operations, air monitoring in real-time will be conducted using a PID. PID readings will be collected on a regular frequency (hourly at a minimum). The locations that will have PID readings performed are: the three selected air sampling locations within the AMCO yard, at the fence adjacent to the property at 320 Center Street, and at the fence adjacent to the lot (349 Mandela Parkway) with EPA's lead stabilization trailer.

Field forms for the air sampling are included in Attachment 1.

2.1 *Ambient (Background) Air Sampling*

Ambient air will be evaluated to reflect daylight background conditions at the Site as drilling activities will occur during daylight hours. Air will be continuously sampled using 6-Liter Summa canisters with flow controllers set for a collection period of 12 hours. The Summa canisters in Prescott Park will be secured to a tree, and at other locations the canisters will be set on a drum or ground surface depending on the sampling location. Ambient air sampling will occur for three consecutive days during the work week, with the daily sampling start time being between 7:00 and 7:30 AM and end time between 5:00 and 5:30 PM. Ambient air sampling will occur when no intrusive activities are happening at the portions of the Site with elevated VOC concentrations.

2.2 *Air Sampling During Drilling within the Source Area*

Air quality will be evaluated while drilling in the source area. Air sampling locations were previously described at the beginning of Section 2.0. Air will be continuously sampled using 6-Liter Summa canisters with flow controllers set for a collection period of 12 hours. Measurement of air quality using a PID will also be performed in conjunction with the air sampling. The air monitoring will include readings at the Summa canisters, at the Site workers' breathing zone, at the fence adjacent to the property at 320 CenterStreet, and the fence adjacent to the lot (349 Mandela Parkway) with EPA's lead stabilization trailer. The air quality sampling and monitoring will occur for three consecutive days while drilling in the source area, with daily sampling/monitoring starting between 7:00 and 7:30 AM and ending between 5:00 and 5:30 PM. PID readings will be evaluated to assess the need for continuing the expanded air monitoring after the initial week of drilling in the source area.

2.3 *Laboratory Analysis*

Summa canisters will be processed and delivered under chain-of-custody control to a California certified commercial laboratory. All air samples, including trip blanks, collected in the Summa canisters will be analyzed for volatile organic compounds (VOCs) by method TO-15.

2.4 *Quality Assurance and Quality Control*

Duplicate air samples and trip blanks will be submitted for analysis for QA/QC purposes. One duplicate sample will be collected during the ambient air sampling, and two duplicate samples will be collected during air sampling while drilling at the source area. The locations selected for collecting duplicate samples are identified in Table 1. Summa canisters will be delivered to the analytical laboratory, and a trip blank will accompany the samples during each shipment.

3.0 Reporting

Results from the performance of this Air Monitoring Plan will be presented in a technical memorandum that will include completed field forms, tabulation of field PID, and other results fromr the air sampling. The evaluation of readings and VOC concentrations, and an evaluation of analytical results. VOC concentrations the air samples from the s-Summa canisters will be compared to (1) background levels and (2) EPA's regional screening levels.

4.0 References

CH2M-Hill, 2011. *Remedial Investigation Final Report, AMCO Chemical Superfund Site, 1414 3rd Street, Oakland, California*. January

Innovative Technical Solutions, Inc. (ITSI), 2009. *Field Sampling and Analysis Plan for Testing and Analysis of Vapor Intrusion, AMCO Chemical Superfund Site*. June 2009.

ITSI, 2010. *June 2010 Addendum to the Remedial Investigation Sampling and Analysis Plan, AMCO Chemical Superfund Site*. June 6.

ITSI, 2011a. *Site-Specific Health and Safety Plan, Remedial and Pre-Design Investigations, AMCO Chemical Superfund Site*. August

ITSI, 2011b. *Work Plan Soil Characterization, AMCO Chemical Superfund Site, 1414 3rd Street, Oakland, California*. October.

LIST OF TABLES

Table 1 Air Sampling Locations and Rationale

LIST OF ATTACHMENTS

Attachment 1 Field Forms

- Air Monitoring Log

- Summa Canister Sampling Log
- Chain-of-Custody form for Air Sampling

LIST OF ABBREVIATIONS

DCN	document control number
EPA	US Environmental Protection Agency
ITSI	Innovative Technical Solutions, Inc.
NAPL	non-aqueous phase liquid
PID	photo-ionization detector
PPE	personal protective equipment
RAC	Remedial Action Contract
Site	Former AMCO Chemical Facility and Adjacent Properties
TM	Technical Memorandum
TO	Task Order
VOC	volatile organic compound

TABLE

Table 1
Air Sampling Locations and Rationale
AMCO Superfund Site, Oakland, California

Sample ID	Schedule	Sampling Location	Number of samples	Sampling Method and Analysis	Rationale
Pre-Drilling Week					
AA01-DDMMYY	Day 1 of the week before drilling starts	Site perimeter fence line adjacent to 1428 Third Street	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess ambient air quality at Site perimeter.
AA01D-DDMMYY (Duplicate)	Day 1 of the week before drilling starts	Site perimeter fence line adjacent to 1428 Third Street	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Quality Control Sample
AA01-DDMMYY	Day 2 of the week before drilling starts	Site perimeter fence line adjacent to 1428 Third Street	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess ambient air quality at Site perimeter
AA01-DDMMYY	Day 3 of the week before drilling starts	Site perimeter fence line adjacent to 1428 Third Street	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess ambient air quality at Site perimeter
AA02-DDMMYY	Day 1 of the week before drilling starts	Source area (near MW-14)	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess ambient air quality at the source area.
AA02-DDMMYY	Day 2 of the week before drilling starts	Source area (near MW-14)	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess ambient air quality at the source area.
AA02-DDMMYY	Day 3 of the week before drilling starts	Source area (near MW-14)	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess ambient air quality at the source area.
LA01-DDMMYY	Day 1 of the week before drilling starts	Large Vacant Lot (at fence adjacent to 356 Center Street)	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess ambient air quality at Large Vacant Lot.

Table 1
Air Sampling Locations and Rationale
AMCO Superfund Site, Oakland, California

Sample ID	Schedule	Sampling Location	Number of samples	Sampling Method and Analysis	Rationale
LA01-DDMMYY	Day 2 of the week before drilling starts	Large Vacant Lot (at fence adjacent to 356 Center Street)	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess ambient air quality at Large Vacant Lot.
LA01-DDMMYY	Day 3 of the week before drilling starts	Large Vacant Lot (at fence adjacent to 356 Center Street)	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess ambient air quality at Large Vacant Lot.
PA01-DDMMYY	Day 1 of the week before drilling starts	Prescott Park (near playground area)	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess ambient air quality at Prescott Park.
PA01-DDMMYY	Day 2 of the week before drilling starts	Prescott Park (near playground area)	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess ambient air quality at Prescott Park.
PA01-DDMMYY	Day 3 of the week before drilling starts	Prescott Park (near playground area)	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess ambient air quality at Prescott Park.
Drilling Week					
AA01-DDMMYY	Day 1 of the week when drilling starts in source area	Site perimeter fence line adjacent to 1428 Third Street	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess air quality at Site perimeter during active drilling.
AA01-DDMMYY	Day 2 of the week when drilling starts in source area	Site perimeter fence line adjacent to 1428 Third Street	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess air quality at Site perimeter during active drilling..
AA01-DDMMYY	Day 3 of the week when drilling starts in source area	Site perimeter fence line adjacent to 1428 Third Street	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess air quality at Site perimeter during active drilling.

Table 1
Air Sampling Locations and Rationale
AMCO Superfund Site, Oakland, California

Sample ID	Schedule	Sampling Location	Number of samples	Sampling Method and Analysis	Rationale
AA01D-DDMMYY (Duplicate)	Day 3 of the week when drilling starts in source area	Site perimeter fence line adjacent to 1428 Third Street	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Quality Control Sample
AA02-DDMMYY	Day 1 of the week when drilling starts in source area	Source area drilling location	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess air quality at location of source area drilling.
AA02-DDMMYY	Day 2 of the week when drilling starts in source area	Source area drilling location	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess air quality at location of source area drilling.
AA02-DDMMYY	Day 3 of the week when drilling starts in source area	Source area drilling location	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO15	Assess air quality at location of source area drilling.
AA03-DDMMYY	Day 1 of the week when drilling starts in source area	Ten feet west of drilling location	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess air quality at a short distance from drilling location.
AA03D-DDMMYY (Duplicate)	Day 1 of the week when drilling starts in source area	Ten feet west of drilling location	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Quality Control sample
AA03-DDMMYY	Day 2 of the week when drilling starts in source area	Ten feet west of drilling location	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess air quality at a short distance from drilling location.
AA03-DDMMYY	Day 3 of the week when drilling starts in source area	Ten feet west of drilling location	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess air quality at a short distance from drilling location.

Table 1
Air Sampling Locations and Rationale
AMCO Superfund Site, Oakland, California

Sample ID	Schedule	Sampling Location	Number of samples	Sampling Method and Analysis	Rationale
LA01-DDMMYY	Day 1 of the week when drilling starts in source area	Large Vacant Lot (at fence adjacent to 356 Center Street)	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess air quality at Large Vacant Lot.
LA01-DDMMYY	Day 2 of the week when drilling starts in source area	Large Vacant Lot (at fence adjacent to 356 Center Street)	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess ambient air quality at Large Vacant Lot.
LA01-DDMMYY	Day 3 of the week when drilling starts in source area	Large Vacant Lot (at fence adjacent to 356 Center Street)	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess ambient air quality at Large Vacant Lot.
PA01-DDMMYY	Day 1 of the week when drilling starts in source area	Prescott Park (near playground area)	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess ambient air quality at Prescott Park.
PA01-DDMMYY	Day 2 of the week when drilling starts in source area	Prescott Park (near playground area)	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess ambient air quality at Prescott Park.
PA01-DDMMYY	Day 3 of the week when drilling starts in source area	Prescott Park (near playground area)	1	6-Liter Summa with 12-hour flow control valve. VOCs by TO-15	Assess ambient air quality at Prescott Park.

Explanation:
AA01-DDMMYY where DDMMYY is the day of sample collection
VOCs – Volatile Organic Compounds

ATTACHMENT 1

FIELD FORMS

AIR MONITORING LOG

Client Name _____ Date _____

Project No._____ Page _____ of _____

Logged by_____

Weather_____

Instrument Types_____

Calibration Standards Used_____

Time	Location	Instrument Readings, (Units)				PPE Used	Activities, Remarks

Air Toxics LTD.

CHAIN-OF-CUSTODY RECORD

Sample Transportation Notice
Relinquishing signature on this document indicates that sample is being shipped in compliance with all applicable local, State, Federal, national, and international laws, regulations and ordinances of any kind. Air Toxics Limited assumes no liability with respect to the collection, handling or shipping of these samples. Relinquishing signature also indicates agreement to hold harmless, defend, and indemnify Air Toxics Limited against any claim, demand, or action, of any kind, related to the collection, handling, or shipping of samples. D.O.T. Hotline (800) 467-4922

180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630-4719
(916) 985-1000 FAX (916) 985-1020

Project Manager _____

Collected by: (Print and Sign) _____

Company _____ Email _____

Address _____ City _____ State ____ Zip _____

Phone _____ Fax _____

Project Info:

P.O. #_____

Project # _____

Project Name_____

Turn Around Time:

❑ Normal

❑ Rush

_____ *specify*

Lab Use Only

Pressurized by: ____

Date: _____

Pressurization Gas:

N_2 He

Lab I.D.	Field Sample I.D. (Location)	Can #	Date of Collection	Time of Collection	Analyses Requested	Canister Pressure/Vacuum			
						Initial	Final	Receipt	Final (psi)

Relinquished by: (signature)	Date/Time	Received by: (signature)	Date/Time
Relinquished by: (signature)	Date/Time	Received by: (signature)	Date/Time
Relinquished by: (signature)	Date/Time	Received by: (signature)	Date/Time

Notes:

Lab Use Only

Shipper Name	Air Bill #	Temp (°C)	Condition	Custody Seals Intact?	Work Order #
				Yes No None	

SUMMA Canister Sampling Log

Location ID:	Date:
Project No.:	Project or Client:
Field Crew:	Location Address/Description:

Sampling System

Canister Serial No.:	Other Info:
Canister Certification Date:	
Canister Leak Check Date:	
Flow Controller Serial No.:	
Associated Duplicate Location ID (if applicable):	

Sampling Log

Parameter	Start	Stop
Local Time		
Label Dummy Time for Label		
Canister Pressure (in Hg)		
Ambient Temperature		
Flow Rate (mL/min)		

Observations and Comments:

Laboratory Analytical Method(s):

TO-15 SIM for VOCs + _____*

Sampler Signature:

* Add leak detection gas